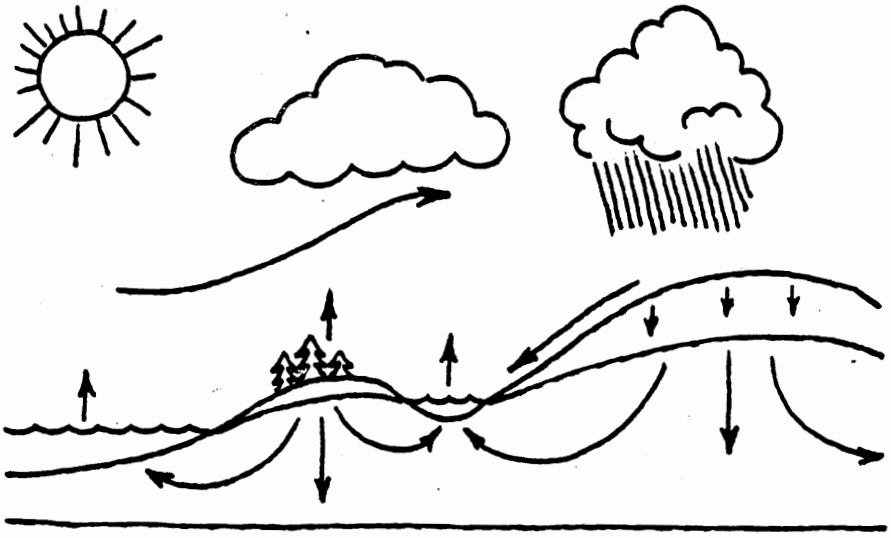
WATERSHED MANAGEMENT STRATEGIES

FOR NEW JERSEY



COOK COLLEGE
DEPT. OF ENVIRONMENTAL RESOURCES

NJ AGRICULTURAL EXPERIMENT STATION

THE STATE UNIVERSITY OF NEW JERSEY
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WATERSHED MANAGEMENT STRATEGIES FOR NEW JERSEY [1]

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INTRODUCTION

George H. Nieswand

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New Jersey residents obtain their drinking water through a complex system involving public and private purveyors and private wells. A major step forward in understanding the intricacies of this system was the completion of Statewide Water Supply Master Plan in April 1982 and its subsequent revisions. The plan underscored the importance of insuring sufficient water for the state's commercial, industrial, agricultural and residential needs and specifically noted that "a watershed...protection program is indispensible to the long run success of the water supply plan" and that "the continued availability of adequate and safe water supplies for future generations will require implementation and enforcement of sound land use policies" (Statewide Water Supply Master Plan, 1982:62).

In response to these concerns, a research team at Rutgers University was asked to investigate and make recommendations concerning appropriate watershed management strategies for the state. The team was to focus on the use of appropriate legal authorizations, institutional structures and educational programs to effect the adoption and implementation of technologically sound and politically feasible intervention strategies that would influence and impact actions and activities within a watershed in order to provide a first line of defense in assuring the sustained availability of safe drinking water and environmental quality of surface waters for the citizens of New Jersey. The directional goal for this effort was to be the reduction of the exposure of surface waters to polluting land uses, activities, treatments and spill incidents.

The focused efforts that produced this report were preceded by an extensive review of the existing body of literature on watershed management and current practices in New Jersey and other states. Of particular importance was the development of an understanding of the New Jersey context that establishes the need for effective watershed management strategies for the state (Chavooshian et al, 1987).

The Need for Effective Watershed Management Strategies

In the last century as major Eastern cities outgrew local water supply sources, they were forced to acquire watersheds in relatively undeveloped valleys and then to transport the water to the urban areas. Boston relies on Quabbin Reservoir; New York City depends on a vast reservoir system in the Catskill Mountains; Newark uses the Pequannock Watershed. The water from these sources is relatively pristine. The watersheds are distant from urban centers, and the cities involved own virtually all of the land surrounding their reservoirs. Because the cities control access to most of these watersheds, it is relatively easy to maintain the physical, chemical and biological integrity of their water.

In New Jersey, as a whole, the situation is far more complex. Most of the watershed lands that serve as catchment areas for surface water supplies in the state are in private ownership, and with few exceptions, the regulation of land use in these watersheds is under municipal control. At the same time, source protection continues to be recognized as essential in maintaining the environmental quality of the state's surface waters and in complementing water treatment in insuring the deliverability of safe drinking water.

New Jersey is a small state with a large and growing population. According to projections prepared for the New Jersey State Planning Commission an

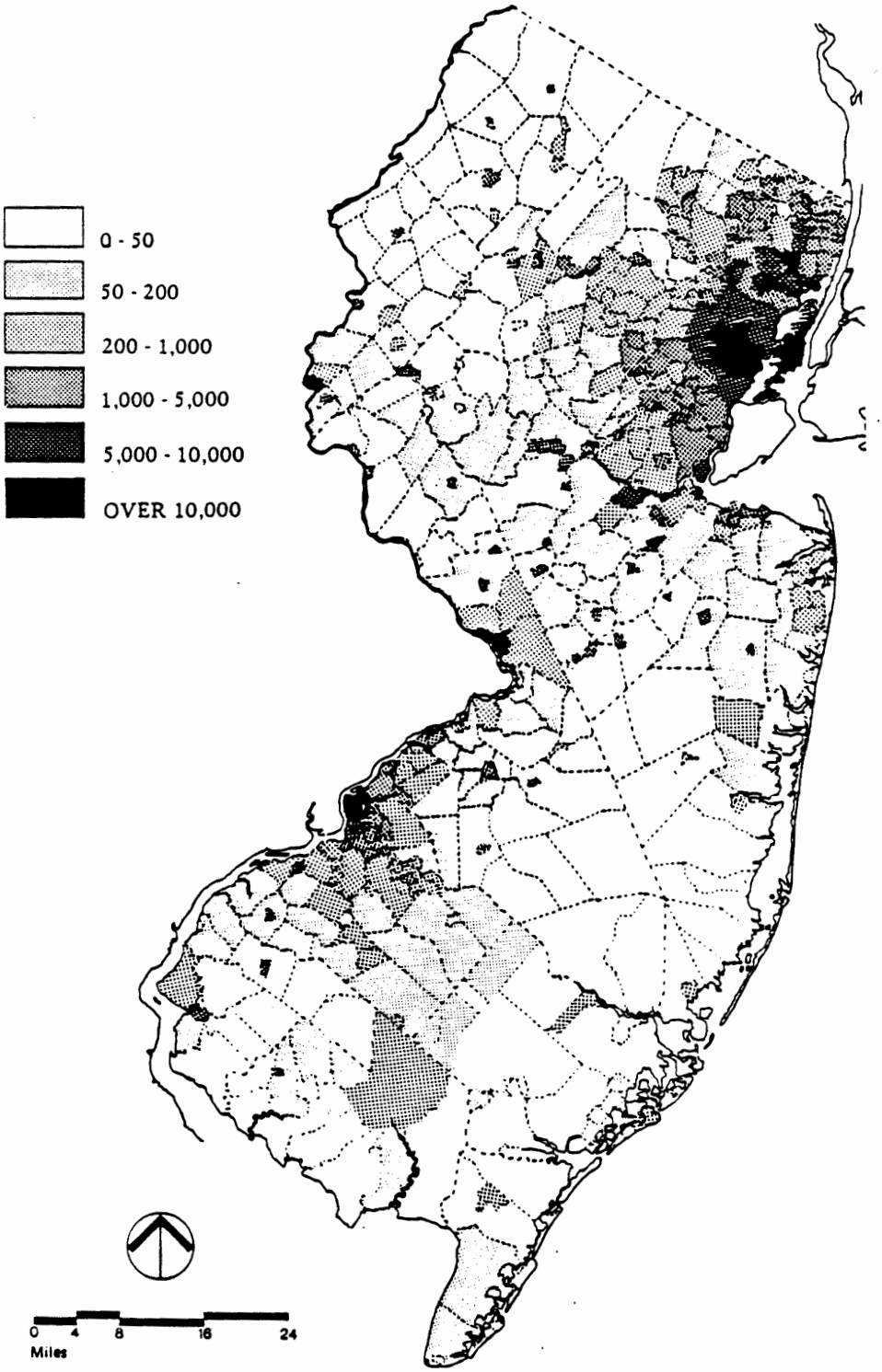
additional 1.3 million residents will be added to the state's current 7.6 million population in the next 30 years. Although New Jersey's population is growing, the state's largest cities are losing population. Population growth is taking place where the countryside meets the radial arms of urbanization flowing out from the northeastern counties, and the Philadelphia/Camden complex. This growth is creating a remarkable transformation of the Garden State. At one time this growth pattern would have been called suburban, but in the 1980s the character of the suburbs has been transformed. Currently, 80% of the state's urbanized population is suburban and 84% of the work force finds employment in suburbia (Sternlieb and Schwartz, 1986). In an earlier era population growth was largely confined to cities. The diffuse pattern of growth today consumes proportionately greater amounts of land per person. Consequently, the projected increase in population will result in substantially greater land alteration than would have been the case even a decade or so ago.

New Jersey's growth has been largely focused in areas near major highways. In particular, growth has taken place along I-287 and along the corridor formed by Route 1 and the New Jersey Turnpike. As can be seen from the accompanying maps, (Figures 1.1 and 1.2), population density has increased largely with the emerging metropolitan complex (metroplex) of northern New Jersey, the Route 1 Corridor, and near Philadelphia. An additional wave of growth can be expected along Interstate Highways 78 and 80.

Metroplex poses a challenge for watershed management. Considering the recent history of land use changes in the state, expectations for continuing growth and development, and the inherent implications for the state's watersheds and surface waters, effective watershed management strategies are an imperative for New Jersey.

FIGURE 1.1

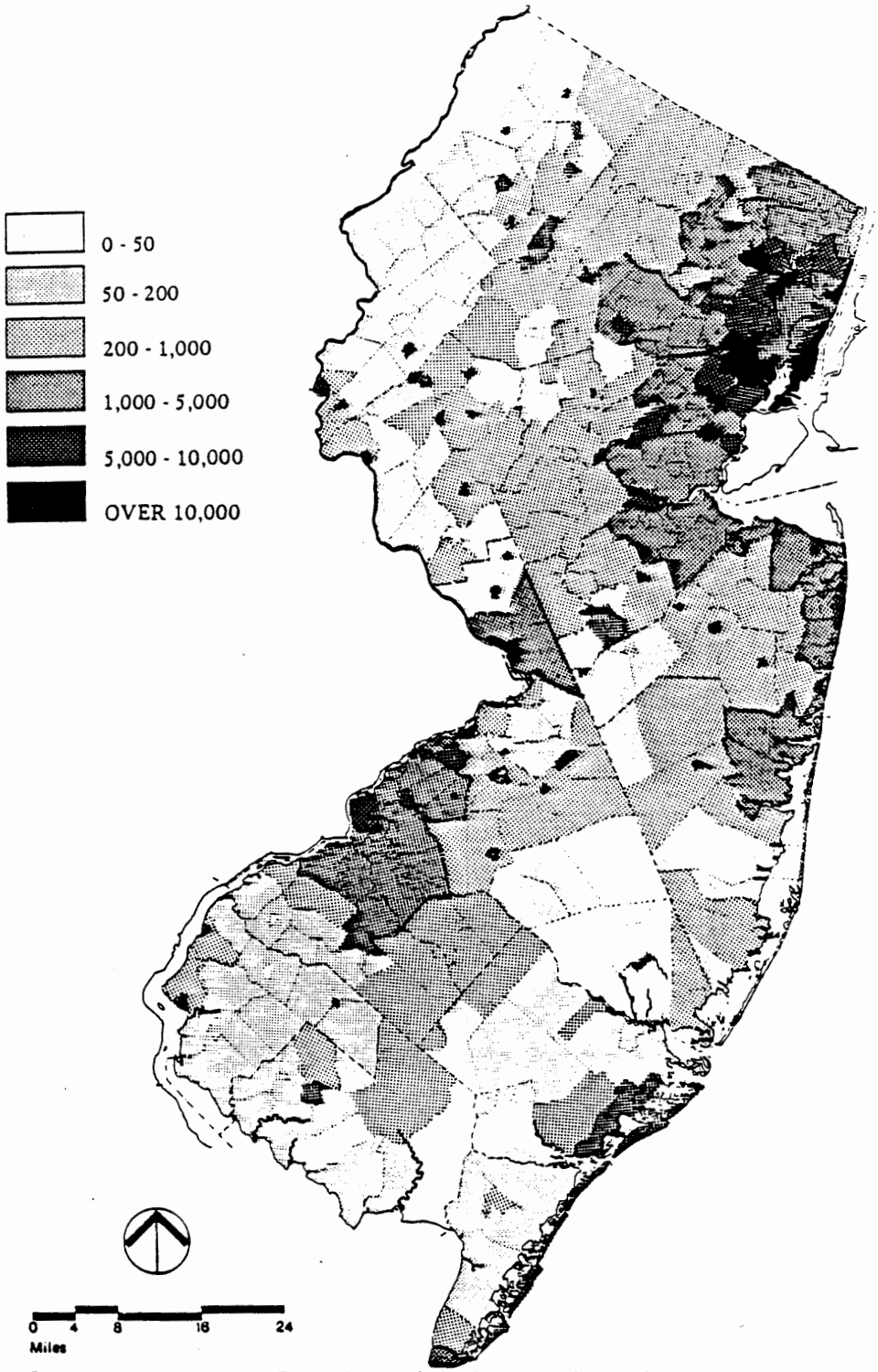
Population Density per Square Mile 1940



Source: New Jersey State Planning Commission, 1987.

FIGURE 1.2

Population Density per Square Mile 1985



Source: New Jersey State Planning Commission, 1987.

About This Report

As was previously indicated, the focused efforts that produced this report were preceded by an extensive review of the existing body of literature on watershed management and practices in New Jersey and other states. Based on this review and an understanding of the New Jersey context that establishes the imperative for the development of effective watershed management strategies for the state, it was decided to concentrate on a selected number of technical issues that were identified as representing key intervention opportunities having the potential for substantial positive impact in protecting surface waters from nonpoint sources of pollution.

The study team organized its efforts around eight subject matter chapters:

- Watershed Management Activities in Other States
- Water Supply/Water Quality Sensitive Lands
- Best Management Practices for Watershed Management
- Buffer Strips in Watershed Management
- Dual-Purpose Detention Basins in Watershed Management
- Stormwater Management Districts as a Watershed Management Strategy
- Onsite Wastewater Management Entities as a Watershed Management Strategy
- Public Education and Participation for Watershed Management

Individual members of the project team were assigned primary responsibility for producing the various chapters as indicated by the authorship associated with each. It should be noted, however, that the recommendations presented at the end of each chapter were thoroughly reviewed and discussed by all of the members of the project team, and as such, they are offered as consensus recommendations from the team.

The general format of each of the chapters that follows is basically the same, consisting of an introduction to the purpose and scope of the chapter, a presentation of definitions as deemed necessary, a review and discussion of

technical background and experience, a summary of findings and presentation of specific recommendations, and a selected bibliography containing items judged to be among the most useful targeted reference documents.

Chapter 2 presents the results of a national survey of "Watershed Management Activities in Other States." This chapter reviews the findings of the national survey, summarizes three top-rated state programs (Wisconsin, Florida and Maryland) focusing on those aspects that merit consideration in New Jersey, and concludes with recommendations for effective watershed management in New Jersey. The focus of these recommendations is program structure and management, rather than the technical issues that are addressed in other chapters.

Chapter 3 examines the nature of "Water Supply/Water Quality Sensitive Lands" and suggest a natural hierarchy for such lands that can be arranged in a generalized descending order of importance relative to the goal of protecting surface waters from potential nonpoint source contamination. The recommendations contained in this chapter include a specific proposal for ranking water supply/water quality sensitive lands.

Chapter 4 presents a discussion of "Best Management Practices for Watershed Management." Both urban/suburban and agricultural best management practices (BMPs) are included. The discussion of urban/suburban BMPs focuses on those practices that can be adopted by communities to reduce the impacts of urbanization on surface water quality. The section on agricultural BMPs focuses on the reduction of sediment loading, which is considered to be the greatest single pollutant in U.S. surface waters and the major problem associated with uncontrolled agricultural runoff. Specific recommendations on the adoption of urban/suburban and agricultural BMPs are included in this chapter.

Chapter 5 investigates the use of "Buffer Strips in Watershed Management." An extensive review of the technical considerations that govern the use of buffer strips for a variety of watershed management purposes is presented. Buffers for sediment control, streambank and streambed erosion control, nutrient and pollutant removal, and reservoir protection, all of which are directly associated with the reduction of pollutant exposure to surface waters, are discussed, as well as buffers for temperature control, aquatic species food source, and wildlife habitat, which are more directly associated with fish, wildlife and open space concerns. A summary of buffer width considerations for these various purposes is included along with specific recommendations for the use of buffer strips in watershed management.

Chapter 6 examines the role of "Dual-Purpose Detention Basins in Watershed Management." The advantages and disadvantages of dual-purpose detention basins are summarized, and questions concerning performance characteristics, design criteria, and maintenance requirements are reviewed. Dual-purpose detention basins are shown to provide a highly effective solution to trapping nonpoint source pollutants, and it is recommended that they be pursued as an integral component of a comprehensive watershed management program.

Chapter 7 looks at the use of "Stormwater Management Districts as a Watershed Management Strategy." The chapter reviews the institutional arrangements that have been tried in other states to provide for effective stormwater management and suggests that a utility would appear to be an excellent approach for providing a stable source of funds for maintaining a stormwater management system. Recommendations consistent with this suggestion are included.

Chapter 8 explores the use of "Onsite Wastewater Management Entities as a

Watershed Management Strategy." The importance of managing onsite and small community wastewater disposal systems as an essential component of an overall watershed protection strategy is stressed, and the use of onsite wastewater management entities that provide technical assistance together with strong regulation and enforcement is recommended. Institutional options for designating such entities are discussed along with a review of proposed and operating onsite wastewater management entities in the U.S. Specific recommendations concerning the implementation of onsite wastewater management entities are provided.

Chapter 9 focuses on the role of "Public Education and Participation for Watershed Management." Elements that contribute to an effective public education/participation strategy are presented and discussed as essential components of any comprehensive watershed management program. Included in this chapter is a review of seven ongoing, watershed-based, nonpoint source pollution outreach programs, three of which are New Jersey based. Specific recommendations regarding the implementation of effective public education/participation programs are provided.

The report concludes with a summary of the findings and recommendations contained in the individual chapters.

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WATERSHED MANAGEMENT ACTIVITIES IN OTHER STATES

Peter J. Pizor

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I. Introduction

Watershed management is a policy of managing activities on watershed lands in order to reduce the exposure of surface waters to polluting land uses, activities, treatments, and spill incidents. This concept of watershed management is supported by the nonpoint source pollution program authorized by various sections of the Federal Water Pollution Control Act and its amendments, especially Section 208 of P.L. 92-500, and by Section 319 of P.L. 99-1004. These acts delegated primary responsibility to the various states, and they in turn created areawide management agencies. Federal support for watershed management was greatest during the "environmental" decade of the 1970s. Federal expenditures exceeded $500 million between 1973 and 1981 (Bureau of National Affairs, Current Developments, 1986. Environmental Reporter, November 14, 1986: 1164).

Lee M. Thomas (1985), Administrator of the Environmental Protection Agency, citing an EPA report to Congress, states that "lakes, reservoirs, and estuaries...are particularly vulnerable to nonpoint contamination." On a national basis, he identified agricultural operations as the largest single contributor to nonpoint source pollution followed by pollutants from urban areas, mining, silviculture, and construction sites.

Watershed management policy is not a federal responsibility even though the federal government does provide some funding and general directions. States are

responsible for program design and implementation, and their responsibility will continue to grow. According to Thomas, "States must take the lead in managing nonpoint sources because they have the adaptability, perspective, and intimate knowledge to develop such site-specific solutions." Although watershed management is far broader than nonpoint source pollution management, most policy and innovation occur at the state level.

Chavooshian et al, (1987) reviewed the literature and identified 51 federal agencies and hundreds of local agencies charged with some portion of watershed management. That report uncovered no systematic reviews of state efforts. This study attempts to fill that gap by identifying leading state watershed management programs. A questionnaire was mailed to professionals in each state asking about watershed management policies. Survey respondents listed the states they felt had the best watershed management programs, and the top three states were selected for more intensive analysis. This chapter reviews the findings of the national survey, summarizes the three top-rated state programs, and concludes with recommendations for effective watershed management in New Jersey. The focus is program structure and management. Technical issues are treated in other chapters.

II. A National Survey

Methodology

Watershed management efforts vary greatly among the states. The most complete analysis of nonpoint source pollution in the 50 states is **America's Clean Water: The States' Nonpoint Source Assessment** prepared by the Association of State and Interstate Water Pollution Control Administrators (ASIWPCA). The ASIWPCA report detailed nonpoint source pollution problems,

but did not deal with watershed management programs. To remedy that deficit a national survey was conducted for the purposes of this chapter. The survey was sent to four professionals in each of the states. Because of the thoroughness of the ASIWPCA study, the president of each state's ASIWPCA chapter received a survey. In addition copies were sent to the director of each state's water resources institute, the director of the state agricultural experiment station, and the ranking water quality official in the state environmental department. The universe consisted of 200 individuals, of whom 14 were eliminated due to duplication or invalid addresses. Sixty-five percent of the respondents, representing every state except Vermont, returned questionnaires, yielding 121 surveys for analysis.

Findings

Sixty percent of the respondents replied that their state had a watershed management program. Programs were identified at all levels of government, but more were listed at the state level than at any other governmental level as shown in Table 2.1. Federal programs accounted for less than a quarter of all reported programs.

Respondents reported using a large variety of watershed management techniques. As indicated in Table 2.2, educational programs were the most common, with a total of 162 mentions. Special land use regulations were cited by 148 respondents, followed by buffers (140), critical area designations (120), and watershed management agencies (102). Watershed zoning, which makes use of what is presumably the nation's most widespread land use control technique, received only 7% of the mentions placing lower than all categories except "watershed patrols," and "other."

Table 2.1 Question: If your state has a watershed management program(s), please indicate the level(s) at which it is administered.

Program Level	No. of Responses	Percent
Federal	62	23.7
State	79	30.1
Regional	24	9.2
County	37	14.1
Local	38	14.5
Private	17	6.5
Other	5	1.9
Total	262	100.0

Table 2.2 Question: To the best of your knowledge are any of the following techniques used in your state for watershed management. Indicate the level(s) of administration, if known.

Technique	Program Level							
	Federal	State	Regional	County	Local	Private	Total	Percent
Land Use Regulations	22	47	11	30	35	3	148	14.3
Watershed Management Agencies	20	29	17	15	20	1	102	9.9
Watershed Patrols	4	8	3	4	9	2	30	2.9
Watershed Districts	7	19	16	16	28	4	90	8.7
Watershed Zoning	7	12	3	20	27	1	70	6.8
Critical Areas Programs	23	48	15	16	15	3	120	11.6
Buffer Strips	20	48	16	19	30	7	140	13.6
Wellhead Protection Zones	4	43	4	9	14	0	74	7.2
Dual Purpose Detention Basins	15	26	5	13	27	5	91	8.8
Educational Programs	26	60	18	23	24	11	162	15.7
Other	2	2	0	1	0	0	5	0.5
Total	150	342	108	166	229	37	1032	
Percent	14.5	33.1	10.5	16.1	22.2	3.6		100.0

According to the survey half of the programs were based at the state (33%) or local (22%) level. Federal programs accounted for only 15% of the total programs. Respondents were asked to list the states they considered to have the most effective watershed management programs. The top-rated program was Wisconsin, with Florida and Maryland in second and third places. Each of these "top rated" states has some features that are similar to features that can be found in New Jersey. Wisconsin's large dairy industry and many lakes and streams provide a direct analogue to many of the farming areas found in the Garden State. Although its population of 4.8 million is not quite two-thirds that of New Jersey, it is inaccurate to consider Wisconsin purely a rural state. Milwaukee has a population of 636,000 and is part of the corridor extending from Chicago, Illinois to Madison, Wisconsin. Concern for clean water springs from both rural and urban sources. Moreover, concern for environmental quality is a prime political factor in Wisconsin, just as it is in New Jersey.

Florida is developing much more rapidly than New Jersey. As in New Jersey, Florida's growth is concentrated primarily in urbanizing corridors. With the exceptions of Orlando and Gainesville-Ocala, Florida's strip cities are found primarily along the state's extensive ocean or gulf beaches. Many areas have suffered from overdrafting of aquifers, particularly near Miami and Tampa. Water quality management policies in Florida are particularly interesting since this is a conservative southern state that has long regarded any interference in the rights of private land ownership negatively.

Maryland is the state that most closely resembles New Jersey. Its population is concentrated along the I-95 corridor extending from Baltimore to Washington. The transition from farming to suburban development springs from the same factors found in New Jersey: service sector and information related

jobs have migrated to corridors, and homes, stores, and other appurtenances of metropolitan development have followed.

The next sections examine the relevant portions of watershed management programs in each of these "top rated" states. All have point, nonpoint, and special area programs. Although each differs in significant ways from New Jersey, in the opinion of the nationwide sample of water quality experts, each state has successfully faced one or more problems that are currently important to New Jersey. It should be noted that New Jersey, itself, has many strong program elements that merit national consideration and that their exclusion in this chapter is simply a reflection of the chapter's focus on exemplary programs outside of New Jersey. In the discussion that follows an attempt has been made to select those aspects of the programs that merit consideration in New Jersey, rather than to summarize all program components.

III. Wisconsin

Overview

Natural and environmental resources are managed by the Wisconsin Department of Natural Resources (WDNR). The WDNR is headed by a commissioner, but unlike most states, including New Jersey, the commissioner is not appointed by the governor, but by an environmental council composed of citizens appointed by the governor for staggered terms. Since there are holdover members from previous administrations the vicissitudes of day-to-day political turmoil are less likely to affect the commissioner.

Over the years Wisconsin has established a reputation among students of state government for progressive and innovative public policies. Environmental concerns rank high with citizens of the Badger State. Accordingly, it was not

unexpected that Wisconsin ranked high in our survey. The following sections examine several important elements of Wisconsin's program.

Program description

Wisconsin has over 43,000 miles of rivers and streams and nearly 15,000 inland lakes. Approximately 30% of Wisconsin's stream miles, 40% of the state's lake surface area, and 70% of its Great Lakes coastal miles are degraded by nonpoint sources of pollution (WDNR, 1986a).

Wisconsin's basin assessment program developed a map of the state delineating critical nonpoint source areas and within those identified priority watersheds. Specific problem areas within each priority watershed were targeted for remedial action.

Wisconsin's nonpoint source water pollution abatement program was created by a 1978 act of the Wisconsin Legislature. Its three premises were: 1) effective controls must be comprehensive, 2) goals of soil conservation are not the same as state's water quality goals, and 3) nonpoint-source pollution is a water quality program. Wisconsin designated the state water quality agency as the lead agency.

This program was successful because it clearly identified its priorities and objectives. The key program objectives were:

* "To identify the most effective approach for achieving specific water quality objectives and to provide adequate financial and technical assistance to landowners and operators for the installation of approved nonpoint-source control practices.

* "To provide coordination between nonpoint-source pollution control efforts and other elements of the state's water quality program.

* "To focus limited technical and financial resources in critical geographic areas," (Konrad et al, 1985).

The key is the use of priorities and targets. Areas are targeted based on

hydrologic units, rather than political boundaries; all urban and rural classes of nonpoint sources are dealt with, and a systematic process is used to identify, rank and select critical watersheds or portions thereof that need additional attention.

The program's operation was comprehensive and systematic from the outset. State enabling legislation required that the WDNR "...identify priority watershed areas where nonpoint source related water quality problems are most severe and control is most feasible and develop best management practices which are the most effective, practicable means of preventing or reducing nonpoint source pollution" (Chapter NR 120 Wisconsin Register, June 1986, No. 366, p. 441). WDNR surveyed the entire state to identify the watersheds that were critical from a nonpoint source perspective. After the preliminary survey about 40% of the state was targeted. The second level of examination was to identify Priority Management Areas (PMAs). PMAs are areas within a watershed that contribute pollutants to lakes and streams. They are selected for inclusion based on six criteria: 1) severity of water quality problems, 2) magnitude of the pollutant load and the potential for reducing it, 3) willingness of landowners to participate, 4) willingness and capability of local agencies to carry out their role in the program, 5) willingness and capability of local agencies and government units to control other sources of pollution, and 6) the potential public use and benefits that would result from the project. More than 130 individual projects have been initiated to address problems in PMAs.

The selection process is objective and includes the following stages:

* A numerical ranking of watersheds based on technical water quality and pollution potential evaluation by the WDNR.
* Review and recommendation of watersheds by 10 regional committees.
* Establishment of a list of 15 to 20 watersheds by a committee with

various agency and interest group representation.

* Final selection by WDNR is based on available funds.

Once the selection process is complete an eight to nine-year planning and implementation cycle begins. The first stage, technical assessment, sets watershed project goals by identifying problems and specifying objectives. It identifies significant nonpoint sources, specifies water quality improvements that can be reasonably expected, and determines best management practices (BMPs). The second stage consists of an implementation strategy. It identifies the tasks necessary, the agencies responsible, the time frame, staff hours needed, and the estimated cost share dollars. Three years are allowed to establish cost share arrangements with landowners. BMP agreements are signed, normally for 10 to 20 years. Cost share varies, but normally ranges from 50% to 70% of the project cost being assumed by the landowner.

Programs are organized by the WDNR, but goals are set and the program is implemented at the local level. WDNR provides program administration, technical expertise, cost share funds, and staff assistance funds. Locally, land conservation committees oversee projects, develop cost share agreements, and maintain records. An important role is played by the Wisconsin Extension Service, Soil Conservation Service, and Agricultural Stabilization and Conservation Service.

In addition to ground and surface water sections, Wisconsin has designated a nonpoint source and land management section. Administratively nonpoint-source pollution is directly tied to land use, and that relationship is explicitly recognized in the WDNR organizational chart. This prevents it from being lost in an interagency or an intraagency shuffle.

Wisconsin also maintains a conservation reserve program that establishes

buffer strips along key waterways. In addition, lake districts have been established. These are recognized units of government with the power to tax. They are self-initiated by concerned jurisdictions.

Summary

The key to Wisconsin's effectiveness is management by objectives tied to local areas and specific local priorities. The program has a clear administrative structure and is backed with a direct fiscal commitment including staff resources, cost sharing (50% to 70%), and cooperative action between the state university and the agricultural extension service.

IV. Florida

Overview

Florida resisted environmental planning until the 1970s when the impacts of its explosive growth forced a legislative response. In 1972 the Environmental Land and Water Management Act, the Water Resources Act, the State Comprehensive Planning Act, and the Land Conservation Act were passed. The first of these extended the range of state involvement in local planning by designating areas of critical state concern and requiring regional reviews of development projects large enough to be considered developments of regional impact. The others established the broad outline of Florida's growth management system.

Florida has developed an effective, integrated, and well funded growth management program. According to John DeGrove (1987) "The glue that holds Florida's powerful growth management system together is a belief by a large majority of its citizens--native and new--that well-managed growth is essential to maintaining and even improving the state's quality of life."

Explosive growth during the 1970s and 1980s forced the state to face the environmental impacts of rapid population growth. Currently Florida adds about 300,000 people per year and by the year 2000 should move to third in total population among the 50 states. Florida is second only to Alaska in the extent of its coastal area with 8,460 linear miles of waterfront. In addition, Florida has 14 river systems and 32 lakes and reservoirs with a surface area greater than 7.8 square miles.

Program Description

The Florida state plan "was intended to be more a strategic destinations document than a typical or traditional comprehensive plan. What was sent to the legislature by the governor and the cabinet was, in fact, unconventional. It was short (less than 50 pages); it was written, for the most part, in plain English; and the goals and policies that made up the plan were meaningful, not mush," (DeGrove, 1987).

The State and Regional Planning Act of 1984 required Florida to prepare a state water use plan. That plan contained the following key assumptions: first, that growth would place continued pressure on available water supplies and overall quality of Florida waters, and second, that existing practices and resource levels would be inadequate under this pressure to ensure that environmental quality would remain constant, and thus additional measures and resources would be required to improve or even maintain present water quality to meet future needs (Florida Department of Environmental Regulation, 1986).

The plan recognized that attaining its objectives would require extensive resource obligations by state agencies, water management districts, regional planning agencies, local governments, and the private sector. According to the plan, "protection of the environment in the face of rapid growth, cannot be

provided at even a maintenance level without proportionate and absolute increases in expenditures at all level[s]." In terms of nonpoint source pollution controls large public expenditures were recommended in the plan. Among the items proposed were:

* water quality management planning: $2 million/year for 5 years.
* develop and implement comprehensive basin plans to assess and abate the impacts of pollutants on hydrological systems: $1 million/year.
* long term water quality monitoring and data base maintenance: $3.5 million/year.
* develop predictive land use models showing pollution impact of land use types: $2 million/year
* storm water controls at an estimated cost of $3,000 per acre and an additional 25 percent of capital costs for operational expenses (Florida Department of Environmental Regulation, 1986).

These figures do not include waste water treatment plant construction and operating costs.

The Environmental Land and Water Management Act served as a national model by requiring a special review of developments above a specified impact threshold. It also identified regions of critical state concern where development should be either heavily restricted or precluded.

The foregoing acts form an integrated method for managing growth and its environmental impacts. The acts are backed with substantial revenues and teeth. Each of the 467 local governments in Florida was required to bring its plans and regulations into conformance with the state plan. Failure to comply could result in withholding state revenue sharing and infrastructure funds. As befits a state surrounded by water on three sides, coastal areas receive special attention. In addition, faced with rapidly growing urban areas, compact patterns of urban development are encouraged. Moreover, once plans are approved no new development may be approved unless there is funding to accommodate the

impacts on water, sewer, roads, schools, parks, recreation facilities, solid waste, and other infrastructure systems.

Planning funds included $4.5 million at the state level as well as the following annual planning grants to localities: 1985, $2.3 million; 1986, $8.8 million; and 1987, $8.0 million.

Florida devotes considerable attention to regional coordination. Countywide planning councils are in effect in several counties and serve to coordinate the efforts of cities, school districts, and water management districts.

A number of watershed management districts have been created in Florida. Some of these play a significant role in watershed management. The role they play varies depending on their institutional capacity. Some are little more than patronage entities with little management capability. Others, such as the Southwest Florida Water Management District, are regarded as national models in stormwater management. Competent water management districts are given extensive responsibility; in others much greater control remains with state officials.

Florida's program is characterized by excellent public and technical documentation illustrating common problems and outlining effective solutions. The **Florida Stormwater Management Manual** consists of sample solutions for Florida. The state makes extensive use of on-site multipurpose detention basins. Maintenance is recognized as important to their operation. The guidelines recommend that a local government or other designated group such as a homeowners' association, be delegated the responsibility for maintaining the structures in the impoundment area. Each basin is to be buffered by a permanent easement of at least 15 feet from the maximum elevation of the storage pool as well as an access easement. These are normally dry basins that

retain stormwater in order to reduce pollution and improve downstream water quality. They are designed for multiple purposes, including recreation, water supply, recharge, flood protection, aesthetic improvement, or some combination of the foregoing.

There is a special set of guidelines for developers or others who must design stormwater management systems that require different design strategies. In Florida this may include satisfying the provisions of the local or regional flood control ordinances, as well as statewide stormwater pollution control regulations.

Florida has evolved a strategy of varying the treatment in the basin based on the storage elevation of the stormwater. For example, an impoundment can be designed with an outlet structure such that the first stage will capture an initial volume of runoff (i.e., 0.5 inch). Subsequently, this water may be slowly released through a subsurface drain or filtration system. In this first stage 80 to 90 percent of the pollutant load may be removed. The second stage begins with a weir or similar orifice that can pass the rest of the stormwater at a predevelopment rate when the water elevation reaches the crest of the structure. The manual provides detailed hydrologic and engineering data on the design and construction of these structures.

The Florida manual indicates that lack of maintenance can inhibit the effectiveness of these systems, and the guidelines recommend annual or semi-annual inspections, as well as brief inspections following major storms. Maintenance of multipurpose stormwater facilities imposes costs and responsibilities and although important has been difficult to implement. Tallahassee innovated by creating a utility to manage and dispose of stormwater. It is financed by a user fee of $1.00 per single-family house and prorated to

other types of development based on their impervious surface area.

Summary

Florida manages growth and watersheds in the context of an overall strategy of growth management. The use of special districts and utilities represents an innovative approach to watershed management. The success of Florida's approach appears to be in part related to the state's ability to delegate to competent local authorities, but maintain program control in other areas. The Florida program has an effective set of documents that communicate policy to builders, engineers, local government officials, and homeowners. Although it is difficult to assess the precise role of these materials, they would appear to greatly strengthen the effort to gain local acceptance of state watershed policies.

V. Maryland

Overview

Unlike New Jersey, Maryland has divided the functions of pollution control and those of natural resource management between two cabinet agencies, the Department of the Environment and the Department of Natural Resources. In addition, counties in Maryland have extensive governmental powers, including broad powers to plan and zone in areas outside incorporated cities. As a consequence, as Maryland metropolitan regions grew into suburban areas, planning and zoning became, in essence, a regional process managed by counties.

Maryland has 19 river systems, 137 lakes, reservoirs, and ponds, and just 32 miles of oceanfront land. The extensive Chesapeake shoreline contributes to the state's total of 2,382 square miles of estuary.

Program Description

Maryland does not have a formal program of comprehensive watershed management (Letter: Gould Charshee to Stephen Born, March 1, 1988). Instead specific programs have been established for particular watersheds, including the urbanizing area feeding the reservoirs for Baltimore, the Patuxent Watershed, and the Chesapeake Bay.

Watershed management in Maryland must address both agricultural and urban pollution sources. Major urban areas near Washington and Baltimore rely on water supply reservoirs whose catchment areas are increasingly impacted by urbanization. In addition, water quality in the Chesapeake Bay has been the focus of a major nonpoint source pollution cleanup effort. Maryland has innovated extensively in watershed management. As early as 1967 Montgomery County required developers to submit sediment control plans with preliminary subdivision plats (Garner and Williams, 1985).

The Chesapeake Bay Agreement

The Chesapeake Bay Agreement was signed in 1983. It is an agreement by EPA, Maryland, Virginia, Pennsylvania, and District of Columbia to restore the bay. Updated by all the parties in 1987, the water quality goal is "to reduce and control point and nonpoint sources of pollution to attain the water quality condition necessary to support the living resources of the bay." The 1987 commitment calls for a 40% reduction in the volume of nitrogen and phosphorous entering the bay. The commitment states that there is "a clear correlation between population growth and associated development and environmental degradation in the Chesapeake Bay system." It commits the states and the federal government "to use the full measure of their authority to mitigate the

potential adverse effects of continued growth."

Reservoir Action Strategy:
Water Supply Reservoirs for Baltimore

Baltimore lies on the growing I-95 Corridor. Three reservoirs provide drinking water for 1.5 million people in the Baltimore metropolitan area. An estimated 94 percent of watershed lands are owned by the private sector. The watershed lies in Baltimore and Carroll Counties with small portions in Harford County and in Pennsylvania. As with many urbanizing watersheds, eutrophication caused by sewage treatment plants, agriculture, and urban development is a major problem.

The reservoir strategy established a goal of reducing phosphorous and sediment loadings for the reservoirs and established an action plan to accomplish the goal. Baltimore recognized that its problems were due to both point and nonpoint source pollution. Point sources were addressed directly by upgrading sewage treatment plants. Nonpoint sources required a more complex strategy, since they were derived from by agricultural and urban sources.

Agricultural sources were identified and treated in concert with Soil Conservation Districts. The areas were ranked and the worst farms, from a pollution standpoint, were treated first. Precise annual goals were established and progress toward them monitored and reported.

Urban sources used preventative and remedial strategies. Failing septic systems were corrected, and improved stormwater management practices were adopted by the counties. Preventative measures included tougher requirements for environmental impact statements required of would-be developers, zoning designed to limit the amount of development within reservoir watersheds, and more stringent soil erosion and sediment control programs. In addition, the

strategy called for better data and instituted a comprehensive reservoir monitoring program to measure progress toward goal accomplishment.

A major program thrust sought the involvement of citizens and local governments. Citizens were targeted with a cooperative public information program to encourage their assistance. Better communication with local governments and citizens included not only information on the program, but also research results from an accelerated study of alternative septic systems. Results were communicated regularly to citizens.

Patuxent River Plan

The Patuxent River watershed drains the area lying between Baltimore and Washington, D.C. and empties into the Chesapeake Bay. It is the largest watershed entirely within Maryland. Its upper reaches face extensive urbanization pressures and include the growing suburbs of Washington and Baltimore, as well as the new city of Columbia. The program, administered by the Patuxent River Commission, was established in 1980. The Patuxent River Commission completed a Policy Plan in 1984 and a Primary Management Area Handbook in 1986.

The Policy Plan recognizes that both point and nonpoint source pollution control must be addressed. Point source control consisted of a $198 million effort to upgrade facilities. Nonpoint source pollution is addressed by the Patuxent River Policy Plan. According to Maryland's top planner, Constance Lieder, "the Patuxent River Policy Plan is a land management plan...without the discipline of land management, the Patuxent River, or any other river, cannot accommodate people and changing land use and still be viable for fish, wildlife, vegetation, and recreational use." (Constance Leider, Secretary, Maryland Department of State Planning, Letter of Transmittal for Patuxent River Policy Plan, June, 1984).

The Patuxent suffers from problems typical of once rural watersheds undergoing metropolitan development. Nonpoint sources accounted for 83% of phosphorous and 51% of nitrogen. Virtually 100% of the sediment came from nonpoint sources. The report concluded that population growth and related land use changes were the fundamental causes of point and nonpoint source pollution.

The Patuxent report made the following recommendations:

* Establish a primary management area delineating land along the river and its tributaries from which pollution is most likely to be transported into the river.

* Provide best management practices and require vegetative buffers.

* Identify major nonpoint pollution sites.

* Retrofit existing development.

* Shift future development to less sensitive areas or require planning to minimize impacts on river as a condition of development approvals.

* Adopt an annual action program showing schedules, actions, and precise responsibilities for plan implementation.

* Base nonpoint source control on BMPs and provide state aid for their installation.

Because the Patuxent flows into the Chesapeake Bay it was eligible for an implementation grant program. This was a demonstration program funded in part by EPA. It established a $1 million cost sharing stormwater program for rivers flowing into the Chesapeake. In addition, stormwater grants were made available for developing areas to allow local governments to implement stormwater management programs.

Agriculture was also targeted under a cost share program. This program authorized $12 million in the years 1983-1985.

A major scientific effort has been mounted to provide better models. A major objective of the nonpoint source study is to assemble and maintain a hydrometeorologic data base and a water quality data base. The aim is to

develop base numbers on the stream and then to be able to evaluate the impacts of various best management practices.

Summary

Maryland has confronted the problems of agriculture and urban growth in its watersheds. The strengths of the Maryland program are: 1) It recognizes the importance of interjurisdictional solutions. The agreements on the Patuxent and the Chesapeake read as international treaties specifying the goals, the fiscal commitment, and the precise obligations of each of the signatories. 2) Counties in Maryland tend to be greater in area than their New Jersey counterparts, moreover their planning role is much greater. This fortuitous circumstance tends to facilitate regional perspectives and regional solutions. 3) Specific goals for regional water quality are identified, and progress toward them is reported annually. 4) The relationship between land use and water quality is explicitly recognized, and land use controls including zoning are an integral part of watershed management. 5) Cost sharing is available. 6) Extensive federal funding was found for the Chesapeake Bay project.

VI. Recommendations

Although the programs described above have been recognized as preeminent, they do not provide a single blueprint that can be uncritically applied to New Jersey. Programs cannot be successfully cloned and moved from one state to another. Moreover New Jersey has many areas of excellence in managing its own water resources. Each state has a unique combination of cultural, physical, land use, political, and economic factors that must be considered. Nevertheless, the experiences of other states can provide valuable insights that can serve as directional beacons as New Jersey develops a comprehensive program of

watershed management. The excellence of the Wisconsin program lies in its application of management by objectives to watersheds. Florida is notable for the close integration of growth management planning and multiple levels of government. Maryland has succeeded in watershed management by involving multiple agencies and levels of government in a management by objectives framework applied on a regional level. In addition, all three states have spent relatively large amounts of money in planning and establishing their watershed management programs. Building on these strengths the following recommendations are offered:

1. **The NJDEP Division of Water Resources should establish an Office of Watershed Management within the Division of Water Resources.**

   Because of the tremendous complexity and diversity of watershed management concerns, which typically involve various levels of government, multiple agencies, and diverse public and private sector interests, an Office of Watershed Management should be established to serve as an identifying, focussing, coordinating and spokesman entity for watershed management activities within the state.

2. **The NJDEP Division of Water Resources should adopt a management by objective approach to watershed management.**

   Recognizing the complexity and diversity of watershed management issues in the state, a management by objectives approach can be used to effectively focus the allocation of scarce resources in a systematic and systemic manner. A management by objectives approach should target:

   * Priority watersheds
   * Priority areas within watersheds
   * Priority problems within watersheds

3. The NJDEP Division of Water Resources should consider a basin approach to the organization of watershed management activities.

Considering the inherent nature of watershed management concerns, which by definition reside within the spatial boundaries of watersheds, the organization of watershed management activities on a river basins basis offers a logical structure with regional underpinnings. Such organization would be consistent with the functioning of an Office of Watershed Management and a management by objectives approach to watershed management activities.

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WATER SUPPLY/WATER QUALITY SENSITIVE LANDS

Robert M. Hordon

3

I. Introduction

To discuss water supply/water quality sensitive lands, it is first necessary to distinguish them from "environmentally sensitive lands," i.e., areas that include steep slopes, floodplains, erodible soils having a high "K" factor, stream corridors, and wetlands. Water supply/water quality sensitive lands are those areas that, by virtue of their proximity to water supply intake points, are particularly sensitive to land use activities that may induce nonpoint source pollution. As a consequence of this proximity, contamination can quickly pass from the raw water into public supplies of drinking water.

Thus, it is recognized that there is natural overlap between water supply/water quality sensitive lands and environmentally sensitive lands. For example, the preservation of open space and a natural environment, which is an acknowledged objective of state planning, would apply to both categories of land. The major difference separating the two types of land is that the term, "water supply/water quality sensitive lands", specifically addresses lands that drain into a stream or impoundment that will be used as a surface source for water supply.

Therefore, water supply/water quality sensitive lands include the immediate area surrounding an intake point, as well as the feeder streams entering a terminal reservoir used directly for water supply. In one sense, however, all the land in a watershed above an intake will eventually drain into and form part of the raw water for that source. It turns out that the land area upstream of

surface water intakes in New Jersey is substantial, as evidenced in Table 3.1 (see also Figure 3.1). Note that the total area, over 2,808 square miles, amounts to a surprising 37.5 percent of the entire state. However, it is this third of New Jersey that collects the runoff that is used to furnish 641 mgd of surface water. This amount of water represents 61.6 percent of the 1,040 mgd produced in New Jersey in 1985 (Solley, Merk, and Pierce, 1988). Another way to look at it is to note that this 641 mgd of surface water is used by an estimated 3,860,000 people, which represents 57.5 percent of the 6,710,000 people in New Jersey served by public water in 1985 (Solley, Merk, and Pierce, 1988).

II. Discussion

It is obvious that different portions of these upstream lands will have different effects on the water quality at the intake points. Some areas are simply farther away from the intake points. Consequently, proximity to intake points, as well as hydraulic time of travel, suggests a natural hierarchy of water supply/water quality-sensitive lands, which can be arranged in a generalized descending order of importance as follows:

1) Those areas immediately surrounding a surface-water intake point, as exemplified by the intakes at the Swimming River reservoir and Oradell reservoir in Monmouth and Bergen Counties, respectively (see Figures 3.2 and 3.3). This first ranking recognizes that all intake areas require some form of protection, even if the intakes are used only occasionally, as in the case of the Hamden pumping station on the South Branch of the Raritan River.

2) The shorelines surrounding a terminal reservoir, which is used as the immediate water-supply source (e.g., Swimming River and Oradell reservoirs; see Figures 3.2 and 3.3).

Table 3.1 New Jersey Watersheds Used for Public Potable Water Supply (see also Figure 3.1)

Watershed	Sub-Watershed	Area[a] (sq. mi.)	Water Supply Source	Purveyor
Hackensack	Hackensack	113.0	Oradell Reservoir	Hackensack WC
			Woodcliff Reservoir	"
			Lake Tappan	"
			DeForest Lake	"
Passaic	Ramapo	160.0	Ramapo River	NJDWSC
				Hackensack WC
	Wanaque	90.4	Wanaque Reservoir	NJDWSC
			Monksville Reservoir	"
	Pequannock	68.3	Charlotteburg Res.	Newark WD
			Canistear Reservoir	" "
			Oak Ridge Reservoir	" "
			Clinton Reservoir	" "
			Kikeout Reservoir	Butler WD
	Rockaway	120.9	Boonton Reservoir	Jersey City WD
			Splitrock Reservoir	" "
			Taylortown Reservoir	Boonton WD
	Passaic	100.0	Passaic River	Commonwealth WC
		762.0[b]	Passaic River	Passaic Valley Water Comm.
	Molly Ann	1.0	Haledon Reservoir	Haledon WD
	Saddle River	16.4	Saddle River	Hackensack WD
Rahway	Rahway	40.9	Rahway River	Orange WD
				Rahway WD
Raritan	Raritan	785.0	Raritan River	Elizabeth WC
		45.0	Lawrence Brook	New Brunswick WD
Wallkill			Franklin Pond	Franklin WD
Delaware	Paulins Kill	[c]	Morris Lake Reservoir	Newton WD
			Dry Brook Reservoir	Branchville WD
	Pequest	[c]	Buckhorn Reservoir	Buckhorn Springs W
	Musconetcong	[c]	Lower Mine Reservoir	Hackettstown MUA
			Burd Reservoir	" "
		[c]	D & R Canal	Elizabethtown WC
				Middlesex WC
				New Brunswick WD
				No. Brunswick WD
	Delaware	916.4[d]	Delaware River	Trenton WD
Navesink		50.0	Swimming River Res.	NJ American WC
Shark River		10.0	Glendola Reservoir	" " "
		6.5	Jumping Brook Res.	" " "
Manasquan		44.0	Manasquan Reservoir	Proposed
Doughty Creek		18.0	Atlantic City Res.	Atlantic City MUA
Laurel Creek		na	Laurel Lake	Salem WD
	Total	2808.2		

Sources: NJDEP, Bureau of Potable Water
USGS, Surface Water Records

[a] Drainage area is above the most downstream public potable surface water intake.

[b] The 762.0 sq. miles of drainage area is the total for the Passaic River above the Passaic Valley Water Commission's intake at Little Falls. Thus, it includes the areas for the subwatersheds listed above it, but excludes the Molly Ann and Saddle River which enter the Passaic River below the Little Falls intake.

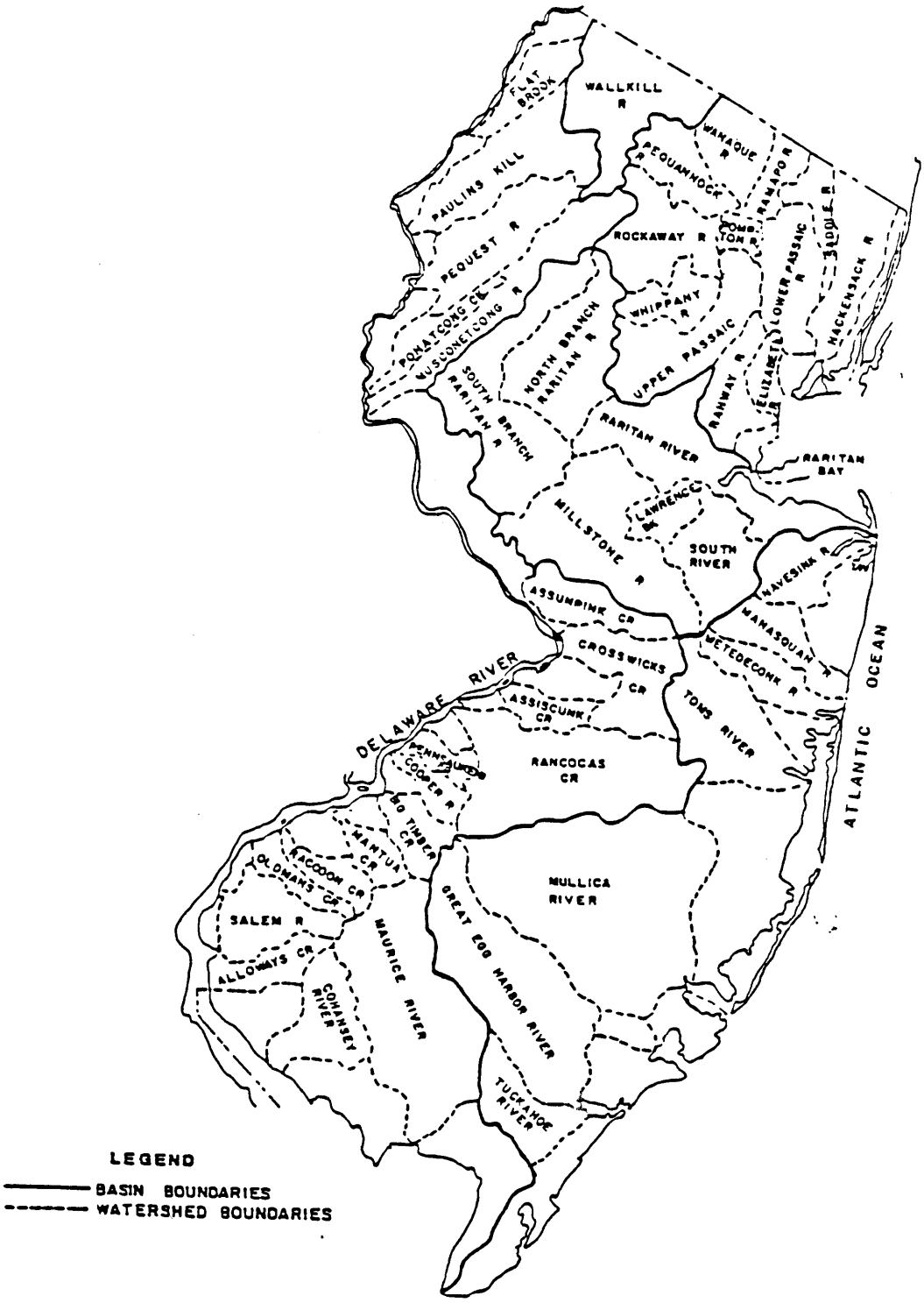
[c] The areas for these subwatersheds are included in the 916.4 sq. miles total for the New Jersey portion of the Delaware River drainage area.

[d] The 916.4 sq. miles of drainage area includes only the New Jersey portion.

Notes: NJDWSC: North Jersey District Water Supply Commission
MUA: Municipal Utilities Authority
WC: Water Company
WD: Water Department

FIGURE 3.1

Drainage Basin Map of New Jersey



Source: New Jersey 1986 State Water Quality Inventory Report.

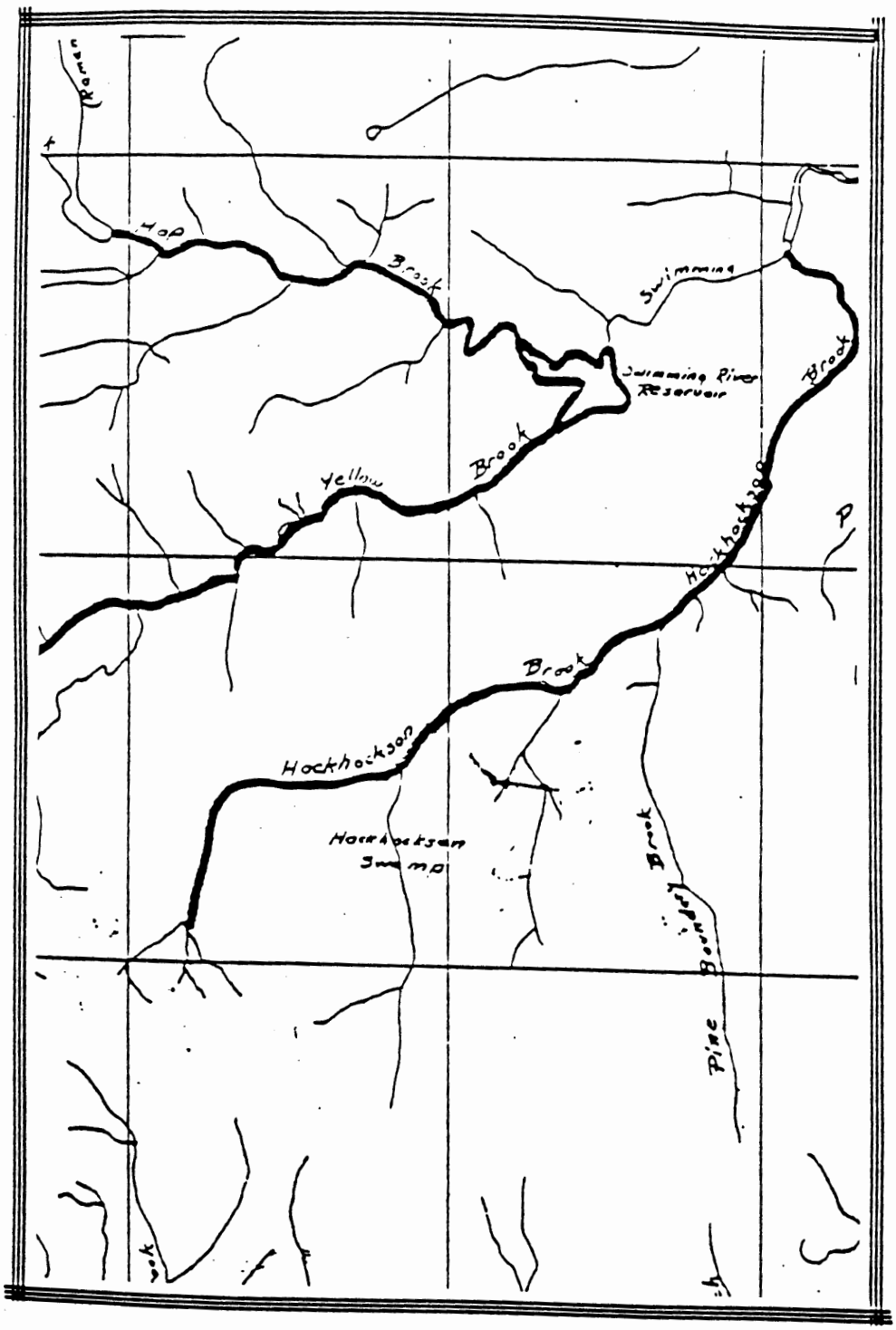

Hop
Brook
Swimming
Swimming River
Reservoir
Brook
Yellow
Brook
Hockhockson
Brook
Hockhockson
Hockhockson
Swamp
Boundary Brook
Pine
N

FIGURE 3.2

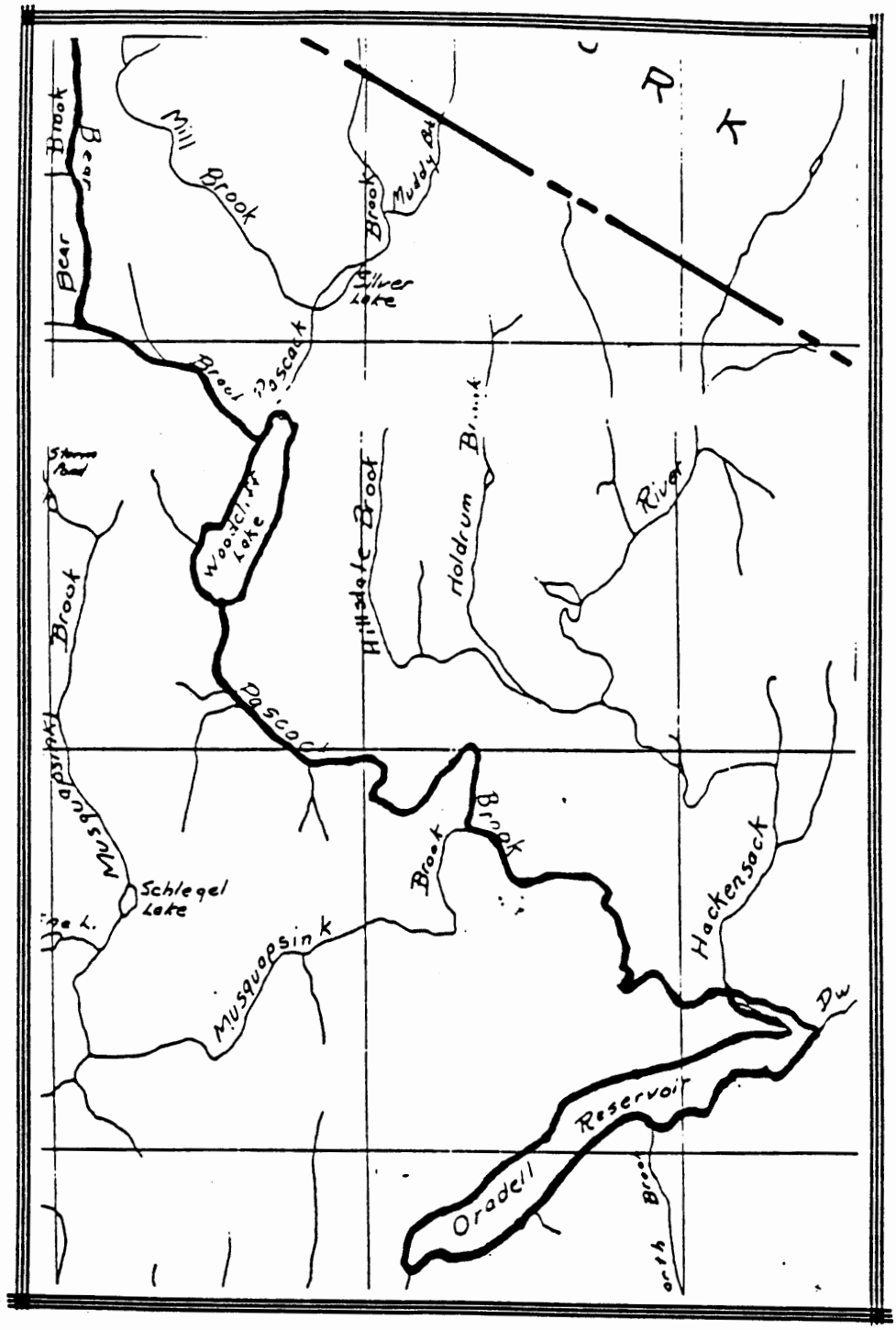

Bear Brook
Mill Brook
Muddy Brook
Silver Lake
Pascack Brook
Woodcliff Lake
Hillsdale Brook
Oldrum Brook
River
Pascack Brook
Musquapsink Brook
Schlegel Lake
Musquapsink
Brook
Hackensack
Reservoir
Oradell
N

FIGURE 3.3

3a) The feeder streams that come directly into a terminal reservoir, such as Yellow Brook and Hop Brook above Swimming River reservoir (see Figure 3.2) and Pascack Brook above Oradell reservoir (see Figure 3.3). Note in Figure 3.2 that Hockhockson Brook flows into Swimming River below the reservoir and would therefore not fit into category 3a since it is not used as a water-supply source.

3b) The feeder streams that are above a surface-water intake on a stream, such as the Raritan and Millstone Rivers above the Elizabethtown Water Company intake in Bridgewater Township (see Figure 3.4).

4) Reservoirs that are upstream of a terminal reservoir (e.g., Woodcliff Lake above Oradell reservoir; see Figure 3.3).

5) The feeder streams that are coming into upstream reservoirs, such as Bear Brook above Woodcliff Lake (see Figure 3.3).

6) The remainder of the watershed.

The purpose of the ranking is straightforward: those areas that are closest in time and space to the intakes must have the greatest degree of protection from potential nonpoint source contamination. The protection required could come from one or more of the following measures:

a) the most effective best management practices (BMPs) possible, even if the cost is high;

b) redundant BMPs, which could be in series if necessary, to provide the highest level of effectiveness;

c) zoning by the local municipality, which should be aware that certain types of land-use activity and density are not compatible with the sensitivity of the land and receiving watercourse.

Several items at this point need clarification. For example, the term "feeder streams," which was used in the previous section on ranking, actually pertains to the stream corridors and associated buffer strips. The feeder streams drain a large amount of watershed area, and the intent is to separate the areas closest to the stream from other areas that are farther away. Also, certain land-use activities, such as landfills and hazardous chemical transfer/warehousing installations, have such a high potential for contaminant generation that their siting requires very careful scrutiny. It is recognized that NJDEP is involved

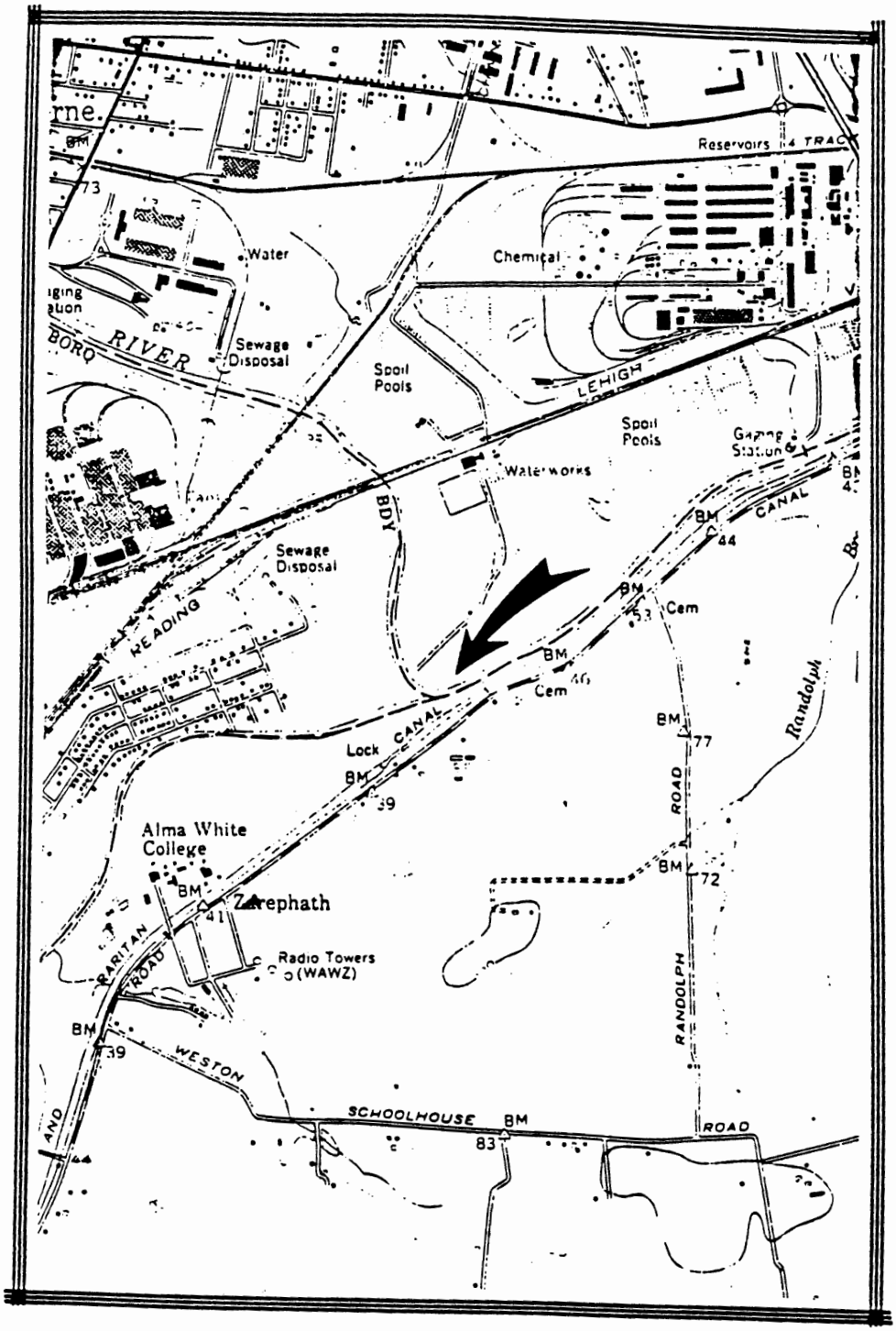

Reservoirs
Water
Chemical
Sewage Disposal
BORO
RIVER
Spoil Pools
LEHIGH
Spoil Pools
Waterworks
BDY
CANAL
Sewage Disposal
READING
Cem
Lock
CANAL
Randolph
ROAD
Alma White College
Zarephath
Radio Towers (WAWZ)
RARITAN
ROAD
WESTON
SCHOOLHOUSE
RANDOLPH
ROAD
N

FIGURE 3.4

with the process of locating a landfill, but zoning for industrial activities falls entirely within the purview of the local municipality.

The rationale for separating terminal reservoirs from upstream reservoirs is based on the simple fact that the terminal, or most downstream, reservoir contains the intake, whereas an upstream reservoir holds water that may be days or weeks from being used in the treatment plant. The upstream reservoirs act as an enormous detention system for the watershed and allow material to settle out prior to movement downstream. In a real sense, each upstream reservoir traps sediments, nutrients and heavy metals and so protects the terminal reservoir. Of course, the efficacy of an upstream reservoir is a function of its size, depth, flushing rate, and pollutant input.

Within each of the suggested water supply/water quality-sensitive land categories that were ranked in the foregoing sections, certain portions are also environmentally sensitive. For example, steep slopes represent an easily identifiable factor for inclusion in land use controls. As one indication of their importance, a study by Hartung and Kress (1977) recommends that stream corridor buffer strips increase in width as slope increases as a means of protecting the stream from construction and developmental activities. The recommended buffer strips vary from a minimum of 50 feet for level slopes to as much as 450 feet for very steep slopes of 45 degrees (see Table 3.2).

TABLE 3.2

RECOMMENDED BUFFER WIDTHS FOR PROTECTING STREAMS FROM CONSTRUCTION AND DEVELOPMENTAL ACTIVITIES

SLOPE (degrees)	BUFFER STRIP WIDTH (feet)
0	50
6	90
12	130
17	170
23	210
26	250
31	290
35	330
39	370
42	410
45	450

Source: Hartung and Kress, 1977.

III. Recommendations

1. The NJDEP Division of Water Resources should issue a technical paper on the nature and importance of water supply/water quality sensitive lands for watershed management.

The publication should be brief, free, and widely distributed, especially to county and local planning boards and planning professionals. It should contain material that would distinguish between water supply/water quality-sensitive and environmentally sensitive lands. This aspect is necessary, since, as noted before, there is natural overlap between the two categories of sensitive lands.

In addition, this material would form an excellent introduction to the ranking of water supply/water quality-sensitive lands.

2. NJDEP Division of Water Resources should adopt and then promulgate a ranking of water supply/water quality sensitive lands, as follows:

* **Rank # 1** of the water supply/water quality-sensitive lands should be assigned to those immediate land areas that are proximate to a surface water intake. These land areas are the most sensitive to any land use activity, and therefore they require the most stringent land-use controls possible.

* **Rank # 2** should be assigned to the shorelines surrounding the terminal reservoirs used for public water supply. These lands immediately abut the reservoirs and are therefore highly sensitive. The required controls should be in the form of buffer strips around the reservoirs where development would be totally restricted.

* **Rank # 3** should be assigned to the corridors surounding the feeder streams that enter terminal reservoirs. The same ranking should also apply to the feeder steams that are upstream of a surface-water intake.

* **Rank # 4** should be assigned to the shorelines surrounding reservoirs upstream of terminal reservoirs. Upstream reservoirs are not immediately used for surface water supplies and therefore require a lesser degree of protection. For example, buffer strips can be smaller than the large buffer strips needed for terminal reservoirs.

* **Rank # 5** should be assigned to the feeder streams entering one or more of the upstream reservoirs.

* **Rank # 6** is a default category, which is the remainder of the watershed. This last category should contain the bulk of the land area in the

watershed. Land use controls are of course recommended, but they need not be as stringent as in the higher rankings.

In summary, these rankings would be clear and apply to all areas of the state that are upstream of the most downstream surface water intake. They represent an attempt to establish a hierarchy of sensitivity to water quality impacts based on proximity to intakes and hydraulic time of travel.

3. The NJDEP Division of Water Resources should assume a lead role in delineating all of the land areas in the state with the recommended rankings on maps at a scale of at least 1:24,000 (1 inch to 2,000 feet).

There is no substitute for a map for portraying spatial information. Even if the delineated zones were approximate (i.e., not surveyed), they would provide the local planning boards with extremely useful information that could only help them in the planning process. NJDEP should be the lead agency and could supervise, for example, the actual work, which could be performed by such existing operations as the Cook College Remote Sensing Center.

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BEST MANAGEMENT PRACTICES FOR WATERSHED MANAGEMENT

Robert M. Hordon

4

URBAN/SUBURBAN BMPs

I. Introduction

It has become readily apparent in recent years that urbanization can adversely impact the streams and receiving watercourses within a watershed. These impacts include increases in flooding, streambank erosion, and export of pollutants. With the exception of dual purpose stormwater management previous management efforts have been primarily directed to reducing the risk of downstream flooding. Another approach on the part of both local and state governments has been to restrict development within the floodplain.

While these approaches have been reasonably effective in reducing flooding problems, they do not address the potential adverse effects of the urbanization process on the water quality within an area. However, a series of structural and nonstructural measures known as "best management practices" (BMPs) have been developed during the last two decades that could remove urban pollutants and protect the aquatic life of downstream areas. In addition, these BMPs could serve a dual purpose, i.e., controlling nonpoint source pollution and at the same time providing opportunities for stormwater management.

Thus, the purpose of this section is to discuss the following topics:

1. What are the impacts of urban runoff on the hydrologic regime?
2. What are some of the BMPs that could be adopted by communities in order to reduce the impacts of urbanization?

It should also be noted at this point that the word "urban" will be construed to represent all forms of residential development at varying densities as well as commercial and industrial development. The common denominator in all these forms of development is the amount of impervious surface that results from the urbanization process.

BMPs can be of the structural type (e.g., detention basins) or of the nonstructural type (e.g., good housekeeping, street sweeping). Since NJDEP is developing a variety of source controls and nonstructural BMPs as part of their nonpoint source control program, the focus of this paper will be on structural BMPs.

II. Stream Quality and the Urbanization Process

Uncontrolled urbanization generally has a profound impact on the quantity and quality of water within any watershed. The objective of this section is to describe some of the potential impacts that have been observed at numerous locations within the U.S.

Changes in Watershed Hydrology

The removal of the natural, vegetated surface as a consequence of initial site clearing and grading has an immediate effect on the hydrology of a stream. Precipitation that formerly had a chance to be absorbed into the ground is now directed to culverts, curbs, gutters, and storm sewers. As a result, the following changes occur in the hydrology of a stream:

a) Postdevelopment peak discharges are about 2 to 5 times higher than predevelopment levels;

b) Postdevelopment storm runoff volumes can be 50 percent greater than predevelopment volumes;

c) The time of concentration, which is defined as the amount of time needed for runoff to reach the stream, can be 50 percent less in the postdevelopment condition;

d) The frequency and severity of flooding usually increases;

e) Perennial streams in headwater areas can go dry during the summer as infiltration opportunity is reduced;

f) Runoff velocity can increase during storm events, due to the combined effect of higher peak discharges, reduced time of concentration, and hydraulically smoother surfaces that are associated with developed conditions.

Changes in Stream Geometry

The channel of an urbanizing stream has to adjust to the aforementioned hydrological conditions, which can result in the following responses:

a) Many streams widen to 2 to 4 times their original width as a response to increased storm flows. Streambank erosion can become quite severe as a result, since floodplain soils are generally unconsolidated and highly erodible.

b) Flood elevations increase as postdevelopment peak discharges increase.

c) Streambanks can be undercut and begin slumping into the channel.

Impacts of Urban Pollutants on Receiving Waters

The process of urbanization increases pollutant export by about an order of magnitude as compared with predevelopment conditions. The major pollutants are as follows:

Sediment. When sediment gets into streams, it increases turbidity, reduces light penetration and degrades the aquatic ecosystem. In addition, many toxicants and trace metals are carried as part of the sediment load. The largest amount of sediments is generated and exported during the construction phase of a development site.

Nutrients. Excessive levels of nitrogen and phosphorus in urban runoff can lead to the overenrichment of receiving waters. This process, which is known as eutrophication, results in undesirable algae blooms in impoundments. Note that most of the nutrients in urban runoff are usually found in soluble forms readily taken up by algae. The controlling nutrient in fresh waters is generally phosphorus.

Bacteria. Public health standards for water-contact recreation are exceeded by high bacterial levels in most cases of undiluted urban runoff. This situation is exacerbated during the summer because bacteria multiply faster in warm weather. It should be noted that even though bacterial levels can be very high during storm events, there is some controversy in the public health field as to whether or not these levels constitute a serious health hazard.

Oxygen Demand. The natural decomposition of organic matter by microorganisms in streams lowers the dissolved oxygen (DO) levels. The biochemical oxygen demand (BOD) test measures the potential DO depletion. The greater the amount of BOD, the larger the amount of oxygen that will be consumed in the process of decomposition. High BOD concentrations during a storm event can lead to anoxic (zero oxygen) conditions that degrade the aquatic ecosystem.

The largest amount of BOD exports occurs from older residential areas that have substantial impervious cover, combined storm sewers, and many pets. Newer, lower density suburban residential areas have reported only moderate exports of BOD.

Oil and Grease. Many different types of hydrocarbon compounds are contained in oil and grease, some of which are known to be toxic to aquatic life at low concentrations. The major source of hydrocarbons in urban runoff is

from crankcase oil and other lubricants leaking from cars and trucks. In uncontrolled runoff situations, hydrocarbons accumulate in the bottom sediments of lakes and estuaries.

Trace Metals. They are a matter of concern because of their potential to contaminate drinking water supplies and their toxic effects on aquatic life. Urban runoff samples have shown the presence of the following trace metals in varying concentrations: arsenic, beryllium, cadmium, chromium, copper, cyanide, mercury, nickel, lead, selenium, thallium, and zinc. Out of this list, the largest concentrations were measured for lead, cadmium, copper, and zinc.

It has been found that well over half the trace metals are attached to sediment, thereby reducing the amount that is immediately available for biological uptake and bioaccumulation. Also, urban runoff is very often diluted with other forms of runoff, which reduces the health risk potential.

Chlorides. Chlorides or salts in urban runoff result from their application to roads, parking lots, and sidewalks for snow and ice removal. Chlorides are extremely soluble and easily enter surface and groundwaters. High concentrations of chlorides may contravene drinking water standards; they also become toxicants to freshwater aquatic organisms, which can tolerate only a narrow range of salinity.

In summary, uncontrolled urban runoff from many locations in the U.S. often contains a mix of pollutants that are associated with development and impervious surfaces. Generally, pollutant load generation on a pound/acre/year basis increases as the percentage of impervious cover associated with development increases. The key at this point is the phrase "uncontrolled urban runoff." The pollutant generation from impervious surfaces can be greatly

employing best management practices, a topic discussed in the following section.

III. Best Management Practices

Within the past two decades, a number of urban best management practices (BMPs) has been developed and refined to the point at which some of the adverse impacts usually associated with development activity can be substantially reduced. Each BMP has advantages and disadvantages depending upon the physical constraints imposed by the site and the proposed density. Therefore, the purpose of this section is to briefly describe the characteristics of the major urban BMPs. Generalized cost estimates, as well as the positive and negative features of each option, will also be included wherever possible.

1. Retention (Wet) Ponds can be a very effective water-quality BMP. If they are properly designed, sized appropriately, and regularly maintained, wet ponds have the potential to remove high rates of sediment, BOD, organic nutrients, and trace metals. Soluble nutrients that contribute to eutrophication can also be removed by biological processes within the pond.

These ponds increase in cost-effectiveness as sites become larger and more intensively developed. They are best suited for residential and commercial developments that have a reliable source of water and are greater than 20 acres.

The positive impacts of wet ponds include the creation of local wildlife habitat, an increase in property values, recreation, and a landscape amenity value. Negative impacts include possible degradation of upstream and downstream habitat; potential safety hazards; occasional nuisance problems, such as odor, algae, and debris; and sediment removal, which can be costly.

The estimated range of removal rates for selected pollutants by retention

(wet) ponds based on various design criteria is as follows:

suspended sediment:	60 to 100 percent
total phosphorus:	40 to 80 percent
total nitrogen:	20 to 60 percent
oxygen demand:	20 to 60 percent
trace metals:	20 to 80 percent

2. Extended Detention Ponds in which the detention time of dry or wet ponds can be extended to 24 hours or more, can provide for the removal of particulate pollutants at a level as great as 90 percent. However, soluble nitrogen and phosphorus levels are only slightly reduced. Opportunities for removal of these soluble nutrients can be provided if the normally inundated area of the pool is managed as a shallow marsh or a permanent pool. Extended detention ponds can also control downstream bank erosion. This BMP is very cost-effective, with construction costs rarely more than 10 percent above the costs reported for conventional dry ponds.

The disadvantages of the extended detention ponds include occasional nuisance and aesthetic problems in the inundated part of the pond (e.g., odor, debris, and weeds), moderate to high routine maintenance requirements, and eventual sediment removal, which can be costly.

The estimated range of removal rates for selected pollutants by extended detention ponds based on various design criteria is as follows:

suspended sediment:	60 to 100 percent
total phosphorus:	20 to 80 percent
total nitrogen:	20 to 60 percent
oxygen demand:	20 to 60 percent
trace metals:	40 to 80 percent

3. Infiltration Trenches represent a useful BMP for good removal rates of both soluble and particulate pollutants. As with other types of infiltration systems, they are not designed to trap coarse sediments. Indeed, they require the installation of grass buffers or special inlets to capture the sediment before it can enter the trench. Infiltration trenches require permeable soil and sufficient depth to seasonal high water and bedrock. In terms of practicality and economics, they are best suited for small sites of 5 acres or less.

The advantages of infiltration trenches are as follows:

a) preservation of the natural groundwater recharge the capabilities of the site;

b) they are easy to fit into the margins of a site;

c) they are one of the few BMPs that can efficiently remove pollutants on small sites.

The disadvantages include:

a) the difficulty in keeping sediment out of the trench during site construction;

b) the need for regular annual maintenance;

c) possible groundwater contamination.

The estimated range of removal rates for selected pollutants by infiltration trenches based on various design criteria is as follows:

suspended sediment:	60 to 100 percent
total phosphorus:	40 to 80 percent
total nitrogen:	40 to 80 percent
oxygen demand:	60 to 100 percent
trace metals:	60 to 100 percent
bacteria:	60 to 100 percent

4. Infiltration Basins can remove both soluble and particulate pollutants that are associated with urban runoff. Coarse-grained sediments should be removed

before they enter a basin. They are best suited for sites where the soils are permeable and have sufficient depth to seasonal high water and bedrock. Infiltration basins have construction and maintenance costs that are similar to conventional wet ponds. They can be used on sites of up to 50 acres.

The advantages of infiltration basins are as follows:

a) preservation of the natural water balance of the site;

b) they can be used as sediment basins during the construction phase of a project;

c) they are reasonably cost-effective in comparison with other BMPs.

The disadvantages include:

a) a high failure rate in areas with impermeable soils;

b) frequent maintenance;

c) possible nuisances, such as odors, mosquitos, and soggy ground.

The estimated range of removal rates for selected pollutants by infiltration basins based on various design criteria is as follows:

suspended sediment:	60 to 100 percent
total phosphorus:	40 to 80 percent
total nitrogen:	40 to 80 percent
oxygen demand:	60 to 100 percent
trace metals:	40 to 100 percent
bacteria:	60 to 100 percent

5. Porous Pavement used on a low-volume parking area has a high capability for removing both soluble and fine particulate pollutants. It is feasible only on sites that have gentle slopes, permeable soils, and ample depth to seasonal high water and bedrock. It is considered to be a reasonably cost-effective BMP. Porous pavement areas can also accept some runoff from rooftop storage or adjacent parking areas paved with conventional materials.

The advantages of porous pavement include:

a) longevity and load-bearing strength comparable to conventional pavement when it is properly designed and maintained;

b) groundwater recharge;

c) augmentation of low flow;

d) control of streambank erosion;

e) reduction of the need for curbs and gutters;

f) preservation of the natural water balance of the site;

g) a safer driving surface during wet weather.

The major disadvantage of porous paving is that it is difficult and expensive to rehabilitate if it becomes clogged with sediment. This means that sediment must be kept off the pavement before, during, and after construction. Other disadvantages include the need for a very high level of construction workmanship, potential damage from freezing if inadequate drainage is provided, and a possible, albeit slight, risk of groundwater contamination.

The estimated range of removal rates for selected pollutants by porous pavement based on various design criteria is as follows:

suspended sediment:	40 to 100 percent
total phosphorus:	60 to 80 percent
total nitrogen:	40 to 80 percent
oxygen demand:	60 to 100 percent
trace metals:	40 to 100 percent
bacteria:	60 to 100 percent

6. Water Quality Inlets (or oil/grit separators) are designed to remove sediment and hydrocarbon loadings originating from parking lot runoff before they go into the storm drains on the site. They do not modify the postdevelopment peak runoff rates from a site. Their purpose is to provide moderate removal of

coarse sediment, oil/grease, and debris. Fine-grained particulate pollutants, such as silt, clay, trace metals, and nutrients, would be only partially removed. Soluble pollutants would pass through the inlets without any removal.

The typical water quality inlet serves a parking lot of 1 acre or less. The costs range from $5,000 to $15,000 per inlet. Maintenance costs are high, because inlets must be cleaned out at least twice a year to remove trapped pollutants and ensure proper functioning of the structure.

The advantages of the water quality inlet are as follows:

a) it blends easily into the site;

b) it is compatible with the storm drain network;

c) it is easily accessible for repairs and maintenance;

d) it provides some pretreatment opportunity prior to the parking lot runoff going into a storm drain or an infiltration BMP.

The disadvantages include:

a) limited removal capability for pollutants;

b) the need for regular maintainance.

The estimated range of removal rates for suspended sediment by water quality inlets is 0 to 20 percent. There is insufficient knowledge about the removal rates for the other pollutants at the present time.

7. Vegetative BMPs include practices that use various forms of vegetation to improve the pollutant removal, habitat value, and appearance of a development site. They can be applied during any phase of the development project and add only a modest incremental cost to the total expense of pond or basin construction. Vegetative BMPs are as follows:

a) Grassed swales: usually used in single-family residential developments as an alternative to curbs and gutters. They can filter out some particulate pollutants but do not remove soluble pollutants, such as

nutrients. Swales reduce runoff velocity and thereby partially reduce postdevelopment peak discharge rates. The excavation and seeding costs for a 15-foot swale range from $4.50 to $8.25/linear foot.

The estimated range of removal rates for selected pollutants by grassed swales based on various design criteria is as follows:

suspended sediment:	0 to 40 percent
total phosphorus:	0 to 40 percent
total nitrogen:	0 to 40 percent
oxygen demand:	0 to 40 percent
trace metals:	0 percent

b) Filter strips: very similar to grassed swales except that they are designed to accept overland flow only. It is necessary that the runoff from adjacent impervious areas be distributed across the filter strips as evenly as possible in order to avoid runoff concentration and channel formation. Moderate rates of particulate pollutant removal are possible. The rate varies as a function of slope, soil permeability, the size of the subwatershed, which is the source of the runoff, and the velocity of the runoff. Filter strip costs are relatively low, ranging from $1,500 to $11,000 per acre depending upon the method of seeding (hydroseeding or sodding).

The estimated range of removal rates for selected pollutants by filter strips based on various design criteria is as follows:

suspended sediment:	20 to 100 percent
total phosphorus:	0 to 60 percent
total nitrogen:	0 to 60 percent
oxygen demand:	0 to 80 percent

trace metals: 20 to 100 percent

c) Urban forestry: entails either the preservation of trees during the construction phase or planting them after the site has been completely developed. One of the major hydrologic benefits of this practice is that the amount of runoff generated from these landscaped areas is often 30 to 50 percent less than that produced from turf or lawns. Another major benefit is, of course, the amenity value of having trees and shrubs on the property. Urban forestry has only a limited pollutant removal rate, although the rate increases markedly for forested buffer strips.

Maintenance requirements are very low once the vegetation becomes established. The total costs for urban forestry practices are in the range of $1,000 to $5,000 per acre.

d) Shallow Marsh Creation: wetland or shallow marsh creation is a variant of basin landscaping. It has a very important role as an urban BMP because it can greatly assist in pollutant removal from urban runoff. Wetlands can be established around the margins of a wet pond and in the lower portions of an extended detention pond. Wetland plants have the ability to use the nutrients found in urban runoff during the summer growing season when the eutrophication threat is greatest.

IV. CONCLUSION

It is clearly recognized that urbanization entails converting undeveloped land with a small degree of impervious cover to land with a high degree of impervious cover. Many studies have shown that pollutant loadings increase as impervious cover increases. This relationship is predicated on "uncontrolled urban runoff." What has occurred in the past two decades is a growing

recognition that a variety of structural devices can be employed during development that can temporarily store or treat urban stormwater runoff to reduce flooding, remove pollutants, and provide some environmental amenities at the same time.

These best management practices (BMPs) can be used by developers to mitigate the hydrologic impact associated with an increase in impervious cover. Obviously, each site will have a different set of physical constraints (drainage area, soil, slope, etc.) that will make one BMP better suited than another. The important point is that one or more of the BMPs listed herein are available now so that they can be effectively incorporated in the design of a development. The inclusion of BMPs should have a positive role in addressing the water-related concerns that a community usually has in evaluating a development proposal.

These BMPs will have a cost, either in a land requirement, or a construction requirement, or both. The costs will vary, depending on the site characteristics and the environmental sensitivity of the receiving watercourses. However, the end result of adopting one or more of the BMPs is the improvement in the urban runoff from a development site in terms of both quantity and quality.

AGRICULTURAL BMPs

I. Introduction

One of the salient observations of the State Erosion, Sediment, and Animal Waste (SESAW) Study for New Jersey (Soil Conservation Service, 1986) was that nonpoint pollution from agricultural sources was a major contributor to water quality problems in the state. Thousands of tons of sediment wash off the

croplands of New Jersey and clog lakes, culverts, road ditches, canals, and rivers. The nutrients and other pollutants that are attached to sediment cause eutrophication problems in many lakes throughout the state. Thus, we have the problem that although agriculture has obvious benefits to the community, for instance, the preservation of open space, it is also a major factor in water quality degradation.

On a national level, sediment from soil erosion is considered to be the greatest single pollutant in U.S. surface waters. During the early 1980s, the National Water Quality Evaluation Project (NWQEP) found that excessive amounts of sediment were resulting in the following problems:

a) a reduction in stream and reservoir capacity;

b) an increase in flooding;

c) a disruption in biological systems;

d) a degradation in drinking water supplies from the transport of nutrients, pesticides, and bacteria to receiving watercourses.

Therefore, the purpose of this section is to identify and briefly discuss the best management practices (BMPs) that can be employed to reduce sediment inputs from farmland. The focus will be on sediment because that is the major problem associated with uncontrolled agricultural runoff.

II. Best Management Practices

The Soil Conservation Service has been concerned with sediment-control measures since 1933. Some of the more important measures (or BMPs) that have been implemented on a national scale are as follows:

1. Conservation Tillage Systems include no- tillage, sod planting, minimum tillage, chisel-plowing and slot-planting. All these measures leave protective amounts of crop stubble on the ground. As a result, the volume of surface

runoff and consequent soil erosion is reduced because soil detachment and transport is itself reduced.

2. Contour-Plowing involves plowing, planting, and cultivating along the contour. This BMP is most effective when the rows are ridged and furrowed so that surface runoff can pond behind the ridge. Greater infiltration can then result, leading to reduced runoff volume.

3. Cover Crop include close-growing grasses, legumes or small grains grown primarily for seasonal soil protection and to provide residues for conservation tillage. The purpose of planting a cover crop is to reduce direct surface runoff and to reduce soil detachment from raindrop impact during the nongrowing

4. Diversions are channels with a supporting ridge on the lower side that are constructed across the slope. The purpose of this structural BMP is to help reduce the soil transport capacity of runoff by decreasing the length of the slope. It also prevents damage downslope from the diversion.

5. Grassed Waterways are vegetated depressions or drainageways that carry surface runoff, preventing rill or gully formation. The waterways can be either natural or constructed.

6. Rotating Grasses and Legumes is part of a conservation cropping system. The closely grown sod crop can significantly reduce soil detachment from raindrop impact as well as diminish the volume of surface runoff.

7. Sediment Basins are structures designed to impound runoff and allow sediment to settle out. The benefits of these basins are mostly off-site, because only downstream water quality is affected rather than the production capacity of the farm. The basins can also substantially reduce downstream flow rates; this factor is important for channel stability, particularly in small watersheds.

8. Streambank Protection and Stream Channel Stabilization are both

structural and nonstructural measures that can reduce streambank erosion. They may also assist in maintaining channels to reduce sediment deposition and remobilization of soil particles.

9. Terraces are a combination of ridge and channel constructed across the slope. They reduce erosion mainly by decreasing the length of the slope. Terraces also have a secondary function in that they reduce sediment delivery by allowing eroded soil to be redeposited before reaching waterways. However, this redeposition may eventually make the terrace an ineffective structural measure. A third benefit of terraces is that they also reduce runoff volume by facilitating infiltration, although not to the same extent that erosion is reduced.

10. Filter Strips are vegetated strips for removing sediment from runoff. They improve water quality by reducing sediment delivery.

III. Conclusion

Agricultural BMP methodologies have been in existence for many decades. There is nothing particularly new about installing them on New Jersey farms. What is relatively uncertain about them is their effectiveness in improving water quality. This aspect of their effectiveness should form the substance of a separate research effort by the SCS or NJDEP.

Some of the watersheds used for public water supply purposes do not have large areas in farms. This category would include the Passaic and Hackensack basins. Therefore, the issue of agricultural BMPs is not as important in these areas. Other watersheds have larger amounts of land in some form of farm activity, such as the Raritan and upper Delaware Rivers. Agricultural BMPs in these basins would therefore be of much greater importance. The Swimming River reservoir in Monmouth County is noted for the large number of horse and

crop farms above the reservoir. This watershed is the subject of a separate NJDEP project on the Navesink estuary.

The major point about agricultural BMPs is that much is known about their installation and cost. The SCS has a wealth of good information that can be made available to the interested public. In this context, NJDEP is working on a pilot program, called the Navesink River Water Quality Improvement Project, that is cooperating with 14 federal, state, county, and local agencies. One problem that must be noted, however, is the large number of absentee owners of farmland who are often less concerned about soil control measures.

RECOMMENDATIONS

1. The State of New Jersey should require all municipalities that have water supply/water quality sensitive lands within their jurisdiction to have all development employ the most appropriate BMPs.

It is imperative that the ranking of water supply/water quality sensitive lands as outlined elsewhere be accompanied by a detailed list of BMPs, which can then be adopted where appropriate. It is recognized that the BMPs that would be best for each site would, of course, have to conform with the particular physical conditions that are site-specific.

2. The NJDEP Division of Water Resources should support an ongoing program to evaluate the effectiveness of existing and emerging BMPs.

The comment has been often made that additional information is required with regard to the efficacy of the various BMPs. This position is entirely reasonable, and plans should be made to commence some form of water quality data acquisition. The list of parameters could initially be limited to the more conventional ones, such as nutrients, BOD, suspended solids, etc., in order to hold down costs.

A water quality sampling program should be instituted by NJDEP or Rutgers (under NJDEP guidance) that would evaluate the pollutant removal effectiveness of existing and emerging BMPs. The sample sites should be geographically dispersed so as to reflect the variety of soils and landscapes in New Jersey.

3. Serious consideration should be given to the use of multiple and linked BMPs in those areas of the state that rank high in water supply/water quality sensitivity.

This suggestion is obviously costly because it calls for system redundancy. It should be required for only those areas where the most stringent measures are necessary. In a sense, extra BMPs are similar in concept to those municipalities that require oversized septic system disposal fields in their ordinances. The cost is higher, but there is extra environmental protection.

4. The NJDEP Division of Water Resources should support a research project on the relationship between agricultural BMPs and their effect on water quality.

The research could be done by SCS or Rutgers or some combination of the two. It would be very useful to know how effective the various agricultural BMPs have been in the past. Perhaps one or two sample watersheds could be studied. The cooperation of SCS would be very important to such a study.

5. The State of New Jersey should require municipalities that have farms located within water supply/water quality sensitive lands to adopt ordinances that require BMPs to be employed.

The fact that sediment is the number one polluter in the nation and that it serves as a transport mechanism for nutrients and other contaminants makes it imperative that any BMP that could reduce sediment transport should be adopted as quickly as possible. It is recognized that the effectiveness of the BMPs may not be fully known, but at least they would offer some degree of protection.

This procedure is even more important for those watershed lands that are ranked highest in sensitivity. It is only reasonable to expect that property owners recognize their obligations to protect community water supply sources.

6. Any farm owner who wishes to qualify for farmland assessment should be required to employ BMPs.

This recommendation would serve as a very useful incentive to encourage the adoption of agricultural BMPs.

7. The NJDEP Division of Water Resources should establish a clearinghouse on technology transfer for all forms of BMPs.

Information dissemination is of obvious benefit for existing and potential users of BMPs. EPA has a large existing technology transfer program on a national basis for its various environmental activities. The University of West Virginia in Morgantown maintains a specialized clearinghouse for information pertaining to small wastewater flows. Both these programs could serve as useful guides for a New Jersey-based clearinghouse on BMPs. The library and academic resources of Rutgers University could assist NJDEP in such a venture.

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BUFFER STRIPS IN WATERSHED MANAGEMENT

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5

I. Introduction

Controversy and uncertainty are inherent in watershed management. For example, decisions to restrict the use of perimeter land through specified buffer widths must contend with protests "that there is no scientific or legal basis for such a policy" (Amon, 1988). Some groups feel that not enough information about buffer strips is available to warrant imposition of control programs. Preoccupation with inductive logic, predicated on confirmation by evidence, is probably the worst way to approach the preservation of stream corridors and watershed management in general. Waiting for a definitive scientific review will mean some water bodies become irretrievably damaged. The purpose here is not to debate modern positivism, but to discuss those examples in the literature that support the argument that specifications for buffer strip widths need not be determined capriciously when the role of buffer strips in watershed management is not fully understood. When the *function* of a buffer strip is considered along with soil, vegetation, slope, and factors directly related to the speed of flow toward the waterway, the myth of arbitrary buffer widths is dispelled.

Regardless of the scientific literature, there will always be those who cannot be persuaded to change their opinion. Duda (1980:105), in his discussion of management alternatives for protecting water quality, cites Sir Francis Bacon (father of the scientific method):

The human understanding, when it has once adopted an opinion, draws all

things else to support and agree with it. And though there be greater weight to be found on the other side, yet this it neglects and rejects in order that its former conclusions may remain inviolate.

The controversy over determining the boundary distance of buffer strips from streambanks, feedlots, and wetlands is a legitimate struggle between environmental advocates and developers, farmers, and landowners. In this chapter the controversy surrounding buffer strips is reviewed from a technical viewpoint to further understand the role of such factors as slope, runoff volume, soil, vegetative cover, and long-term maintenance in determining buffer widths.

II. Some Definitions

Buffer strips - A buffer strip is a reference term for the uncut zones of grass or other erosion-resistant vegetation between a waterway and an area of more intensive land use (EPA, 1984). When left in their natural condition, bands of vegetation that flank the edge of streams, ponds, lakes, and wetlands help protect, or "buffer," water resources and aquatic systems from pollution and disturbance by adjacent land uses (Rogers et al., 1987).

Buffer strips are natural drainage systems with a multifunctional role. Buffer strips along streambanks provide protection for stream ecosystems (Steinblums et al., 1984), create shade (Brazier and Brown, 1973), act as barriers to debris caused by logging, wind, or disease (Froehlich, 1973); and help to stabilize streambanks by maintaining root masses. Vegetated buffers are an effective technique for coordinating land use and runoff control because they prevent or reduce contamination from surface runoff containing silt, oils, chemicals, bacteria, and nutrients.

Buffer strips are simply nature's way of preserving stream valleys. This distinction, along with their multifunctional role, classifies them as a "Blue-Green" technology.[1] They function as *natural* drainage systems while offering

[1] The term "Blue-Green" was coined and applied by Earl Jones in the 1960s as a descriptor for natural settings and the multifunctional roles they can play and the extraordinary influence they can have on the quality of the urban

recreation opportunities, establishing open space, increasing property values, protecting cultural resources, and enhancing aesthetic values.

The term "buffer strip" is sometimes used interchangeably with Streamside Management Zones (SMZs), riparian zones, greenways, filter strips, transition areas, and grassed waterways--natural or constructed vegetative depressions that carry surface runoff while preventing the formation of gullies. Tourbier et al. (1980), for example, discuss buffer strips as a system of greenways:

> Greenways are based on areas of coherent natural constraints in development which also offer the opportunity to "structure" urban development with a stream valley system which is functional, beautiful, and comprehensive. They provide for flood damage control, and protect water quality for the potential recreational use of "Scenic Rivers" in an urban setting. Land use controls for such areas should be selected according to development pressure, site characteristics and the vulnerability of the area (1980:15).

They demonstrate, through overlay mapping of the Neshaminy Creek in Pennsylvania, that steep slopes, poorly drained soils, and woodlands combine to form areas ideally suited for appropriate water resource conservation measures.

The Delaware Valley Regional Planning Commission (1981:3-27) offers the following related definitions:

Grassed Waterways - Concentrated flows of surface runoff are directed through grass covered drainage swales or channels. The grassed surface retards flow velocities and maintains soil porosity while providing relatively stable channel lining. In addition, a small amount of runoff filtering occurs due to the velocity reduction, resulting in improved water quality. Whenever possible, grasses native to the site should be selected for use to insure acclimation.

Filter Strips - Sheet flows of surface runoff are directed across grass buffer strips which slows the sheet flow causing the heavier particulates to fall out while simultaneously enhancing infiltration of the runoff. These strips of close growing grasses can be established at the perimeter of disturbed or impervious areas.

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environment. The concept is explained by Jones in an article entitled "Urban Hydrology - A Redirection." ASCE Journal (August 1967). The simplicity of the concept has caused some to wonder why there are so few examples of this idea consciously carried out (Westmacott, 1980).

Seepage Areas - Surface runoff is directed into small grass-covered areas that infiltrate the water and filter out particulate contaminants. Seepage areas are created by excavating shallow depressions in the land surface or by constructing a system of dikes or berms to temporary pond water over permeable soils.

III. Management Complement

Many effective means of protecting and preserving water resources are available. There are also many ineffective techniques attempted by landowners as quick solutions to long-term problems. Techniques do not work equally well in every situation. Many people feel that nonstructural measures, such as buffer strips, parkland acquisition, flood-proofing, and various standards and requirements for drainage system design are better solutions because they do not present hazards to local water resource ecosystems inherent in many structural solutions (Poertner, 1988).

Large-scale nonstructural solutions are much cheaper than the costs for the use of small-scale structural solutions (U.S. EPA, 1984). Buffer strips within stream corridors have an economical advantage in that they frequently lend themselves to use as linear parks and may be suitable for public recreation use (e.g., walking and bicycling paths), as well as for flood control.

The results of some studies suggest that nonstructural practices, such as buffer strips, are a promising alternative method for controlling pollution in surface waters. The following discussion examines the results of these studies and the application of buffer strips as a watershed management strategy for the State of New Jersey. Although a funding program specifically associated with buffers does not exist in New Jersey, there is encouragement from the recent passage of the Freshwater Wetlands Protection Act in July 1987. Other programs that recommend nonstructural practices include the Stormwater Management Act (P.L. 1981), the Flood Plain Management and Stream Encroachment programs

administered by the New Jersey Division of Coastal Resources, and the Green Acres program. Buffer strips are regulated under the D & R Canal State Park Law of 1974 and the New Jersey Pinelands Protection Act of 1979.

IV. Buffer Strip Functions

Buffer strips serve a variety of functions within a watershed. Buffers for sediment control, streambank and streambed erosion control, nutrient and pollutant removal, and reservoir protection are directly associated with the reduction of pollutant exposure to surface waters. Buffers for temperature control, aquatic species food source, and wildlife habitat are more directly associated with fish, wildlife and open space concerns. The various buffer strip functions, however, are not exclusive of one another. Buffers which serve water supply/quality concerns also affect fish, wildlife, and open space. A buffer strip can serve many functions at once. In determining the type and width of a buffer strip, one must be concerned with the most critical function to be performed by the buffer strip.

Buffers for Sediment Control
(50-200 feet)

Sediment deposition is a natural process that takes place during periodic flooding (Lowrance et al., 1985). Upland erosion caused by farming, forestry, or any land use that removes vegetation and disturbs the soil accelerates sediment deposition in streamside areas. Such deposition can change soils, drainage, and vegetation (Trimble, 1974). Excessive sediment loading contributes to the decline of fisheries. High sediment concentrations clog the gills of fish and fish food organisms. Moderate sediment concentration may cause unsuccessful spawning. "Sediment in water reduces light penetration and plant growth, which disrupts

the food chain supporting fish and wildlife" (Duda, 1985:225).

Fine-grained sediment has an affinity for absorbing and transporting such pollutants as insecticides, herbicides, trace metals, and plant nutrients. Nitrogen and phosphorous released from fertilizer and animal wastes also move with eroded soil, contributing to eutrophication of rivers, lakes, and estuaries. The cost to the public of sediment polluted water is significant in terms of increased flood damage, restocking of fish, development of alternative water supplies, restoration of degraded rivers and lakes, control of nuisance weeds, dredging, and channel alterations or dams to mitigate flooding in areas with clogged channels. These costs, plus damage to fish and wildlife, exceed $6 million annually. A summary of estimated costs is in Table 5.1.

The Conservation Foundation estimates that agricultural activities account for 70 percent of the 4.5 billion metric tons of soil erosion each year (Clark, 1983). Gianessi and Peskin (1981) suspect about 66 percent of the suspended solids loading rivers nationwide is attributed to agricultural sources.

Table 5.1 Summary of Annual Economic Damage Caused by Sediment as Presented to Congress[1]

Type of Damage	Annual Cost Estimate (millions of dollars)
Crops, Structures, Forests	1,000
Reservoir Sedimentation	800
Waterway Dredging	600
Ditch Cleanout	200
Increased Water Treatment	100
Commercial Fisheries, Recreation, Other	500

[1] Based on preliminary data presented by the Conservation Foundation (Clark, 1983).

Design and Evaluation

Near-stream vegetation is important because it allows a gradual release of sediment into the stream channel. When near-stream vegetation is absent, levels of suspended solids increase quickly during storm events because the "friction" of the flood plain is reduced (Schlosser and Karr, 1981; Robinson and Collier, 1980). Levels of suspended solids increase at a slower rate in stream channel sections with well-developed vegetation.

The U.S. Department of Agriculture, Soil Conservation Service's 1988 amendments to the National Handbook of Conservation Practices recommends that filter strips for sediment and related pollutants should be at least 66 feet for slopes of less than 10 percent and proportionately up to 99 feet for 30 percent slopes. The analytical basis for these figures was not given.

Perhaps the most comprehensive model available for buffer strip design with respect to sediment removal is the Kentucky filter strip model developed by several teams of Kentucky researchers. Experimentation began in the lab with the work of Barfield et al. in 1977. The model was later extended for unsteady flow and nonhomogeneous sediment by Hayes et al. (1979) and verified using field data by Hayes and Hairston (1983). Barfield et al. (1979) experimented with flow, sediment load, particle size, flow duration, slope, and media density to determine the sediment-filtration capacity of grass media. Sediment outflows were found to be primarily a function of slope and media spacing. The Kentucky researchers observed that the upper portions (first meter) of a filter strip were critical as the majority of the sediment was deposited there. When this area became buried in sediment, efficiency declined. The efficiency of the vegetal media decreased dramatically with higher runoff rates.

Planning Considerations:

average stocking rate of shrubs
average size of woody stems less than 1 inch in diameter
nutrient uptake per unit of area by the plants
water spreading through the filter
runoff velocity
slope

Effectiveness

Nearly all the sediment eroded from a field will drain directly into a lake or stream system if there is "no intervening obstructions or flattening of the land slope" (Wischmeier and Smith, 1978:47). The USEPA reported that grassed waterways will reduce sediment from cropland between 5 and 40 percent (EPA, 1984). In the same report construction costs for grassed waterways were $1-2 per foot or $72 per acre; maintenance costs were $1-14 per acre per year.

Karr and Schlosser (1977) tested the effectiveness of bluegrass sod in trapping total sediment discharge under ideal conditions of broad sheet flow. In their experiment a 50-foot-wide strip reduced sediment concentration by only 54 percent. Wong and McCuen (1981) relied on mathematical modeling of such factors as slope, vegetation cover, and runoff velocity to determine the sediment control for various buffer strip widths. They concluded from their modeling that a 200-foot buffer strip with relatively steep slopes and dense vegetative cover would reduce sediment transport by 90 percent.

Buffers for Streambank and Streambed Erosion Control
(25-213 feet)

Streambanks contain the flow of water. Their resistance to the erosive flow of water is related to the types of rock found in the area, the age of the stream, and the streambank vegetation. Youthful streams in rocky terrain will

have fairly straight streambanks, and while more mature streams have curving banks of soil or gravel (Jones and Battaglia, 1986). Streambanks of rock are very resistant to erosion. The root structures of woody vegetation further enhance the erosion resistance of streambanks.

Design and Evaluation

Streambank erosion is caused by increased stream velocity, obstacles in the stream, floating ice and debris, wave action, and direct rainfall. People are also responsible for streambank erosion by introducing increased runoff, soil compaction, removal of vegetation, and placing debris and obstacles in the stream. Any activity that disturbs and compacts the soil results in increased runoff and erosion (van Groenewoud, 1977). This includes the practice of crossing streams with logging equipment, the construction of culverts and bridges, and the improper construction of roads. Nonsuspendable soil material (fine sand, etc.) becomes dislodged by by such activities and plugs the interstitial spaces in the stream's gravel bed and causes most of the damage. Megahan and Kidd (1972) studied streams in Idaho and determined that erosion from roads increased sediment deposition by an average of 750 times that of similar undisturbed watersheds for a period of 6 years after construction.

When the interstices in gravel-bottomed streams fill with fine sediment there is a drastic decrease in the presence of large insect larvae, a main source of food for fish living in this type of stream:

> Sedimentation and the filling of the interstices with sand and silt also interfere with the reproduction of some fish such as salmon and trout. They normally bury their eggs deep in the gravel where they are safe from predators and washout. The eggs are, however, very dependent on the intergravel flow of water for their oxygen supply and the removal of metabolites. Fine sediment in the interstices cuts off the flow of water and these types of fish will not lay their eggs in such places. If eggs are already present, the lack of oxygen will kill them (van Groenewoud, 1977).

Buffer strips protect against streambank erosion. After rock, the best streambank stabilizer is woody vegetation (i.e., trees and shrubs). These plants hold the soil together with their root structures. Vegetated buffers trap eroding soil from adjacent land. van Groenewoud (1977:12) states that "if penalties against violation of the buffer strip are included in the regulations a 15 m (50 ft) buffer strip is sufficient to protect the brook."

Planning Considerations:

Ideally, vegetated buffers would be planned, constructed, and stabilized in advance of the facilities that will discharge into them. When vegetated buffers are constructed and stabilized at the start of site disturbance, the unnecessary off-site impacts, extra maintenance, reworking of grades, revegetation of slopes and grassed waterways, and extra expenses to the developer can be avoided. Vegetated buffer strips should also be retained in their natural state.

Existing woodlands should be preserved under open space requirements in municipal zoning and subdivision laws. Woodland buffers, however, should not be viewed as a substitute for upland erosion control.

Effectiveness

Whipple et al. (1981) observed a correlation between woodland buffers and a reduction of bank and bed erosion in streams. According to their classification system, a buffer strip 25 feet wide provides only moderate levels of protection. Natural wooded strips over 50 feet in width were considered excellent. A wooded strip less than 10 feet was considered poor, and any width in between was classified as "medium" in terms of reduced bank and bed erosion.

A corridor that has woody plants and shrubs should be at least 25 feet in width, and as much as 200 feet in width when adjacent slopes are steep, according to the **Streambank Stabilization and Management Guide for Pennsylvania**

Landowners. Under the Conservation Reserve Program, authorized by the Food Security Act of 1985 and administered by the Agricultual Stabilization and Conservation Service (ASCS) for the purpose of converting highly erodible land to permanent grass and tree cover, filter strips must be no less than 66 feet wide.

The width of the required buffer strip depends on the slope, the rate of precipitation, the type of vegetative cover, and the texture and structure of the soil. Trimble and Sartz (1957) suggest a basic strip of 65 meters (213 feet) that increases 60 centimeters (2 feet) in width with every 1 percent increase in slope.

Buffers for Nutrient and Pollutant Removal
(150-300 feet)

Runoff that transports sediment to water bodies also carries nutrients. Large portions of nutrients are attached to sediments and cause water quality problems:

> Excess nutrient loading to watercourses by both surface and subsurface runoff accelerates plant growth, particularly that of phytoplankton and algae. This over-production causes water quality problems including noxious odors, reduced light, and shortages of dissolved oxygen, a necessary element in maintaining stream quality (Rogers et al., 1987:5).

Vegetated buffers keep nutrients and other pollutants from entering water bodies by absorbing them through their root systems. Dillaha et al. (1986a) maintain that "the filtration of solid particles by vegetation during overland flow and the absorption process are not as well understood as the infiltration and deposition process" (1986a:5). The filtration capacity of vegetative buffer is an important characteristic relating to particulate matter (i.e, soil, aggregates, manure) while absorption is significant to the removal of soluble pollutants.

Infiltration is important because it decreases the amount of surface runoff.

Design and Evaluation

Dillaha et al. (1986b) developed a simplified procedure for the design and evaluation of vegetative filter strips (VFS) used for removing sediment, nitrogen, and phosphorus. The following equations describe the vegetative buffer strip performance:

(1) $RTSS = 71.41-29.23Q^2 + 2.55\ W$ $\quad r^2 = 0.87$

(2) $RTN = 70.38 + 88.26Q-110.26Q^2$ $\quad r^2 = 0.91$

(3) $RTP = 74.03 + 74.47Q-97.96Q^2$ $\quad r^2 = 0.90$

where: RTSS, RTN, and RTP are the percentage reductions in TSS, T-N, and T-P respectively; Q is the flow rate into the filter per unit length, L/s-m (liters/sec-/min); and W is the filter width, m. (Filter slope was not statistically significant in the regressed equations.)

Equation 1 is appropriate for filter strips less than 11.2 meters (36.75 feet.) in width and for flow rates less than 1.8 L/s-m. RTSS was negligible at higher flow rates. Equations 2 and 3 are appropriate for flow rates between 0.4 and 1.3 L/s-m. RTN and RTP were assumed to be 90 percent for flow rates less than 0.4 L/s-m. From these regression equations, Dillaha et al. (1986c:8) developed the following design/evaluation procedure:

1. Obtain topographic map of area proposed for protection by VFS;
2. Delineate subwatersheds within the field from a topographic map which will drain through the VFS and determine the drainage area for each subwatershed;
3. Estimate the total volume of runoff which will be discharged from each subwatershed using the SCS total runoff volume method or other appropriate method for the desired design storm;
4. Estimate the VFS length through which flow will pass for each subwatershed, VFS longitudinal length in areas with shallow sheet flow or channel width through VFS in subwatersheds with developed drainageways;

5. Determine flow rate per unit length through the VFS for each subwatershed;

6. Estimate percent reduction in desired pollutant for each subwatershed using the regression equations; and

7. Weight percent reductions on an areal basis to determine if VFS are appropriate for the field under investigation.

Nutrient and bacterial removal are particularly important in developing rural areas where there are septic systems and agriculture. For locations having these conditions Rogers et al. (1987) recommend a minimum buffer of 100 feet. In watercourses that drain to water supply areas, they recommend a minimum buffer of 200 feet for sediment and nutrient removal.

Planning Considerations:

Flow hydraulics - The removal capacity of buffer strips depends on the contact time of surface runoff. Slowly moving runoff allows the removal mechanisms to function.

Rates of: denitrification (for N), vegetative uptake (for both N and P), deposition, and adsorption (for P).

Physical site characteristics: soils, topography, and site hydrology.

Forest attributes: dense and diverse vegetation, rates of both uptake and evapotranspiration of water, and presence of high organic content in the soil profile.

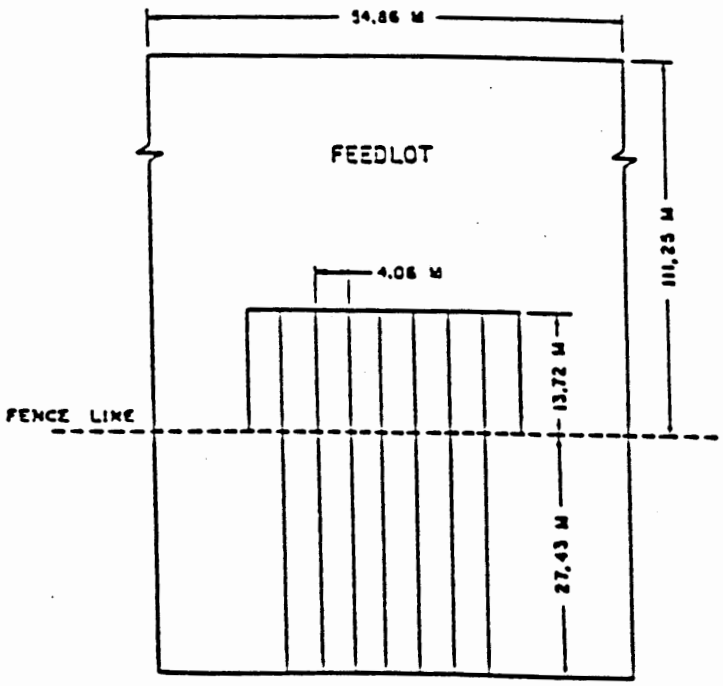
Effectiveness

Runoff from livestock feedlots is a long-recognized source of pollution. Research in nonstructural feedlot-control practices indicates that buffer strips are a promising alternative method to runoff catchment basins.

Young et al. (1980) investigated the ability and feasibility of land and cropping practices to absorb and retain pollutants below active feedlots. Rainfall simulator tests were conducted for 2 years on six plots in west central Minnesota. Field plots were 41.15 meters long by 4.06 meters wide on a 4 percent

slope. Their upper length (13.72 m) lay within an active feedlot and their lower lengths (27.4 m) extended below the feedlot (see Figure 5.1). In the first year, plots were planted in either corn (*Zea mays*) at a density of 59,000 plants/ha, orchardgrass (*Dactylis glomerata*) at a rate of 13.55 kg/ha, or a mixture of sorghum- (*Sorghum vulgare*) sudangrass (*Sorghum sudanensis*) at a rate of 33.6 kg/ha. In the second year only corn and oats (*Avena sativa*) were tested. A 25-year, 24-hour storm was simulated to induce runoff and erosion. Rainulator results from 2 years of testing are shown in Tables 5.2 and 5.3.

Figure 5.1
Feedlot Buffer Strip Design Layout



Source: Young et al. 1980.

Buffers planted with the orchardgrass reduced total runoff by 82 percent, compared to 81, 61, and 41 percent reductions on plots planted with orchardgrass, sorghum-sudangrass, and oats. Sediment was reduced by buffer strips of corn by 86 percent, orchardgrass by 66 percent, sorghum-sudangrass by 82

Table 5.2 Runoff and Sediment Transported from Beef Cattle Feedlots and Cropped Buffer Strips (average of two replications)

	Antecedent soil-moisture content[1] 0-15 cm %	Runoff cm	Sediment kg/ha
	1977		
Feedlot[2]			
Dry run	32	6.86	643.3
Wet run	35	7.67	1473.5
Total		14.53	2116.8
Corn[3]			
Dry run	22	0	0
Wet run	36	0.25	138.9
Total		0.25	138.9
Orchardgrass[3]			
Dry run	25	0.43	367.8
Wet run	31	2.39	344.1
Total		2.82	711.9
Sorghum-Sudangrass[3]			
Dry run	24	1.55	127.2
Wet run	34	4.06	255.9
Total		5.61	383.1
	1978		
Feedlot[2]			
Dry run	68	7.11	2412.6
Wet run	66	7.26	1706.1
Total		14.38	4118.7
Corn[4]			
Dry run	31	1.17	279.1
Wet run	38	3.71	508.0
Total		4.88	787.1
Oats[4]			
Dry run	44	3.12	392.2
Wet run	50	5.38	644.6
Total		8.51	1036.8

Source: Young et al., 1980.

[1] Gravimetric, dry weight basis.

[2] 13.72 m long (45 ft.)

[3] 27.43 m (90 ft.) long buffer strip + 13.72 m (45 ft.) of feedlot

[4] 21.34 m (70 ft.) long buffer strip + 13.72 m (45 ft.) of feedlot

Table 5.3 Dissolved Nutrients in Runoff from Beef Cattle Feedlots and Cropped Buffer Strips (average of two replications)

	Total Kjeldahl nitrogen	Amonium nitrogen	Nitrate nitrogen	Total phos-phorus	Ortho-phos-phate
	kg/ha				
	1977				
Feedlot[1]					
Dry run	9.71	2.50	0.34	4.76	3.36
Wet run	7.36	2.19	0.03	4.68	2.93
Total	17.08	4.69	0.37	9.45	6.29
Corn[2]					
Dry run	0	0	0	0	0
Wet run	0.31	0.09	0.02	0.17	0.10
Total	0.31	0.09	0.02	0.17	0.10
Orchardgrass[2]					
Dry run	1.19	0.40	0.06	0.46	0.31
Wet run	4.02	1.23	0.28	1.79	1.12
Total	5.21	1.63	0.34	2.25	1.43
Sorghum-Sudangrass[2]					
Dry run	2.69	0.68	0.32	1.44	1.10
Wet run	5.88	1.79	0.35	3.47	2.57
Total	8.57	2.47	0.67	4.91	3.67
	1978				
Feedlot[1]					
Dry run	15.68	1.93	0.08	7.55	2.63
Wet run	9.56	1.38	0.09	5.66	1.74
Total	25.24	3.31	0.17	13.20	4.37
Corn[3]					
Dry run	1.53	0.24	0.21	1.03	0.79
Wet run	3.88	0.48	0.54	2.45	1.81
Total	5.41	0.72	0.75	3.48	2.60
Oats[3]					
Dry run	6.10	1.01	1.05	2.90	1.94
Wet run	7.69	1.22	0.87	3.65	2.58
Total	13.80	2.23	1.93	6.55	4.52

Source: Young et al., 1980.

[1] 13.72 m long (45 ft.)

[2] 27.43 m (90 ft.) long buffer strip + 13.72 m (45 ft.) of feedlot

[3] 21.34 m (70 ft.) long buffer strip + 13.72 m (45 ft.) of feedlot

percent, and oats by 75 percent. Total nitrogen in runoff was reduced 87 percent with orchardgrass and 84 percent with the sorghum-sudangrass mixture. Young et al. (1980:487) concluded that on feedlot areas of the size tested, buffer strip lengths of 36 meters (118 feet) provided "sufficient" reductions of both nutrients and microorganisms in feedlot runoff.

A draft report by the USEPA (1982) indicates that grassed waterways provide between 5 and 40 percent reduction in phosphorus and pesticides. The report does not specify a buffer width. According to the same report, significant pollution reduction can be achieved at nominal costs.

Wooded buffers perform better than grassed buffers for removing nutrients. Peterjohn and Correll (1984) demonstrated that wooded buffers 150 feet wide retain 80 percent of phosphorus and 89 percent of nitrogen. Clark (1977) observed that in developed areas buffer widths of 100 to 150 feet were inadequate in filtering nutrients. Other studies that reported on removal rates of forested cover as a function of distance through the buffer are Cooper et al. (1986), who report that the majority of removal was accomplished within a 16 meter (52.49 feet) buffer, and Schnabel (1986) who reports that a 15 meter (49.21 feet) buffer width accomplishes the majority of removal.

Doyle et al. (1975) studied the movement of various pollutants in runoff water from manured land and evaluated the effectiveness of forest buffer zones in improving the water quality. They found that the concentration levels of N, P, K, and Na in runoff water at the 0.0 meter distance from the treated area were dependent on the number of rains previously leaching the manure, but independent of the total rainfall and amount of runoff collected.

> It appears probable that the temperature and moisture conditions in the manure and soil have a strong influence on the release of nutrients into the runoff, but the accumulation of manure from the autumn and summer applications may also be a significant factor affecting the water quality of

runoff from the manured area (Doyle et al., 1975:301-302).

Under the conditions of their experiment, a forest buffer strip of 7.6 meter (25 feet) was sufficient to prevent stream pollution from animal wastes. The authors note, however, that in the winter months this may not prove sufficient due to the decreased infiltration rates and longer fecal coliform and fecal streptococci survival.

Phosphorus from feedlot runoff is associated with very fine sediment and requires a much wider buffer strip than that required for sediment removal alone. Dillaha et al. (1986a) used a rainfall simulator to evaluate the effectiveness of vegetative filter strips for the removal of sediment and phosphorus from feedlot runoff. Fresh dairy manure was applied at rates of 7,500 kg/ha and 15,000 kg/ha to nine experimental field plots (5.5 x 18.3 meter bare source area). Water samples were collected at the base of a 0, 4.6 meter or 9.1 meter filter located at the lower end of each plot. With shallow uniform flow the 9.1 meter and 4.6 meter vegetative filter strips removed 91 percent and 81 percent of the incoming suspended solids, and 69 and 58 percent of the incoming phosphorus, respectively. Vegetative filters on concentrated flow plots removed 40 to 60 percent less sediment and 70 to 95 percent less phosphorous than plots with shallow uniform flow. Dillaha et al. concluded that unless vegetative filter strips can be installed so that concentrated flow is minimized, it is unlikely that they will be very effective.

Buffers for Reservoir Protection
(75-300 feet)

"The first step in assuring a safe and acceptable public water supply is protecting the quality of its source" (Roberts and Krishnaswami, 1982:28). While

there may be little disagreement with this premise, there is no universal agreement on just what the best practicable standards for protection are when it comes to water supply sources. Certainly proper management of inland wetlands is vital to achieving the maximum protection of water supply sources within the watershed. Proper forest management (i.e., the creation of vegetative buffer zones on the edges of reservoirs and water courses) and the control of urban growth are also essential "if long-term economic burdens are to be minimized in managing water supply sources" (1982:28). But it is not clear from the literature just what the proper buffer strip width around a reservoir should be.

Generally, it is assumed that the greater the width of undeveloped land around a reservoir the greater the degree of protection. According to Hordon (1987), buffer strip widths around reservoirs are often determined by administrative convenience rather than scientific rationale. Hordon points out that there is no national standard for reservoir protection.

The Safe Drinking Water Act (N.J.S.A. 58:12A-a *et seq*) requires adequate protection for the source of supply. However, there are currently no specific regulations in New Jersey requiring buffer zones around reservoirs. According to the act, the purveyor bears the ultimate responsibility for the quality of its water and is considered liable for offenses.

Havens and Emerson (1983) studied purveyor practices in 44 selected reservoir systems in the United States. They developed an average buffer strip width value for each of the 44 reservoirs based on two ratios: 1) the ratio of total land acquired to the land area flooded for water supply storage, and 2) the ratio of total land acquired to the total area of the watershed. As shown in Table 5.4, buffer widths ranged from 2,150 feet to a low of 65 feet. The mean and median values for buffer widths in the Havens and Emerson study were 807

and 620 feet, respectively. The next logical step to their research would have been to compare water quality parameters among these resevoirs over time. Perhaps then a scientific rationale for buffer strips around reservoirs would have been clearer.

Table 5.4 Buffer Strip Widths for Selected Reservoirs

Reservoir	Purveyor	Buffer Strip Mean Width (feet)
Scituate	Providence	2150
Wanaque	North Jersey WSC	1700
Ashokan	New York City	1450
Round Valley	State of N.J.	1425
Prettyboy	Baltimore	1075
Loch Raven	Baltimore	865
Wachusett	Boston	780
Meander Creek	Mahoning V., Ohio	690
Kensico	New York City	630
Schoharie	New York City	610
Milton	Youngstown, Ohio	606
Spruce Run	State of N.J.	550
Rockwell	Akron, Ohio	535
Lake Tappan	Hackensack WC	450
Oradell	Hackensack WC	400
Woodcliff Lake	Hackensack WC	300
O'Shaughnessy	Columbus, Ohio	250
Griggs	Columbus, Ohio	65

Source: Havens and Emerson, 1983.

In a study conducted by Hennigan et al. (1981) only nine states had regulations for the protection of surface water supplies. Regulations usually included the following provisions:

* Prohibition of point-source inputs.
* Prohibition of contact recreation, especially within 1,000 feet of the water supply intake.
* Limitations or prohibitions on intensive land use in a buffer strip that ranges in width from 75 to 300 feet.
* Limitations on watershed development outside the buffer strip.

The most restrictive regulations regarding the sale of water supply water-

shed land by water purveyors were found in Connecticut. A permit for the sale or change in use of "Class I" or "Class II" watershed land is denied by the Connecticut Health Commissioner unless the purveyor can demonstrate that the sale of the land will not have a significant adverse impact upon the future purity and adequacy of the public potable water supply. The classification of a purveyor's land is based on the following criteria (Connecticut Council, 1977):

Class I includes all lands:

1. Within 250 feet of the high water of a reservoir or 100 feet of all watercourses. Watercourse is defined as any stream, canal, marsh or swamp.

2. Within the area along the watercourses which are covered by the banks, beds and water of a stream; within lands subject to stream overflow; within associated wetlands and the shoreline of lakes and ponds.

3. Lands with slopes of 15 percent or greater without significant interception by wetland, swales and natural depressions between the slopes and the watercourses.

4. Within 200 feet of wells.

5. A delineated aquifer outcrop or direct recharge area in current or future use.

6. An area with shallow depth to bedrock (20 inches or less) or poorly drained soils as defined by the SCS that is adjacent to the lands described in (3) and (4) above and that extends to the top of the slope above the receiving water.

Class II land includes:

1. All lands in a watershed used as a source for public potable water supply.

2. Lands outside a public drinking water supply watershed but within 150 feet of a stream contributing directly to a reservoir.

Watershed managers in North Carolina, unsatisfied with an arbitrary width for reservoir buffer strips, took a functional approach. Buffer strips were considered a means of delay in the event that a spill or other source of pollutant migrated toward the reservoir. The response time of various local agencies was analyzed, and a buffer strip width became a measure of the length

of time it would take a liquid spill to traverse it in 1 hour. The buffer strip width can then vary according to type of soil, extent of vegetated cover, steepness of slope, and related factors that pertain directly to the speed of flow toward the reservoir.

Buffers for Stream Temperature Control
(25-200 feet)

Buffer strips have a significant impact on the microclimate of surrounding areas. With the removal of natural vegetation, air and soil temperatures increase with the transfer of this heat to surrounding areas, such as wetlands (Havens 1979). Havens further states that local relative humidity would decrease with the loss of evapotranspiration, combined with high air temperatures.

Temperature is directly related to stream ecology. High water temperatures mean less oxygen is being dissolved. Unless the water is turbulent, oxygen will not be at a satisfactory level for animal and plant life (van Groenewoud, 1977). An increase in sunlight reaching streams increases productivity by algae and mosses. Increased temperature also heightens the activity of chemicals such as nitrogen which in turn promotes build up of algae and mossess.

Design and Evaluation

Properly designed buffer strips can be stable and can provide adequate shade for stream ecosystems. Steinblums et al. (1984) studied the environmental factors that affect buffer strip stability and stream shading. These authors found in their evaluation of 40 buffer strips at elevations of 2,000 to 4,000 feet in the Cascade Mountains of western Oregon that stability was a function of one vegetative and six topographic variables, and shading was related to three characteristics of buffer strips and one of adjacent clear-cuts. (see Table 5.5).

Table 5.5 Variables Used to Predict Buffer Strip Stability (VOLREM) and shading (ACD)

Variable	Definition	Unit
VOLREM	The measure of buffer strip stability in volume remaining after losses.	Percent of initial initial volume
DISTWIND	The slope distance from the outer edge of the buffer strip to uncut timber in the direction of damaging winds.	Feet
ELEVRIDG	The change in elevation from the midpoint of the buffer strip to the top of the nearest major ridge in the direction of damaging winds.	Feet
DISTRIDG	The horizontal distance from the outer edge of the strip to the nearest major ridge in the direction of damaging winds.	Feet
ORIENT	Direction of streamflow: Compass azimuth (indicator variable). Westerly 180°-360° = 1 Easterly 0°-180° = 2	
ELEV	Elevation of the midpoint of the buffer strip above sea level.	Feet
STABRATE	Visual estimate of natural stability of the buffer strip (indicator variable) Stable = 1 Moderately stable = 2 Unstable = 3	
WETVOL	An interaction term multiplying the gross timber volume of the buffer strip immediately after timber harvest and moisture class. Based on understory indicator species.	
ACD	Angular canopy density, the measure of buffer strip shading effectiveness. Indicated by shading of the stream at minimum flow.	Percent, as measured by an angular canopy densimeter
WIDTH	Average width of buffer strip.	Feet
ORIGBA	Original basal area of the timber comprising the buffer strip.	Ft^2/acre gross
SLPCC	Slope of the clearcut adjacent to the buffer strip.	Percent
SLPCRK	Slope of the streambank within the buffer strip.	Percent

Source: Adapted from Steinblums et al. (1984).

Predictive equations were developed from these relationships to aid assessment of stream protection and to aid rapid evaluation of design modifications.

Of the variables related to stability, **wind damage** accounted for nearly 94 percent of volume loss; the remainder was due to logging damage, insects, and disease. Buffer strip stability was correlated with DISTWIND, ELEVRIDG, DISTRIDG, ORIENT, ELEV, STABRATE, and WETVOL (refer to Table 4 for variable definition). Timber volume remaining in buffer strips (VOLREM) is expressed by the following equation:

$$\begin{aligned} \text{VOLREM} = {} & 109.0 - 0.011\ \text{DISTWIND} \\ & + 0.012\ \text{ELEVRIDG} \\ & - 0.0023\ \text{DISTRIDG} + 7.55\ \text{ORIENT} \\ & - 0.0044\ \text{ELEV} \\ & - 4.48\ \text{STABRATE} - 0.032\ \text{WETVOL.} \quad (1) \\ R^2 = {} & 0.74 \end{aligned}$$

In the data analyzed by Steinblums et al., a significant relationship between buffer strip width and stability was not apparent. Nor was the age of a buffer strip significantly related to stability. However, species composition of the buffer strip was an important factor determining windthrow occurrence and amount.

Brown and Brazier (1972) studied stream buffer strip characteristics and stream temperatures along nine small streams in Oregon. They concluded that "angular canopy density is the only buffer strip parameter which is strongly correlated with stream temperature control" (1972:44). Swift and Baker (1973), together with Brown et al. (1971) and Patton (1980), appear to be satisfied that buffers 50 to 100 feet wide (25 to 50 feet on each side) are sufficient to secure normal forest stream temperatures within a flow distance of 700 to 100 feet. Hewlett and Fortson (1982) disagree.

Hewlett and Fortson (1982), in a paired watershed experiment on the southeastern Piedmont of Georgia with buffer strips varying from 35 to 50 feet

in width, have shown that stream water temperatures increased as much as 20°F even though a partial buffer strip of trees and shrubs was left in place to shade the stream. The authors suggest that "forest cover reductions in areas of gentle land relief may elevate the temperature of shallow ground water moving to the stream, even with a substantial buffer strip in place" (1982:983). The Georgia study suggests: 1) reexamination of the idea that evaporation and radiant cooling under shade may be neglected in computing stream temperature change due to overstory manipulations; and 2) that the temperature of effluent groundwater should be monitored to determine whether, in addition to direct solar radiation, elevated soil temperatures outside the buffer may be affecting stream temperature (Hewlett and Fortson, 1982:988). The study further indicates that high forest cover is more efficient in moderating water temperature than low vegetal cover and that the height of the cover may also need to be considered in buffer design. In New Jersey, as in the Piedmont region, further study needs to be undertaken before specific design criteria for water temperature buffer strips are established.

Stream orientation is an important factor in stream temperature control. van Groenewoud (1977) reports that the north side of east-west running streams does not need the protection from sunlight by a protective strip. The south side would need a strip with a width approximately the height of the trees.

Because buffer strip failure is a frustrating and recurring problem, buffer strips must be properly designed and evaluated on a site-specific basis. Damage due to wind, disease, or other environmental factors can have catastrophic effects. Debris from wind- or disease-damaged buffers can load stream channels when mobilized during high flows, posing a threat to downstream structures, deflecting flow into banks, and causing erosion.

Planning Considerations:

vegetation height
canopy characteristics
topography
stream orientation

Effectiveness

Buffer strips with enough trees and brush to provide adequate shading can be highly effective for protection against thermal pollution. The width depends on stream size and angle of adjacent slope. The USEPA (1984) lists the costs of "Streamside Management Zones" as medium to high. A report by the New Jersey Department of Environmental Protection (1983) states that a minimum band width of 30 feet generally will be adequate for a streambank strip of trees to provide temperature control.

Brown and Brazier (1972) feel differently. According to this team a band width of 80 feet will provide maximum shading; however, 55 of the 80 feet accomplishes 90 percent of that maximum. They note that a 100- to 200-foot standard width for all buffer strips will provide adequate protection for most streams. Burton and Likens (1973) concluded that a 33-foot-wide strip "was very effective in buffering stream temperature fluctuations." Aubertin and Patric (1974) concluded from a study along a small stream in West Virginia that buffer widths 33 to 66 feet wide "prevented excessive increases in water temperature."

The research findings of a study reported by van Groenewoud (1977) show that as the width increased for both hardwood and softwood stands beyond 7.5 meter (25 feet) the percentage of sunlight reaching a stream slowly decreased from 12 to 4 percent. "A buffer strip over 15 m (50 ft) is thus sufficient to protect the stream water from reaching temperatures detrimental to aquatic life" (1977:11-12).

Buffers for Aquatic Species
(25-50 feet)

Buffer strips act as food sources. In many woodland streams, 95 percent of all food consumed by the invertebrate fauna is derived from leaves, branches, etc., that fall into the stream from trees and shrubs (van Groenewoud, 1977; Fisher and Likens, 1973; Sedell et al. 1973). It is obvious that removing the buffers also removes the food source. Replacing vegetation with other species changes the food source and affects the invertebrate and fish populations that are food-specific.

Design and Evaluation

Only those trees whose foliage can drop into the streams contribute as a food source. According to van Groenewoud (1977), few trees farther than 15 meter (50 feet) from the stream will be major contributors.

The New Jersey Department of Environmental Protection (1983) discloses that a 50-foot buffer does not offer appreciable benefits over a 25-foot buffer for food web benefits. The New Jersey DEP recommends a 50-foot-wide buffer strip for trout-associated streams regulated by the Flood Hazard Areas Regulations.

Planning Considerations:

terrestral species
invertebrate and fish populations

Buffers for Wildlife Habitat
(200-300 feet)

Buffer strips are important habitats for endangered, as well as non-endangered, plant and animal species. Over 61 percent of plants (NJDEP, 1984) and 83

percent of animal species (NJDEP, 1980) occur in wetland and stream-corridor areas. In addition to providing habitat for forest residents, buffers have the distinguished value of including freshwater marsh on the floodplains, thus supporting another whole ecosystem. The interaction between these two different kinds of habitat islands ensures a variety of species.

Design and Evaluation

Different species require different sized habitats. Small or narrow buffer widths may not shelter desired animals. Stout and Applegate (1975) provide detailed information on required habitats for mammals and other species found in New Jersey. In addition to the effect of size or scale of "natural" areas on wildlife, vegetation is a primary determinant of wildlife types and abundance. Because wildlife types and abundance can be managed, it is important that the design and evaluation of buffer strips for wildlife habitat reflect the attitudes of the residents toward wildlife.

Forman et al. (1976) studied avian distribution patterns in 30 different forest islands in the New Jersey Piedmont area. Thirty-five percent of bird species encountered were found only in forests of at least 3 ha (7-1/2 acres). Twenty-two percent were only in forests of at least 8 ha (20 acres). They concluded that to maintain regional diversity of upland forest birds, top priority should be placed on identifying and protecting large forests rather than protecting an equal area of small forests. In this area the most valuable forests would be larger than 40 ha or 99 acres.

Taylor (1977) maintained that buffer widths of 400 feet (200 feet on either side of the stream), proposed in West Windsor, New Jersey, would fulfill the requirements established by Forman and others for adequate wildlife habitat. Two-hundred-foot buffer widths were felt to be sufficient corridors to permit

species to radiate out to and utilize the larger woodlots adjacent to the area.

The literature on mammal habitats supports slightly larger buffer widths. Maestro (1973) stated:

> It has already been presupposed that an average corridor width of 600 feet will eliminate the problem of home range and human disturbance for deer...Basically speaking those program elements which produce the least human disturbance should be located adjacent to the areas most sensitive and/or of most value to wildlife.

Wildlife biologists Leedy et al. (1978) determined that a buffer strip width of 600 feet (300 feet on either side of a stream) provided the required habitat elements.

Planning Considerations:

vegetation
size or scale
population values attached to wildlife

V. Operation and Maintenance

Healthy, balanced shoreline environments are largely self-maintaining. The key characteristics, according to Jones and Battaglia (1986), are:

1. woody vegetation is intact on the streambanks
2. no structures are located on the streambank
3. the channel changes are minimal
4. bank erosion is controlled with no streambank failure, and
5. adjacent land is not excessively eroding

These characteristics are retained by maintaining the shoreline environment and "by avoiding land use practices that will shift the natural equilibrium and initiate active erosion" (1986:15).

Maine, Minnesota, Vermont, Washington, and Wisconsin regulate the use of lake shoreland (Havens and Emerson, 1983). Land that is within 250-1000 feet of a lake is required to have a minimum lot size of 1/2 acre with an additional minimum setback of 50-150 feet for septic disposal systems. In some cases, land around a lake is placed in a "conservancy" zone, which prohibits most forms of

development.

Buffer strips require periodic inspections particularly after heavy storm events. Supplementary erosion controls may appear necessary (e.g., transplants, live stakes, riprap, cribwalls, fascines). Periodic inspections are also important to maintain soil porosity. Intensive recreation or heavy machinery can compact the soil, leading to decreased percolation and aeration and eventual plant death. Maintenance could be accomplished by periodically removing thatch, trees that have fallen, and other debris. Mechanical aeration may be necessary.

The U.S. Department of Agriculture Soil Conservation Service (1988) recommends the following for operation and maintenance of vegetated buffer strips:

1. Protect the filter strip from damage by farm equipment, traffic and livestock. Sheet flow must be maintained.
2. Fertilize, lime and control weeds as necessary to maintain vigorous growth of vegetation (consider nutrients in waste runoff).
3. For wildlife habitat maintenance, the vegetation should be harvested, mowed, cut, or otherwise reduced in height or density after July 20 and before September 1, to provide nesting cover in the spring and protective cover against adverse weather conditions during the winter.
4. Repair erosion or equipment damage to area immediately so filter strip will continue to perform properly. Reshape and reseed as needed.

The major cost components of buffer strips are additional land requirements and maintenance (DVRPC, 1981). When buffer strips have to be constructed the costs of materials (i.e., shrubs, trees, sod, grass seed, etc.), equipment, and labor are involved. The following figures are general guidelines provided by the Delaware Valley Regional Planning Commission (1981):

Permanent Seeding (by machine)
Initial placement: $790 - $1220 per acre
First year maintenance: $50 - $120 per acre

Sodding (including site preparation)
Initial placement: $2400 - $3600 per acre
First year maintenance: $240 - $2900 per acre

Hydroseeding: $1450 - $1700 per acre

Sodded Ditches: $5 - $8 per linear foot

The most often needed maintenance practice for vegetated filter strips below feedlots and croplands is periodic mowing. Hayes et al. (1979) determined that periodic mowing of fescue and rye maintained their rigidity. Since the most serious problem affecting vegetative filter strips is flow inundation (Barfield et al., 1977, 1979; Hayes et al., 1979, 1983; Dillaha et al. 1986a, 1986b), vegetation must remain erect and nonsubmerged for optimum effectiveness. Dillaha et al. (1986a, 1986b) reported that regular mowing promoted thicker growth. They recommended a maximum grass height of approximately 15 centimeters. The Grass Filter Strips in Virginia publication (VDSWC, 1983) states that periodic herbicide application for weed control and mowing are required for efficient VFS operation.

The following summary of maintenance practices is offered by Dillaha et al. (1986c:24-25) as a result of their observations of vegetative filter strips (VFS) on 33 farms in the Chesapeake and Chowan River Basins.

1. Vegetative filter strips should be mowed and the residue harvested a minimum of 2 to 3 times per year to promote a thick vegetation with optimum pollutant-removal capabilities.

2. Vegetative filter strips should be limed and fertilized annually along with the rest of the field according to soil test recommendations.

3. Caution should be used when applying herbicides to VFS or adjacent fields for weed control. If herbicides are applied to fields, sprayers should be turned off before crossing VFS or using them for turn rows.

4. Vegetative filter strips should not be used for roadways because roadways change flow patterns which can lead to concentrated flow problems. If a VFS must be used for a roadway then the VFS should be 8 to 10 feet wider than normal and the roadway should be located on the downslope side of the filter so that field runoff will be filtered

before it can concentrate in the disturbed roadway area.

5. Cattle should be excluded from VFS at all times but especially during periods when soils are moist and VFS are most susceptible to damage from hooves.

6. VFS should be inspected for stand establishment after planting and if stand is inadequate, the area should be re-fertilized and overseeded.

7. Vegetative filter strips should be inspected regularly for damage caused by tillage operations, misapplication of herbicides, gully erosion, sediment inundation, etc and repaired as soon as possible.

8. Vegetative filter strips that have accumulated sufficient sediment so that they are higher than adjacent fields should be plowed out, disked and graded if necessary before reseeding. This is necessary to reestablish flow conditions favorable for optimum VFS performance.

9. Care must be taken during all tillage operations to avoid tilling into the VFS and reducing its effective width. If moldboard plowing is practiced, the last plow pass should turn soil towards the filter and the disturbed area next to the filter should be carefully disked to minimize gully formation and other flow problems.

VI. Current Management Practices in New Jersey

Management practices in New Jersey for stream corridors and wetlands are legislated through flood plain management, drainage, soil erosion, land use, wetlands, and water quality laws. Buffer strips are voluntary except in the Pinelands and Delaware and Raritan Canal Park where they are regulated by law. There are no buffer strip regulations for agricultural practices.

New Jersey Pinelands Protection Act of 1979

Under the Wetlands Management Program (Article 6, Part 1, sections 6-101 through 6-114) of the New Jersey Pinelands Comprehensive Management Plan (hereafter referred to as CMP) a buffer protection area is required to preserve the natural upland to wetland transition and to reduce potential impacts from upland development activities. If an applicant can demonstrate that the proposed

development will not have a significant adverse impact on the wetland, then the buffer width can be altered. In the Pinelands region, buffer delineation is therefore variable and determined on a site-specific basis.

In 1983 Roman and Good proposed a model (Pinelands Wetlands Buffer Delineation Model) for determining the minimum site-specific buffer width required to protect wetlands, as an aid to the Pinelands Commission staff. The model underwent a 1-year field test and verification program. Verification of the model continues as a long-term process. The model is periodically revised and updated through a long-term monitoring process and as new scientific findings become available. Under the Pinelands Wetlands Buffer Delineation Model a minimum 300 foot buffer area is recommended:

> It is recommended that a minimum 300 ft buffer area be maintained between wetland boundaries and proposed upland development activities in the Preservation Area District. This will aid in the maintenance and protection of wetlands within this Pinelands inner core ecosystem. As set forth by the state legislation and supported with adoption of the CMP, the Preservation Area District is recognized as an exceptionally valuable entity of the Pinelands and must be given utmost protection from environmentally degrading impacts. In keeping with this legislative intent, wetlands of the Preservation Area District should be afforded maximum protection, and thus a minimum 300 ft buffer is recommended...This buffer should aid in the maintenance of wetland wildlife habitat and food web functions, natural hydrologic links, function to filter excess suspended sediments associated with resource extraction operations an ameliorate microclimate alterations (Roman and Good, 1985:10-11).

Freshwater Wetlands Protection Act of 1987

New Jersey's Freshwater Wetlands Protection Act and the Coastal Wetlands Act passed in 1970 represent "one of the most comprehensive regulatory systems for protecting wetland resources anywhere in the nation" (Wells, 1988). Much of the controversy during the 4-year legislative battle for freshwater wetlands protection dealt with wetland buffer areas. According to the New Jersey act, buffer widths are based on a three-part wetlands classification system: excep-

tional, intermediate, and ordinary. This classification and associated recommended buffer widths is given in Figure 5.2.

The D & R Canal State Park Law of 1974

The Delaware and Raritan Canal Commission (DRCC), established by the Delaware and Raritan Canal State Park Law of 1974 (N.J.A.C. 13:13A-1 et seq), regulates land use within the 100-year flood line plus a 100-foot buffer for streams draining an area greater than 50 acres. The DRCC requires a minimum 400- 500-foot buffer strip between the Canal Park and the developed portion of a project site. Decisions are made case by case, and in some cases, 1,000 feet is required.

VII. Municipal Initiatives in New Jersey

Several municipalities in New Jersey have taken the initiative in establishing ordinances with specifications for buffer strips. The Stream Corridor and Flood Plain Protection Ordinance of Princeton Township restricts development within a stream corridor. Buffer strips in the Princeton Township ordinance have a variable width determined from:

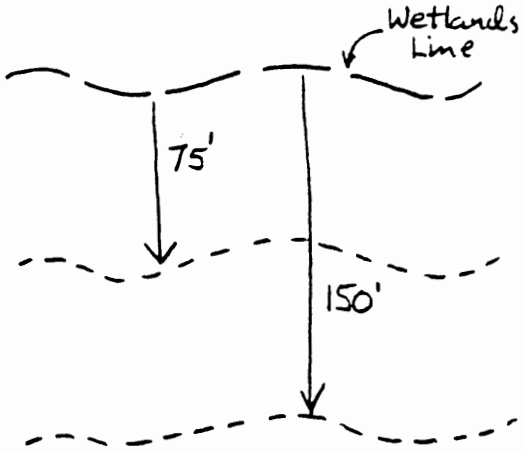
a. The top of both channel banks of the stream.
b. The outer limits, on each side of the stream, of any floodplain and/or wetlands, whichever of these is greater; and
c. The top of any critical slope contiguous to the floodplain, wetlands, or channel banks (defined as having slopes of 12 percent or more).

The schedule for determining buffer widths in the Princeton Township ordinance is shown in Table 5.6.

Figure 5.2

Wetlands Type and Buffer Distances

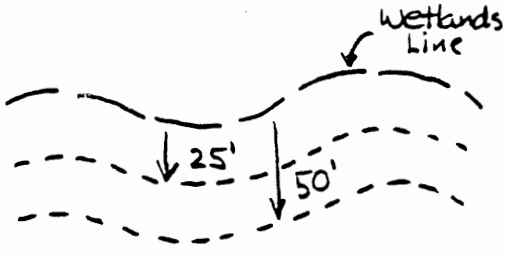
1. **Exceptional (70-150')**



Wetlands with exceptional resource value are those that provide habitat for threatened and endangered species and wetlands that drain into "trout production waters," the states's most pristine inland waters.

The 150' buffer distance can be reduced by obtaining a transition area "waiver" or under an approved transition area "averaging plan." In no case can the minimum distance of 75' be reduced.

2. **Intermediate (25-50')**



Wetlands with an intermediate resource value are all wetlands not included in (1) above and (3) below.

The 50' buffer distance can be reduced by obtaining a transition area "waiver to a minimum of 25'. Under an approved transition area "averaging plan", however, the 25' distance can be reduced (in some cases eliminated) but only if there is a commensurate increase in the 50' distance.

3. **Ordinary (0')**

NO BUFFER REQUIRED

Wetlands with an ordinary resource value are certain isolated wetlands, and man-made drainage ditches, swales or detention facilities.

No buffers are required for wetlands classified as ordinary.

Source: New Jersey Conservation Foundation

Table 5.6 Schedule for Determining Associated Buffer Strips

Stream Category	Minimum distance from top of channel banks of stream	Minimum distance on either side of stream from outer limits of any flood plain and/or wetland	Minimum distance on either side of stream from top of any critical slopes[1] contiguous to channel banks or flood plains
Millstone River Stony Brook	150 feet	75 feet	50 feet from point of grade change to less than 12% for a distance of at least 25 feet.
Harry's Brook Mountain Brook Van Horne's Brook Cherry Brook	60 feet	40 feet	30 feet from point of grade change to less than 12% for a distance of at least 25 feet.
Intermittent or unmapped[2] streams or sections tributary to, or in upper reaches of, permanent streams	50 feet	25 feet[3]	25 feet from point of grade change to less than 12% for a distance of at least 20 feet.

[1] defined as 12% or greater

[2] i.e., on flood plain maps

[3] but if no delineated flood plain, then 25 feet from outer limits of contiguous wet soils or wetlands.

Source: Stream Corridor and Flood Plain Protection Ordinance for Princeton Township.

The concept of buffer strips has a fairly long-standing tradition in West Windsor Township. Implementation of the concept has been pursued on a *de facto* basis over the past two decades. By 1974 the Township Committee adopted the Floodplains and Watercourses Ordinance. In 1977, the Environmental Commission of West Windsor Township formally recommended a Green Belt Plan to the planning board for inclusion in the recreation and conservation plan element of the municipal master plan. Although the aesthetic value of green belts or buffer strips was fairly evident to the Environmental Commission, the paramount considerations were environmental:

The fragile character of the floodplain areas should be recognized. Much of the floodplain is wooded, with moisture-tolerant types, such as Red Maple and Sweetgum predominating. Destruction of these trees, and associated understory, would severly disrupt the acquatic buffer zones of the stream corridors.

Oak-dominated upland forests are not abundant in West Windsor. While every effort should be directed toward the preservation of all upland forest stands, particular conservation emphasis should be placed on those which are contiguous to the stream corridor areas. These stands, it is clear, constitute a logical and desirable component of the green belts.

The green belt structure is a prerequisite for the protection and preservation of wildlife within the Township. A minimum width of 400 feet (200 feet on either side of the floodway) has been defined in an effort to provide adequate dimensions for viable wildlife corridors (West Windsor Environmental Commission, 1977:2).

The West Windsor Enviornmental Commission's choice of a 400-foot-wide belt (200 feet on either side of the floodway) is based on the advice of numerous renowned scientists.

VIII. Summary

Research studies have shown that buffer strips act as filters and barriers against erosion, overland flows of sediment and pollutants, and stream ecosystem disruption. Buffer strips serve a variety of purposes and apply to water supply/water quality concerns as well as fish, wildlife and open space concerns. In this regard they perform a beneficial role in overall watershed management.

The width of the required buffer strip depends on the intended function or purpose it will serve. A buffer strip 15 meters or 50 feet wide may be sufficient to protect stream water from reaching temperatures detrimental to aquatic life, but wholly inadequate for nutrient and pollutant removal. A summary of buffer width considerations is presented in Table 5.7.

Table 5.7 Summary of Buffer Width Considerations

Function	Width[1] (feet)
Sediment Control	50-200
Streambank and Streambed Erosion Control	25-213
Nutrient and Pollutant Removal	150-300
Reservoir Protection	75-300
Stream Temperature Control	25-200
Aquatic Species	25-50
Wildlife Habitats	200-300

[1] Buffer width setbacks are from the waters edge.

Conclusions drawn from the USEPA's Chesapeake Bay Study have particul relevance for New Jersey. Vegetated buffer strips were tested in the coast plain of Maryland. Two-thirds of New Jersey's land area also lies in the coast plain. The Chesapeake Bay Study conclusions are summarized below (Magette al., 1987:2-3):

1. Buffer strip performance in reducing nutrient losses from agricultural lan is highly variable.

2. Buffer strips are more effective in removing suspended solids from runo than in removing nutrients.

3. Removals of runoff-transported sediment (and perhaps chemicals attache thereto) at the interface between buffer strips and unslope areas ma constitute a large percentage of the total amount of sediment prevente from leaving areas protected by buffer strips.

4. Vegetated filter strips appear to be less effective as time goes on reducing nutrient and suspended solids losses in runoff.

5. Buffer strip preformance generally diminishes as the ratio of vegetated unvegetated area decreases.

6. The effectiveness of buffer strips is highly dependent on the condition the filter itself.

7. Subsurface (leaching) losses can be an important component of inorgan nitrogen movement from agricultural areas. When these losses are co sidered together with surface losses, the relationship between buffer stri width and nitrogen removal is not clear.

8. Since the ability of buffers strips to remove nutrients and suspended solids in this closely controlled experiment was so highly variable, the performance of buffer strips in actual use is probably much less than expected (although no performance criteria have been established).

9. Buffer strips should not be relied upon as the sole, or even primary means of preventing nutrient movement from agricultural management systems.

Three essential components of a watershed management program that incorporates buffer strips are: a) proper design, b) maintenance, and c) site-specific evaluation. The most influential condition affecting buffer strip performance is the occurrence of concentrated flow at some point in the buffer. Buffer strips perform best when runoff moves through them in a thin, uniform flow. Usually, natural topographic features prevent this. Variations in buffer strip management (e.g., mowing or no mowing), widths, and type and density of vegetative cover (e.g., riparian or farmer-planted) were all observed affecting performance (Magette et al., 1987:38).

There appears to be no simple low-cost solution to the problems of flooding, soil erosion, sedimentation, and pollution of land and receiving waters once the problem has occurred. If land development is to be permitted without ruining the stream valleys, developers are advised to adopt a prevention strategy that utilizes blue-green technologies, that is, natural systems, such as buffer strips, that carry out protective functions. The benefits to the landowner of an effective, long-term watershed management program that emphasizes prevention-oriented strategies are many: improved habitats for fish and wildlife, control of topsoil loss, improved depth of the stream, increased property value, and improved scenery, among others.

The cost of restoring damaged streams and wetlands is enormous. At a time when public expenditure budgets are shrinking and public concern for

environmental quality is escalating, it is, it seems, a matter of common sense to protect without delay these precious commodities. Buffer strips are a sensible component of long-term solutions that would match local conditions, the possible techniques, and the objectives of the landowner.

IX. Recommendations

1. Buffer strips should be pursued as a watershed management strategy.

A new emphasis needs to be placed on "natural" techniques to preserve and enhance site characteristics and water quality. Natural techniques, such as buffer strips, are those that capitalize on and are consistent with natural resources and processes (Lakatos, 1980). Buffer strips have a simple and direct value placed on them as "natural systems prized both for their aesthetic quality and their ecological processes" (Hays, 1987:151).

The place of buffer strips in watershed management needs a comprehensive approach. This may require legislative initiatives. At present, the NJDEP has several programs that regulate elements of stream corridors. These programs include stream encroachment, freshwater wetlands protection, storm water management, and soil erosion and sedimentation control. None of these programs, however, present the opportunity to protect stream corridors as a comprehensive system. In New Jersey, "the protection of stream corridors for scenic, aesthetic, or wildlife habitat values are currently not areas that can specifically enter into DEP decision making" (NJDEP, 1988:12).

2. Buffer strip widths should be derived from a parameter based model.

Buffer widths along a stream corridor will understandably vary both spatially and temporally. Most streamside buffer widths extend 25-300 feet from the water's edge. Without a systematic evaluation of the landscape to ensure

adequate buffering, these boundaries are arbitrary. Mere citations of wide buffer strip requirements that have been adopted or proposed in other jurisdictions do not provide adequate technical justification for inclusion of similar requirements in New Jersey regulations (NJDEP, 1983). Buffer strip widths should conform to the established water quality goal for that particular water resource and the intended function to be performed by the buffer strip.

A parameter based decision for buffer strip widths is recommended. Parameters should be derived from a formula, similar to that done for the Pinelands. Parameters would include, but are not limited to, land cover, land use, impervious surface area, the speed of runoff toward the waterway, slope, soil type, parent material, permeability, etc., and a healthy margin of error.

3. In the absence of a parameter based model, buffer strips protecting surface water supplies should be maintained at a minimum 300 feet from the waters edge.

There is no definitive study on acceptable buffer widths surrounding surface water supplies (i.e., reservoirs), therefore, every effort should be made to be on the side of caution and go beyond the minimal standards in the current scientific literature.

A minimum of 300 feet from the waters edge may be inadequate in some water supply watersheds and far too generous in others, depending on the pollution potential, human pressures and future desires. Extreme care must be taken in establishing buffer widths. An inadequate width invites violation of the needed buffer. Once that violation occurs, the value of the buffer strip has been lost forever.

4. Every effort should be directed toward the preservation of all upland forest buffers; particular conservation emphasis should be placed on those which are contiguous to the stream corridor areas.

The possibility of putting stream corridor areas and reservoir lands into a

"conservancy" zone should be investigated. A directory of the natural areas o vegetation and wildlife is available to municipalities from the NJDEP, Division of Parks and Forests, Natural Areas Office.

5. As opportunities arise for land reclamation, every effort should be made to restore the area to its natural vegetation.

Land area for buffer strips should be seized whenever possible. Preserving what is left of the natural landscape by protecting existing buffer strips, through zoning and ordinances, may not be enough to reduce soil erosion, improve water quality or to sustain wildlife cover. Some areas (e.g., land on the edge of croplands next to surface water resources) should be **restored** to grass, trees, or permanent wildlife plantings. In order to reintroduce wildlife to some areas, buffer strips will have to be created. This is an expensive and lengthy proposition. In central New Jersey it takes between 50 and 100 years for a mature forest to regenerate. Green Acres funding might provide a source of revenue for various phases of land acquisition. Also, the Conservation Reserve Program, authorized by the Food Security Act of 1985, will pay up to $50,000 annually for 10 years to qualified landowners for the purpose of converting highly erodible land to grass and tree cover.

6. Buffer strips for watershed management should be designed and evaluated on a site-specific basis.

Every site presents a unique array of physical resources, occupancy requirements, land use conditions, and environmental values (Lakatos, 1980). Variations of such factors will require variations in design standards for optimal achievement of buffer strip objectives. The NJDEP should develop a Watershed Management Program that will include appropriate technical criteria related to site characteristics for stream corridors. On-site inspection of specific tracts for

buffer strips should be required when the intended use is for limited types of passive recreation. Minor lateral extensions to the buffer strip may be prudent.

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DUAL PURPOSE DETENTION BASINS IN WATERSHED MANAGEMENT

Sandra M. Holler

6

I. Introduction

An important function of watershed management, deserving more attention from state, regional, and local government agencies, is the control of runoff from nonpoint sources to lakes and streams.[1] Lakes are particularly vulnerable to nonpoint pollution because they are natural depositories for pollutants transported by rivers. The nonpoint pollution problem becomes even more acute in water supply watersheds where the limitations of drinking water standards and treatment technologies are already posing public health risks. For many states, including New Jersey, the goal of achieving "fishable" and "swimmable" water quality will not be fully achieved unless effective solutions are deployed to reduce nonpoint source pollutant concentrations or loads. This chapter analyzes, from the perspectives of efficiency and practicability, one technique that can be used to control nonpoint pollution: dual-purpose detention basins. It briefly reviews the various policy issues involved in developing an effective program for controlling nonpoint source pollution.

Nonpoint source pollution can be generated by any land area. The EPA's Environmental Photographic Interpretation Center (EPIC), which has been identifying, characterizing and inventorying nonpoint sources of pollution since 1973,

[1]By runoff is meant water from rain, snow melt, or irrigation that flows over ground surface and drains into a water body such as a stream, lake, or reservoir. Pollutants from air and land collect in runoff which then carries them to receiving waters (EPA, 1984:C-5).

defines a nonpoint source as: "any area in which activity is occurring that produces contaminants which enter the receiving water in an intermittent and diffuse manner." A study by the Association of State and Interstate Water Pollution Control Administrators (ASIWPCA, 1985) shows that nationally **agricultural activities** are the leading primary source of nonpoint pollution in both rivers and lakes. Sources of agricultural nonpoint pollution include cropland, both row (e.g., corn and soybeans) and field (e.g., wheat), animal production on rangeland and pastureland, and livestock facilities. Nonagricultural sources account for an estimated 36 percent of the degradation to surface water quality nationwide. According to some estimates, urban nonpoint source problems affect 20 percent of the nation's rivers and over 50 percent of the nation's drainage basins (Sturges, 1983; EPA, 1980). The relative contribution of primary nonpoint pollution sources impacting rivers and lakes is graphically illustrated in Figure 6.1.

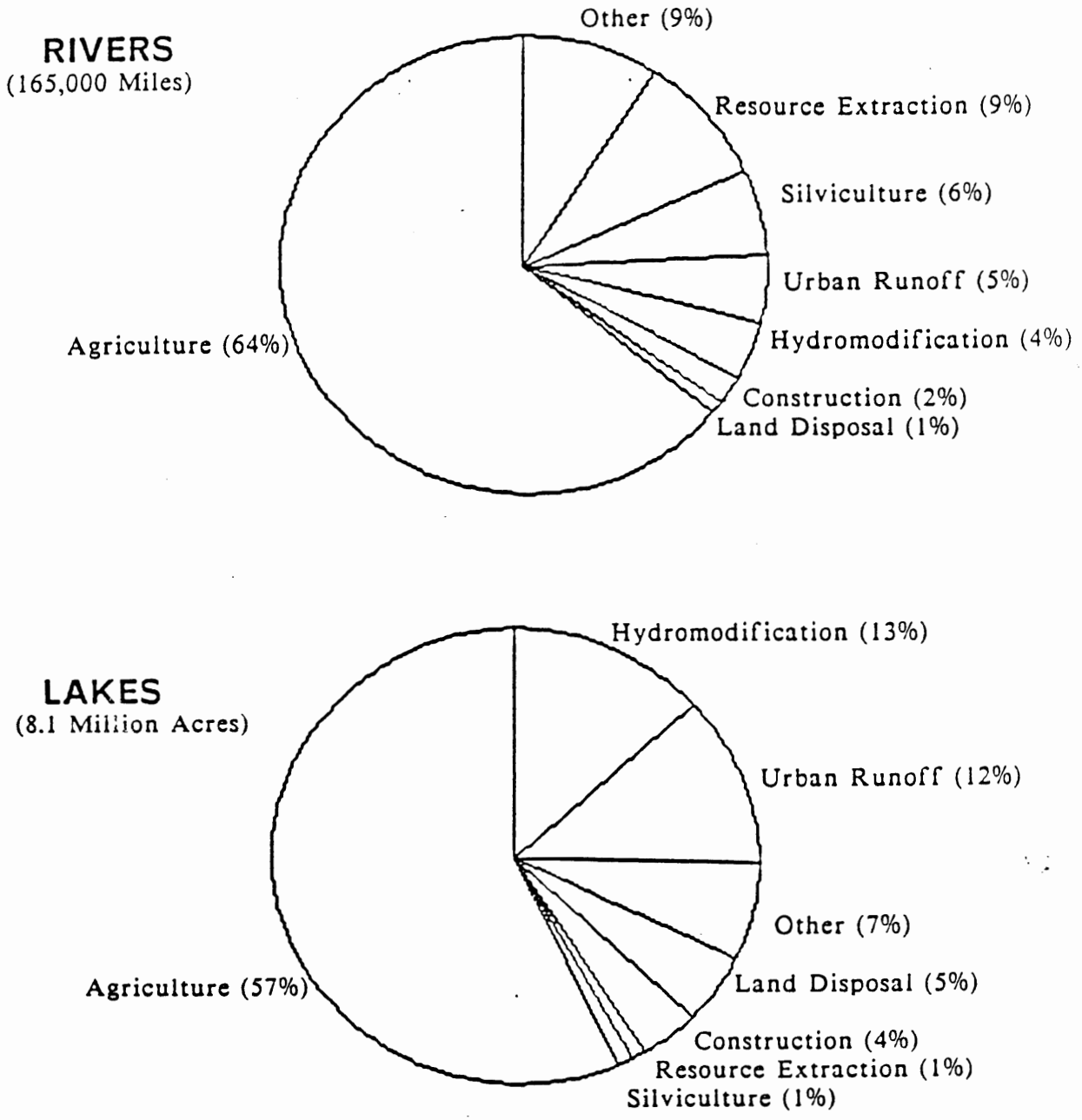
Many troublesome pollutants come from nonpoint sources. Their water quality and associated impacts can be referred to in Table 6.1. According to the ASIWPCA study, **sediment** (i.e, sand, silt, clay, and organic materials) negatively impacts more river miles than any other pollutant, but **nutrients** from fertilizers and animal wastes affect more lakes and estuaries (see Figure 6.2). Results of the Nationwide Urban Runoff Program (NURP) suggest that metals and inorganics mobilized during storm events have the greatest potential for long-term impacts on aquatic life (EPA, 1983).

Water quality in every New Jersey watershed is affected to some degree by nonpoint pollution sources. Conclusions regarding stream water quality in New Jersey are consistent with national trends:

> The primary nonpoint sources were agricultural and urban/suburban runoff. Pathogens (fecal bacteria), sediment and nutrients were the most common nonpoint pollutants (New Jersey 1986 State Water Quality Inventory Report, 1986:II-9).

Figure 6.1

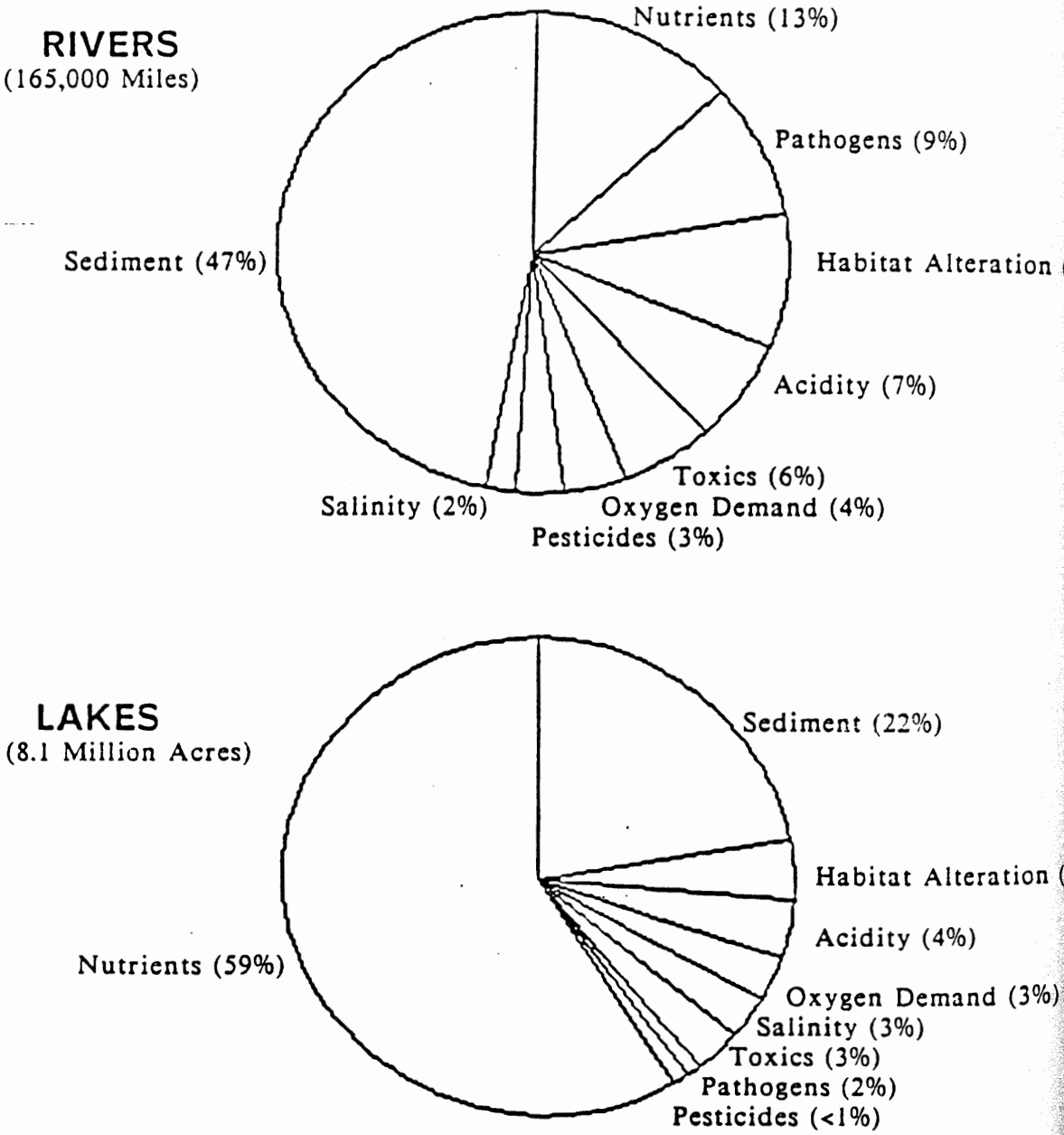
Primary Nonpoint Sources in Impacted Waters



Adapted from America's Clean Water. ASIWPCA, 1985.

Figure 6.2

Primary Nonpoint Source Pollutants in Impacted Waters



Adapted from America's Clean Water. ASIWPCA, 1985.

Table 6.1 Nonpoint Source Water Quality Impacts

Pollutant	Nonpoint Source(s)	Water Quality and Associated Impacts
Sediment	cropland forestry activities pasture streambanks construction activities roads mining operations existence of gullies livestock operations (streambanks) other land disturbing activities	* Decrease in transmission of light through water. - Increase in primary productivity (aquatic plants and phytoplankton) upon which other species feed, causing decrease in food supply. - Obscures sources of food, habitat, hiding places, nesting sites; also interferes with mating activities that rely on sight and delays reproductive timing. * Direct effects on respiration and digestion of aquatic species (e.g., gill abrasion). * Decrease in viability of aquatic life--decrease in survival rates of fish eggs and therefore in size of fish population affects species composition. * Increase in temperature of surface layer of water, increases stratification and reduces oxygen mixing with lower layers, therefore decreasing oxygen supply for supporting aquatic life. * Decrease in value for recreational and commercial activities: - Reduced aesthetic value. - Reduced sport and commercial fish populations. - Decreased boating and swimming activities. - Interference with navigation. * Increases drinking water costs.
Salts	agricultural activities mining operations urban runoff	* Favors salt-tolerant aquatic species and affects the types and populations of fish and aquatic wildlife. * Fluctuations in salinity may cause greater problems than absolute levels of salinity. * Reduces crop yields. * Destruction of habitat and food source plants for fish species. * Reduced suitability for recreation through higher salinity levels (skin/eye irritation) and higher evaporation rates. * Affects quality of drinking water.
Pesticides & Herbicides	all lands where pesticides are used: (cropland, forest, pastures, urban/ suburban, golf courses, waste disposal sites) sites of historical usage (organochlorides) urban runoff irrigation return flows	* Hinders photosynthesis in aquatic plants. * Sublethal effects lower organism's resistance and increase susceptibility to other environmental stresses. * Can affect reproduction, respiration, growth and development in aquatic species as well as reduce food supply and destroy habitat for aquatic species. * By definition these chemical are poisons: if released to the aquatic environment before degradation they can kill non-target fish and other aquatic species. * Some pesticides/herbicides can bioaccumulate in tissues and other species.

Table 6.1 cont.

Pollutant	Nonpoint Source(s)	Water Quality and Associated Impacts
		* Some pesticides/herbicides are carcinogenic and mutagenic and/or teratogenic. * Reduces commercial/sport fishing and other recreational values. * Health hazard from human consumption of contaminated fish/water.
Nutrients (Phosphorus, Nitrogen)	erosion from fertilized areas urban runoff septic systems animal production operations cropland or pastures where manure is spread	* Promotion of premature aging of lakes and estuaries--eutrophication. - Algal blooms and decay of organic materials create turbid conditions that eliminate submerged aquatic vegetation and destroy habitat and food source for aquatic animals and waterfowl. - Blooms of toxic algae can affect health of swimmers and aesthetic qualities of waterbodies (odor and murkiness). - Favors survival of less desirable fish species over commercially/recreationally more desirable/sensitive species. - Interference with boating and fishing activities. - Reduced quality of water supplies. - Reduced dissolved oxygen levels can suffocate fish species. - Reduction of waterfront property values. - NO_3 (Nitrates) can cause infant health problems.
Metals	urban runoff mining operations	* Accumulates in bottom sediments, posing risk to bottom-feeding organisms and their predators. * Can bioaccumulate in animal tissues. * Can affect reproduction rates and life spans of aquatic species. * Disrupts food chain of aquatic environment. * Can affect recreational and commercial fishing. * Can affect water supplies.
Bacteria	animal operations cropland or pastures where manure is spread septic systems urban runoff wildlife	* Introduction of pathogens--disease-bearing organisms--to surface waters. * Reduced recreational usage. * Increase in treatment costs for drinking water. * Human health hazard.
Sulfates	mining operations	* Significant changes in acidity of streams. * Leaching of toxic metals from soils and rock surfaces. * Elevated levels of acidity and metals can be lethal to fish and eliminate entire aquatic communities. * Severely limits domestic and industrial water use.

Source: U.S. EPA. 1984 and 1987

With no end in sight for New Jersey's zeal for growth, it is important for everyone's welfare (developer and resident alike) that the state be allowed to grow without adversely affecting the water resources, particularly water supply reservoirs.[2] When a site is developed the stormwater volume and the peak discharge rate (how fast the stormwater leaves the site) increase dramatically (Livingston, 1987). Water that would normally infiltrate back into the ground flows overland, causing flooding and property damage. But concern is not only with flood protection. Petroleum products and metals, including cadmium from urban surfaces, transported by stormwater runoff pose a significant and well-documented water quality problem. The high velocity and quantity of urban stormwater runoff has been found to be a major cause of aquatic habitat disruption through erosion, sedimentation, and scour (EPA, 1984).

Alternative Approaches

There are three basic approaches to dealing with nonpoint pollution problems (Clark and Haverkamp, 1984):

Avoidance/Compensation. The most common approach is to avoid the effects or compensate for them where necessary. For example, we know that sediment can increase flood damage and make drinking water supplies unpotable. By building dams, levees, or other flood-control devices,[3] we avoid the first

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[2]The Garden State economy is booming. Politicians are happy to point out that New Jersey has the second highest per capita income in the nation. Between 1980 and 1987 population increased by 200,000, and 300,000 new jobs were added in the state. Government analysts predict another 1.2 million New Jerseyans by the year 2010, putting the state population at just about 9 million (Sanders, 1988).

[3]Flood-control devices are capital-intensive, expensive to maintain, and short-term solutions to a problem. They may even exacerbate the flood problem. Levees, for instance, artificially raise streambeds by restricting the deposit of

impact. By building better water supply treatment facilities we avoid the second. Both are examples of avoiding the problem. In some cases, attempts are made to compensate for the damage after it occurs.

Allowance/Entrapment. A second approach allows the nonpoint source of pollution to exist, but tries to trap the pollutants before they reach receiving waters. The construction of sedimentation ponds and buffer strips along streams are explicit examples of this kind of policy.[4]

Prevention/Source Reduction. The third approach is to prevent the problem from occurring in the first place. Restricting floodplain development and filling would mean no flood losses. The ecological role of wetlands and other habitats associated with floodplains would not be destroyed by development or filling. If sediment is a problem, erosion and runoff controls can be installed on agricultural lands or construction sites to reduce the amount of contamination that would otherwise enter a body of water.

Control Techniques

Techniques are available for nonpoint source pollution control that are effective, efficient, and affordable. A complete list and analysis of the various techniques available for controlling nonpoint source pollution can be obtained from several studies (Tourbier and Westmacott, 1980a and b; Novotny and Chesters, 1981). Technique differences are an important consideration in adopting

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sediments from streambanks.

[4]One of the fears with basins and buffer strips is the cumulative impact of pollutants being captured in them. At the time of this publication, field studies could not be obtained for review.

policy tools for a nonpoint source pollution control program:[5]

> It is quite possible to identify a set of efficient techniques and then adopt policies which perversely induce the adoption of quite another set of responses (Clark and Haverkamp, 1984:44).

Basically, there are two types of control techniques: structural and nonstructural. Nonstructural techniques do not involve construction in order to be effective. Examples would include site planning, good housekeeping, mulches, and ground covers. The applications of appropriate structural and nonstructural techniques are called Best Management Practices (BMPs) and are defined as:

> ...a practice or combination of practices that are determined...to be the most effective, practicable (including technological, economic, and institutional considerations) means of preventing or reducing the amount of pollution generated by non-point sources to a level compatible with water quality goals (Rey, 1980).

Of the principal structural alternatives available for removing pollutants draining from agricultural and developing areas, detention/retention basins are the most effective.[6] The detention/retention basin system or dual-purpose basin, when designed or retrofitted for pollution control, provides a highly effective approach to water **quantity/quality** considerations.[7] Strong endorsements come from the professional community:

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[5]Policy tools are efforts relied upon to stimulate the adoption of pollution control measures by individual landowners, developers, and farmers. In the past, policy tools have relied predominantly upon education, technical assistance, and cost sharing. Other tools are available: the soil-loss tax, cross-compliance, regulation, contracts, and public purchase.

[6] The principal structural alternatives for controlling nonpoint source pollutants are runoff retention/detention basins, in-line storage, and in-line screens (EPA, 1984). The family of structural best management practices also includes diversion or filter structures, energy dissipators, roadside swales, and porous pavement.

[7] Reconciling water quality and water quantity programs has been advocated as a strategy for achieving our national water goals more efficiently (Whipple, 1980). New Jersey stormwater management regulations require both water quality and water quantity controls.

The use of dual purpose detention basins, required to be built by developers as a condition of developing the land, is the only feasible means which has been found to prevent further increases in nonpoint source pollution (Whipple and Hunter, 1980:iii).

Site-level controls involving engineering structures have proved useful for taking care of pollution that could not be eliminated using land use controls (Miller and Burby et al., 1981).

Combinations of storage and wet-weather treatment, integrated with dry-weather treatment facilities and nonstructural control measures on an area-wide basis, are found to provide the greatest and most cost-effective control of stormwater pollution (Finnemore, 1982:706).

Flood and erosion control technology must be integrated with pollution control, so that the retention and drainage facilities required for flood and erosion control can be simultaneously designed or retrofitted for pollution control (Field, 1985:204).

II. Definitions

Detention basin - an embankment and associated space for impoundment of water or, alternatively, the space for impoundment partially or entirely created by excavation rather than by embankment, in either case designed to temporarily retain stormwater runoff (N.J.A.C. 7:8-1.3).

Infiltration basin - a stormwater management basin designed to infiltrate retained water to the subsurface and which is not an injection well (N.J.A.C. 7:8-1.3).

Retention basin - a stormwater management facility which temporarily impounds runoff and discharges the outflow through a hydraulic structure to a downstream conveyance system. Unlike a detention basin, a retention basin includes a permanent pool.

Dual-purpose detention basin - a stormwater management facility that provides both quality and quantity control. Dual-purpose basins may consist of ponds constructed to temporarily store water for the purposes of flood control and particulate removal. Such basins potentially reduce flood peaks and sediment settlement downstream. In some designs the "first flush" after a storm is routed to a retention area where it can percolate into the ground. The remaining flood volume is routed to a detention area and released at the predevelopment peak-discharge rate.

A number of considerations make dual-purpose basins highly attractive techniques for nonpoint source pollution control. Not surprising, detaining

runoff in basins for a period of sufficient duration for suspended sediments to settle out has certain disadvantages too. The advantages and disadvantages of dual-purpose detention basins are summarized below, from the work of Tourbier and Westmacott (1980).

Advantages

1. There has been considerable experience in engineering dual-purpose detention basins. They are the most reliable way of avoiding possible action for damages to downstream riparian owners.

2. Dual-purpose detention basins can be managed as a nonpoint source pollution abatement device.

3. The problem of silting downstream lakes and other facilities will be avoided.

4. These basins can often be incorporated into a planned system of open space based on natural drainage patterns.

5. A dual-purpose detention basin may be more cost-effective than several less effective "at source" erosion control measures.

6. Because of their dual-purpose appeal, it is often easier to incorporate detention/retention basins into urban developments.

Disadvantages

1. Regular removal of sediment and debris is required if the design capacity is to be maintained.

2. Their performance for flood control may not be high if flood storage volume is used for a permanent pool.

3. Dual-purpose detention basins remove sediment and other pollutants from stormwater after erosion has occurred and hence does not go to the root of the problem.

4. If not properly maintained, dual-purpose detention basins may encourage mosquitoes.

5. Dual-purpose detention basins are not ecologically rich due to the smothering of bottom (benthic) organisms by mud.

Research into the design and performance of detention basins has revealed a number of important insights. Water quality performance (i.e., the favorable influence on receiving water quality by reducing the mass loading of pollutants that would otherwise be carried into such waters by storm runoff) depends on appropriate biological, physical, and chemical mechanisms. Some studies show

that the requirement to retain particulate pollutants adds little to the storage capacity of a basin designed to prevent postdevelopment flooding. Other insights include the significance of the variability and intermittent nature of storm runoff. Still other studies have shown that performance depends on both area and volume provided.

III. Performance Characteristics

Raush and Schreiber (1981) were able to show that sediment retention basins could be 56-95 percent efficient in removing gross sediment loads depending on retention time, basin geometry, and incoming sediment size distributions. In a project conducted in Boston, Massachusetts, dual-purpose basins were 60-97 percent effective for solids reduction (Aronson, 1983a, 1983b; Field, 1982; Field, 1985). Removals of chemical oxygen demand (COD) and BOD were also significant (10-56 percent and 54-88 percent, respectively).

The performance of dual-purpose basins is affected by the variability and intermittency of storm runoff. Kamedulski and McCuen (1978) modeled the response of a detention basin in Montgomery County, Maryland, for storms of various intensities and durations and for two land-use conditions: a highly pervious, exposed soil condition, and a semipervious, exposed soil condition. Their research resulted in several important conclusions:

1. Inflow volume has a significant effect on both peak discharge reduction and sediment trap efficiency.
2. Storm duration has a significant impact on both the required storage and the ability of the basin to control peak reduction and thus is important in detention basin design.
3. The use of one return period as the basis for a detention basin design policy does not lead to a design that reflects the intent of stormwater management.

Whipple et al. (1983) modeled the passage of 2-, 10-, and 100-year mean frequency floods through dual-purpose detention basins. Results showed that "the requirement to retain particulate pollution adds little to the storage needed to prevent post-development increases in flooding from various sizes of design criteria for flood control and for alleviation of channel erosion tendencies" (1983:2). From their laboratory and field tests, it was concluded that substantial quantities of BOD, suspended solids, total phosphates, total hydrocarbons, and six heavy metals are removed by simple sedimentation. Sedimentation does not significantly reduce fecal coliform and total organic carbon.

Settleability

The effectiveness of dual-purpose detention basins depends on the settling velocity of sediment particles and other pollutants draining from the site. Mallory (1973) was able to compute settling velocities from the volume, size, and density of the particle and the density of the fluid. Velocity in the pond is reduced by increasing the surface area of the basin. Hence, the effectiveness of the basin increases with an increase in surface area. Table 6.2 shows the relationship between particle diameter, settling rate, and minimum surface area requirements. From the table it can be appreciated that the economical use of dual-purpose detention basins depends on the size of the particles to be removed. Settling is significantly slower in cold water (Tourbier and Westmacott, 1980b).

Table 6.2 Minimum Surface Area Requirements Assuming an Overflow Rate of 20.5 gpm

Material	Particle Diameter (microns)	Settling Rate (cm/sec)	Min. Surface Area for Settling Chamber (sq. ft)
Coarse Sand	1,000	10.0	0.20
Coarse Sand	200	2.1	
Fine Sand	100	0.8	2.50
Fine Sand	60	0.38	
Fine Sand	40	0.21	
Silt	10	0.015	133.56
Coarse Clay	1	0.00015	13,356.00
Fine Clay	0.1	0.0000015	1,335,600.00

Sources: Mallory, C.W. 1973. "The Beneficial Use of Stormwater," Office of Research and Monitoring; and Tourbier, J.T. and Westmacott, R. 1980. Water Resources Protection Measures in Land Development: A Handbook. (Revised Edition) Newark, DE: University of Delaware, Water Resources Center.

The USEPA (1986), with support from the National Urban Runoff Program (NURP), monitored the performance of detention basins for control of urban runoff quality. Their analysis methodology, based on the comparisons between observed and predicted performance, was able to provide sufficiently reliable estimates of basin performance for use in planning activities. Results of 46 separate settling column tests indicated the following:

* There is a wide range of particle sizes, and hence settling velocities, in any individual urban runoff sample.

* The distribution of settling velocities can be adequately characterized by a log-normal distribution.

* There is a substantial storm-to-storm variability in median (or other percentiles of) settling velocity at a specific site. The range indicated is about one order of magnitude in observed values for any percentile of the distribution in a specific storm. Uncertainty in the coefficient of variation of the site-averaged settling velocity distribution (95 percent confidence interval) is smaller, but still appreciable (about a factor of 5).

* Assuming the data available for analysis are representative, the foregoing indications, with regard to storm-to-storm and site-to-site differences, support the pooling of all available data to define "typical" characteristics of particle-settling-velocity distributions in urban runoff, and the assump-

tion that such results are generally transferrable to other urban runoff sites.

Trap efficiency

Several research studies (Curtis and McCuen, 1977; Aron et al., 1976) were able to show that soil particle size has a significant effect on the trap efficiency of a dual-purpose detention basin. Runoff volume in the inflow has a significant effect on both peak discharge reduction and sediment trap efficiency. "Control of the flow length in the detention basin and the detention time can be used to increase sediment trap efficiency" (Kamedulski and McCuen, 1979:185).

The duration of retention directly relates to the trap efficiency of pollution in dual-purpose basins. Modeling studies by the Northern Virginia Planning Commission (1979) showed that trap efficiency would be several times greater for storage released over a 40-hour period as compared to normal retention for reduction in peak flows.

Field determinations of basin trap efficiency were conducted by Whipple and Hunter (1981). Based on sampling in five areas, lead and hydrocarbons settled out in 32 hours at 60 percent and 65 percent, respectively, as compared to 70 percent for suspended solids. Biochemical oxygen demand, copper, and nickel settled out more slowly with more variability (20-50 percent range). Zinc was the slowest to settle out, from 17 to 36 percent in the total period of 32 hours.

IV. Site Characteristics and Application

Dual-purpose detention basins must be located at or near the lowest point of the site to maximize interception of site runoff. Basins draining roadways and parking lots must collect all runoff as the majority of the pollutants removed by dual-purpose detention basins originate from these sources (NJDEP,

1986).

Dual-purpose detention basins are applicable on almost any site. A dual-purpose detention basin does not depend on infiltration therefore soils are not a primary design consideration. If soils are excessively drained and the runoff is of very poor quality, it may be necessary to line the facility to prevent infiltration and the interception of the groundwater table. The risk to groundwater quality from leaching pollutants should be investigated before a site is selected. "Basins that do intercept the seasonal high water table may have unstable side slopes and may create maintenance problems due to the seepage especially where mowing is required" (NJDEP, 1986:5).

Site characteristics (e.g., proportions of pervious and impervious surface areas) will often determine the strategic location of on-site detention devices and their configuration. The choice of strategic locations can be made with the help of computer simulation models (e.g., Corps of Engineers STORM, EPA SWMM model, Penn State Runoff Model). The Penn State Runoff Model is particularly attractive because it combines a timing of subbasin flood flow (peak) contributions with sufficient program simplicity to allow small agencies or firms to engage in runoff modeling without substantial programmer training effort (Lakatos, 1980).

Dual-purpose basins can be integrated into a site's open space, landscaping, or recreational areas. Incorporating basins into overall site design has the advantage of reducing operation and maintenance needs, increasing aesthetics, and reducing the amount of land required for stormwater management. The advantage to the developer is in combining stormwater management requirements with local government requirements for open space and landscaping (Livingston, 1987:3). In some urban areas where land is expensive, retention areas can be

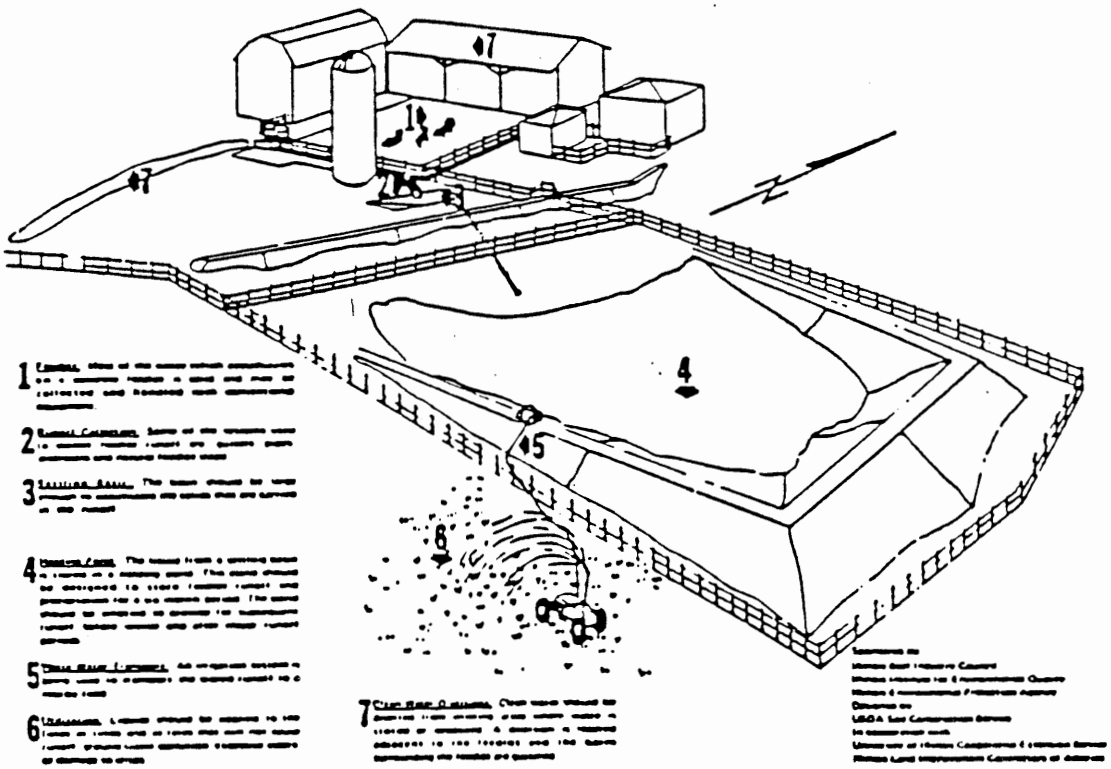
placed beneath parking lots or other improvements, however, maintenance becomes more difficult.

Engineering structures have proved useful for controlling pollution from a given site that could not be eliminated using land-use controls (i.e., zoning). Miller and Burby et al. (1981) cite the example of the Delaware and Raritan Canal, where no attempt was made to control the type and location of development. Site-level regulations were used exclusively to protect water quality. The Delaware and Raritan Canal Commission issued regulations requiring dual-purpose basins. The USEPA (1984:2-3) stated that "flexible, site-specific, and source-specific decision-making is the key to effective control of nonpoint sources."

Most applications of dual-purpose detention basins occur in urban and urbanizing areas. There are, however, examples of successful agricultural applications (Gilbertson et al., 1971; Swanson and Mielke, 1973; Swanson et al., 1975; Lawfer, 1975). An experimental dual-purpose detention basin has been in operation for feedlot-runoff control since 1973 on the Lawfer dairy and livestock farm in northern Illinois. The system (illustrated in Figure 6.3) has been monitored by the University of Illinois Agricultural Engineering Department. A study of water and soil samples showed that about 1/10 of 1 percent of the liquids in the holding pond were solids, indicating that the settling basin was effectively separating the solids from the liquids. Preliminary studies indicated that the amount of plant nutrients in the irrigation water was relatively small (Lawfer, 1975).

Figure 6.3

Dual-Purpose Detention Basin for Feedlot-Runoff Control



Source: Lawfer, 1975.

V. Design Criteria

The main hydraulic criterion for dual-purpose detention basins is that they reproduce or improve predevelopment flow rates (flood control). The main water quality criterion is that they reduce nonpoint source pollution from storm runoff. The accomplishment of this combination of purposes must recognize that most flood damage results from storms less frequent than one per year, while storms more frequent than one per year carry most of the particulates. One can easily recognize the competing processes at work in dual-purpose detention basins that may enhance or degrade removal of specific pollutants. Dual-purpose detention basins must therefore store the volume of a selected design storm, release it

through one or more outlets sized to the desired reduction of flood damage downstream slowly enough to remove particulates, but fast enough to control for the possibility of a large flood (see Figure 6.4). This can be accomplished by

> ...providing a small *retention outlet* at the bottom of the detention basin, sized for slow release of runoff from small storms, with main outlets, designed for flood control, at a higher elevation. The selected small storm controlled by the retention outlet is known as the *settleability design storm* (Whipple, 1981:643).

Outlets should be arranged to remove the maximum amount of particulate pollution for the smaller storms. Some sacrifice of flood control effectiveness for smaller discharges would be permissible if important advantages in controlling runoff pollution could be gained (Whipple and McIntosh, 1979).

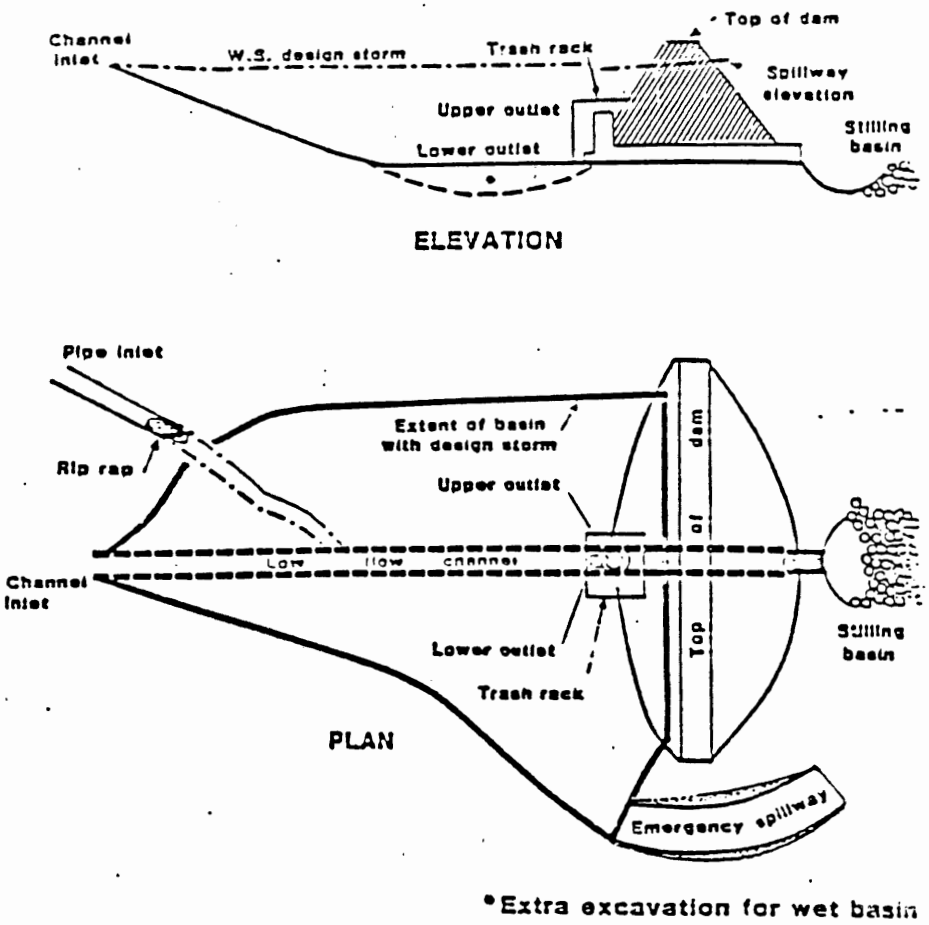
The New Jersey Stormwater Management regulations require that the 2-year, 10-year, and 100-year storm postdevelopment peak runoff rates cannot exceed the predevelopment conditions. In addition, the New Jersey regulations require prolonged detention of the settleability design storm. This translates into three principal outlets sized to provide the required reductions:

> The discharge structure will typically have three principal outlets. The water quality outlet will usually be small in comparison to the other outlets. The use of a restrictor plate containing an orifice designed to provide the required retention should be used in place of a small pipe in the structure. The restrictor plate can be removed to facilitate maintenance or to allow alterations of the water quality outlet...In most cases, the second stage outlet will be designed to act as the primary control for the 10-year storm ...The third stage outlet is designed to control the 100-year storm (NJDEP, 1986).

The use of multiple outlets at different elevations improves the performance and reliability of the spillway. A multistage outlet structure is illustrated in Figure 6.5.

Figure 6.4

Nomenclature for Dual-Purpose Detention Basin



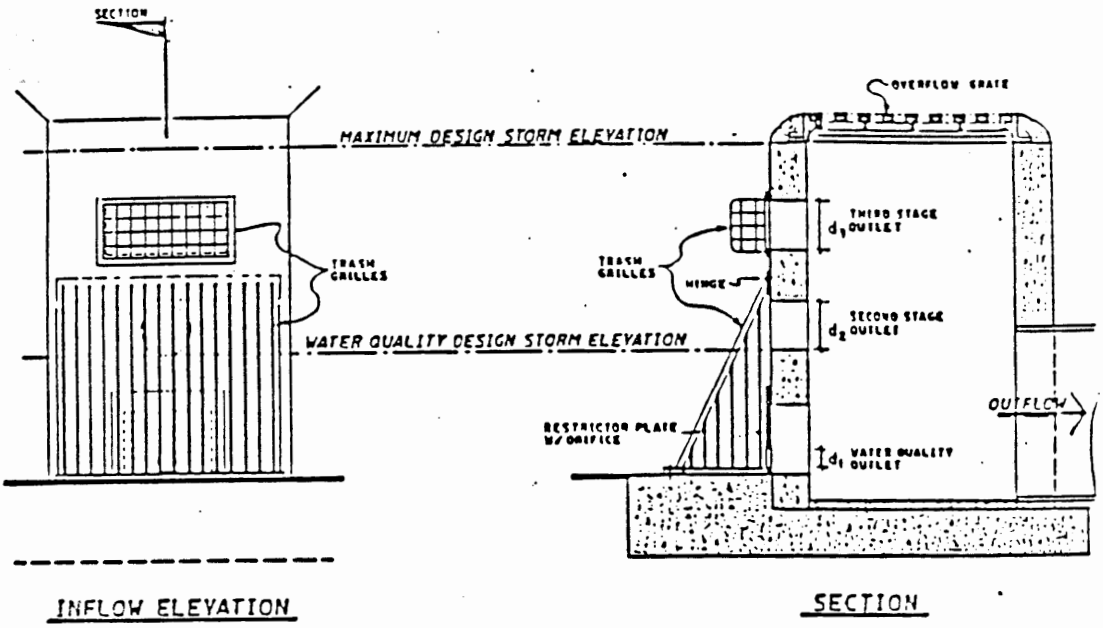
Source: Whipple et al. 1983.

In New Jersey, the settleability design storm is 1-1/4 inches in 2 hours (3.17 cm/2 hr) or the 1-year, 24-hour storm. New Jersey standards require the water quality design storm either be retained for up to 36 hours to promote the settlement of particulate pollutants or controlled through infiltration practices to achieve zero runoff (Kaiser and Burby, 1987). An 18-hour period of evacuation is acceptable in residential areas. According to Whipple (1981:785), this degree of retention "will remove 60% of the total suspended sediments in urban runoff, a similar proportion of the petroleum hydrocarbons and lead, and perhaps 45% of

the BOD, copper and phosphates." Dissolved pollutants, such as nitrates, are unaffected by retention.

Figure 6.5

Multiple Stage Outlet Structure for a Dual-Purpose Detention Basin



Source: NJDEP. 1986. A Guide to Stormwater Management Practices in New Jersey. Trenton, NJ: State of New Jersey Department of Environmental Protection, Division of Water Resources.

Under the New Jersey Storm Water Management Act (P.L. 1981, c.32) detention basins must adhere to the following regulations (N.J.A.C. 7:8-3.4):

1. There will be no detention basins in the floodway except for those on-stream.

2. New development, including construction of detention basins, should be avoided in flood plains, but where this is unavoidable, the plan and the ordinance must require a special examination to determine adequacy of proposed detention measures during the 100-year flood. One acceptable method is to apply the 100-year design storm to both the site and to the entire watershed contributing to the flood plain, assuming that the two peak simultaneously at the point in question. The time of concentration assumed for the entire watershed should be that appropriate to the larger

area, rather than the shorter period applicable to the site.

3. In addition, such development must be in compliance with all applicable regulations under the Flood Hazard Area Control Act, N.J.S.A. 58:16A-50 et seq.

4. In cases where detention basins, other than on-stream basins, are to be built in flood plains and in default of an analysis such as described above, detention storage provided below the elevation of the 100-year flood (either specially calculated or taken from an official State flood plain delineation map) will be credited as effective storage at a reduced proportion as indicated in Table 6.3.

Table 6.3 Allowable Proportion of Storage to be Assumed Usable in Detention Basins in the Flood Plain

	DRAINAGE BASIN AREA AT SITE		
Elevation of storage[1]	Less than 5 Sq. Mi.	5-100 Sq. Mi.	Over 100 Sq. Mi.
less than 2 ft.	40%	65%	90%
2 - 4 ft.	25%	50%	75%
over 4 ft.	10%	25%	50%

[1] provided below 100-year floodplain

5. This effective detention storage, plus any other supplementary measures will be required to provide for storm water detention, in accordance with established standards.

The most efficient design appears to be a shallow pond with a large surface area (NJDEP, 1986; Tourbier and Westmacott, 1980b). In some cases the increased area for settlement cannot be provided and yet a superior performance is required. Coagulants or flocculants may be added to increase effectiveness. In addition, runoff can be passed through specialized sedimentation devices having a more effective removal rate/surface area ratio than ponds. Microstrainers or screens (e.g., rotary screen, drum screens) may be used to remove sediment of more than 23 microns. Dissolved air flotation is another useful technique when

there is insufficient surface area for natural settlement. This technique attaches air bubbles to suspended particles. Operating costs will be relatively higher due to the energy required to compress air and release it into the basin (Tourbier and Westmacott, 1980b).

Dual-purpose detention basins designed for controlling feedlot runoff and disposing of it should include a) diversion of overland flows from outside the feedlot, b) control of runoff and soil erosion, c) adequate control of wind movement and snow accumulation, and d) maintenance of adequate drainage if high water tables or surface inundation are problems (Swanson et al., 1973). Climate is a major factor in designing and managing control, collection, and disposal systems for feedlot runoff (Swanson et al., 1973).

VI. Maintenance

Even properly designed and constructed dual-purpose basins will not perform as intended without periodic maintenance. The usual maintenance involves cleaning and dredging pipes and basins, and mowing and repairing land covers. Maintenance requirements should be included in the design criteria. An example of maintenance consideration in design would be...

> the requirement that detention basins be designed so that the amount of sediment expected to accumulate in one year will not decrease the available volume of storage to the point where the basin does not meet the performance standards for peak discharge control methods (Hawley and McCuen, 1987: 803).

Dual-purpose detention basins may be designed and installed for temporary purposes (e.g., during the construction period) or as a permanent feature of the landscape. For permanent basins, regular removal of sediment and debris is particularly critical. In time, dual-purpose detention basins can become unsightly muddy impoundments. Sediment build-up can reduce flood control capacity.

Cleanup should be a standard practice after every storm event. Floating debris can be removed by fitting the spillway with a trash rack. Trash racks reduce the possibility of clogging the outlets. The New Jersey Department of Environmental Protection recommends hinged racks to further facilitate the removal of accumulated debris.

A prime consideration in the design and maintenance of detention systems is the prevention of nuisance algae and aquatic plant growth. Environmental administrators for the state of Florida recommend a perimeter swale/berm in addition to a littoral zone (about 30 percent of the pond) that is concentrated near the discharge point and is planted with suitable aquatic plants. A major concern of New Jersey officials with detention basins is the potential for them to become breeding grounds for mosquitos. In order to prevent stagnant water, the detention basin "should be oriented to take advantage of prevailing winds to promote mixing and aeration or should include mechanical aerators such as fountains" (Livingston, 1987:4).

The regulations for maintenance and repair of detention basins under the New Jersey Storm Water Management Act (N.J.A.C. 7:8-3.4 (5)(i)(ii)) specify:

1. Maintenance of detention basins and infiltration means, or of other alternatives, is a very important aspect of a storm water management program. Control measures shall be designed so as to provide for mechanical maintenance operations. Responsibility for operation and maintenance of storm water management facilities, including periodic removal and disposal of accumulated particulate material and debris, unless assumed by a governmental agency, shall remain with the property owner and shall pass to any successor or owner. In the case of developments where lots are to be sold, permanent arrangements, satisfactory to the approving agency shall be made to insure continued performance of these obligations.

2. A schedule of maintenance inspections shall be incorporated into the local ordinance. Ordinances shall also provide that in cases where maintenance or repair is neglected, the municipality or the county has the authority to perform the work and to back-charge the owner.

VII. Regional and Local Differences

Local factors may modify design and performance projections. Feasible local options for surface area and depth will vary according to such factors as rainfall patterns, soil types, seaonal high groundwater table, soluble fractions of site-specific pollutants, and settling velocities in urban runoff.

Perhaps more important than differences in physical and spatial attributes are political factors operating regionally or within a specific locale that influence the system of governance. Local and county governments ultimately affect the use of BMPs for nonpoint source pollution control because they decide what gets budgeted and implemented.

In New Jersey, home rule sentiments are very high. Consequently, local officials exercise tremendous power. In other states this point may seem inconsequential, but not in New Jersey where there happens to be so many of them. Within New Jersey's 7,504 square miles are 567 municipal governments. By way of comparison, New Jersey has more governments than Arizona, Delaware, Hawaii, Maryland, Nevada, New Mexico, Rhode Island, and Wyoming combined (O'Neill, 1987). It is not surprising that New Jersey holds the record as the state with the most governments per square mile. In political terms this means the chances for issue divergence are great, and consensus building small.

Water quality problems often transcend municipal boundaries. More importantly, solutions to problems created at the municipal level cannot always be found at the same level. One solution to this problem lies in a provision in the New Jersey Municipal Land Use Law (N.J.S.A. 40:55D-77), which allows for a joint exercise of power among municipalities. "Instead of each one trying to provide the same service, they can come together to provide that service in a more efficient way to a larger region" (Epling, 1987:17). When it comes to

nonpoint pollution control, municipalities should be encouraged to work out regional solutions. Dual-purpose detention basins, depending on their location, can provide regional benefit.

Although the costs of best management practices that address stormwater runoff control are borne largely by residents within the respective municipality, benefits extend beyond this group to the society at large:

> Benefits of BMP implementation can include improved potable water supplies, restored recreational opportunities, restored or continued commercial fishing and shellfishing opportunities, and maintenance of land values due to the aesthetic appearance of receiving waters. In addition, damage to drainage systems, obstruction of navigation channels and harbors, and the frequency and severity of floods can be reduced. Good housekeeping practices often have additional benefits to the landowners who apply them. For example, educational programs on the proper use of fertilizers and pesticides frequently result in better lawns and gardens, and programs on proper streambank management not only minimize erosion but improve the appearance and value of property (EPA, 1984:2-35).

VIII. Developed vs. Developing Urban Areas

The USEPA (1984) finds a distinction in the feasibility and management costs of structural control practices depending on whether the area is developed or is developing. In highly developed urban areas, exhibiting high land values and limited space, nonpoint source runoff will be difficult to control. Structural solutions will be very expensive; land-use planning and nonstructural controls will have limited utility. "Developing urban areas offer the greatest potential for utilizing the full range of structural and nonstructural BMPs" (1984:2-36).

Dual-purpose detention basins and stormwater management generally are techniques for developing areas, with little, if any, applicability to existing development (Whipple, 1988). For the latter, other BMPs especially source controls, must be resorted to.

IX. Implementation

The implementation of nonpoint source pollution controls has an important economic dimension. In most situations, there are feasible land management practices for reducing nonpoint source pollution, but inducing landowners to employ those practices requires attention to the economic benefits and costs of changing their uses of land (Braden et al., 1984). In appreciation for limited program funds, control measures should be the least costly means of achieving the desired pollution reduction. Unfortunately, a major institutional weakness in controlling nonpoint source pollution is the lack of analytical tools for identifying a least-cost set of strategies for a watershed.

Braden et al. (1984) demonstrated the usefulness of the Sediment Economics (SEDEC) simulation model for designing an economically efficient strategy for reducing sediment deposition from cropland into a small watershed. The model conjoins farm planning economics (including a function relating soil losses to crop yields) and a sediment delivery relationship. It can be used "to identify minimum payments needed to make a landowner indifferent between unconstrained farming and best management practices that attain specified reductions in sediment loads" (1984:69). Tremendous research opportunities exist for refining and expanding SEDEC to other applications of nonpoint source pollution control.

The lack of integration of the "autonomous federal and local agencies and professions involved in flood and erosion control, pollution control, and land management and environmental planning" at both the planning and operational levels (Field, 1985:204) is an institutional problem that hinders the implementation of dual-purpose basins.

Whipple et al. (1987) discuss additional planning and institutional aspects of implementing nonpoint source pollution controls. Conventional stormwater man-

agement plans usually result in small detention basins on many lots, making them more appropriate for local rather than state control. According to the USEPA (1984:xii), "the localized nature of nonpoint source pollution makes a national strategy ineffective by not providing enough flexibility and specificity to solve local problems." The drawbacks include "the excessive amount of land required, the difficulty of maintenance, and the planning and regulatory burden entailed by such a large number of facilities" (Whipple et al., 1987:782).

Regional (master) basins are more economical (in terms of embankment and outlet construction, land acquisition) than many small ones, but they are more difficult to obtain. Only when the developer receives his financing is he ready to pay for improvement costs (Whipple, 1981). In order to obtain wider use of regional (master) basins, four actions need to be taken (Whipple, 1981:645):

1. Provide a source of funds for advance planning of watersheds for master basins, including location of sites and estimate of costs.
2. Require developers to pay in cash for detention requirements, the funds to be held in escrow.
3. Allow some deferral in providing the first increment of detention, in order to accumulate sufficient funds first to buy the site and then to build a major facility.
4. Arrange for a government agency, or possibly a cooperative, to construct and maintain the structures.

In 1987 an amendment to the Clean Water Act was enacted that provided for a national nonpoint source pollution program. Under the Clean Water Act, the USEPA is the lead federal agency for facilitating and coordinating the management of NPS pollution. Pending development of a national system of nonpoint source control,

> It appears to be generally accepted that stormwater management for new developments, including quality controls, can best be implemented by means of land-use planning authority exercised over developers at the time of site plan approval, whereas the application of nonpoint source controls over existing developments, whether they involve detention facilities or not, must

be implemented by either the municipalities themselves or by existing property owners (Whipple et al., 1987:789).

The USEPA encourages a variety of enforcement and regulatory tools. The agency expects states, in cooperation with appropriate levels of government and the private sector, to take the lead in developing NPS management programs.

The persistent and pernicious nature of nonpoint pollution seems to rule out reliance on voluntary programs. Voluntary compliance assumes knowledge about options. Landowners, developers, and farmers will not all be knowledgeable about the water quality and associated impacts of nonpoint source pollution. Even if landowners, developers, and farmers are aware of the magnitude of the nonpoint source pollution problem and the water quality impacts, they may not be sure of the best system for controlling it (Clark and Haverkamp, 1984).

X. Summary

The spread of impervious surfaces (i.e., development) along with uncontrolled crop and livestock production (i.e., pesticide, fertilizer, and feedlot use) guarantee a nonpoint pollution problem and, on a larger scale, a watershed management problem. Site-level controls involving engineering structures have proved useful for taking care of pollution that could not be eliminated using land-use controls.

Within the agricultural community and the already developed and rapidly developing areas characteristic of New Jersey, the policy approach to nonpoint source pollution seems to be one of allowance/entrapment. Dual-purpose detention basins provide a highly effective solution to trapping nonpoint source pollutants. Until a prevention/reduction policy approach meets public approval, an allowance/entrapment policy will have to do. It is better than nothing. In the meantime, local, county, and state leaders should still strive for a watershed

management policy that prevents and reduces pollution at the source.

Water supply watersheds should be given priority for establishing protection strategies that control runoff from nonpoint sources. Nonpoint pollution loads from land development can be of sufficient magnitude to pose a health risk to public drinking water supplies. With increasing growth and the resultant generation of pollutant hazards, the need to protect New Jersey's surface waters is urgent. Dual-purpose detention basins may allow designated growth areas to develop without adversely affecting surface water supplies.

XI. Recommendations

1. Dual-purpose detention basins should be pursued as an integral component of a comprehensive watershed management program.

Combinations of detention and retention facilities, integrated with nonstructural control measures on an areawide basis, are found to provide the greatest and most cost-effective control for runoff pollution. Hence, dual-purpose detention basins are a viable alternative for maintaining receiving water quality standards. Though on-site water quality control is effective, on-site flood control is not always effective. The alternative is to allow off-site or regional collection systems (i.e., master basins). Master basins are more economical than many on-site detention facilities for flood control. NJDEP standards for multifrequency control of stormwater runoff are consistent with long-term comprehensive planning ideals.

2. Dual-purpose detention basins should be designed to minimize and facilitate maintenance requirements. Local governments should be given the authority to perform necessary maintenance on privately owned systems when the owners fail to fulfill their maintenance responsibilities. Maintenance oversight (i.e., periodic on-site inspection) should be rendered by the New Jersey Department of Environmental Protection. Easements guaranteeing access for maintenance and inspection purposes should be required whenever dual-purpose detention basins are

located on private land.

Consideration of maintenance in the design of dual-purpose basins will result in lower costs for the responsible parties and may reduce the amount of damage caused by neglect (Hawley and McCuen, 1987). Without proper maintenance basins tend to become unsightly muddy impoundments with little aesthetic value and little flood-control capacity. Cleanup after every storm event should be standard practice.

3. The autonomous federal, state, and local agencies and professions involved in flood and erosion control, nonpoint source pollution control, land management, and environmental planning should be integrated at both the planning and operational levels.

The fragmentation of control is an institutional problem that hinders the implementation of dual-purpose detention basins.

4. Funding alternatives should be investigated for sustaining on-going research and monitoring of dual-purpose basin performance in New Jersey's watersheds.

More information is needed to evaluate the efficiency of current dual-purpose detention basin operating criteria to remove particulate pollution. Further research should be accomplished to extend the data base. Funds are necessary to support monitoring and field testing.

5. The detriment of groundwater should be considered in the design and operation of dual-purpose detention basins.

Consideration must be taken so that runoff, with its heavy pollution loads, prevented from leaving a site does not seep into the ground. It does no one any good to shift the problem.

6. The NJDEP, Division of Water Resources, should improve its outreach mission as a technology transfer for information, advice, and technical assistance to local communities.

The New Jersey DEP published the required rules for the Stormwater Management Act in February 1983. A Guide to Stormwater Management Practices came out in 1986. Still, efforts have not been sufficient to bring all of New Jersey's 567 municipalities into compliance with the Stormwater Management Act passed in 1981. To insure the successful implementation of the stormwater management program, the New Jersey DEP should a) make available adequate resources (grants and staffing) to provide technical assistance to the interested municipalities and counties, b) broaden its public education so that local governments are aware of their responsibility, and c) evaluate regulations to ensure that the intent is not lost in the technical vocabulary.

Finally, it is hoped that...

. . . the construction industry continues to exercise resourcefulness in solving runoff problems. Dual-purpose detention basins are just one example of solving water quality and quantity problems.

. . . the general public is not forced to subsidize the costs of environmentally abusive development.

. . . legislation is enacted which sets performance standards for various watersheds.

. . . all units of government place more emphasis on how to construct, operate, and maintain land and water uses.

. . . more New Jerseyans recognize the value of their state's watersheds and demonstrate it by fighting for better stewardship.

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STORMWATER MANAGEMENT DISTRICTS AS A WATERSHED MANAGEMENT STRATEGY

7

Robert M. Hordon

I. Introduction

The goal of stormwater management is to provide the physical mechanisms and institutional procedures whereby the extra runoff that is generated by the urbanization process is handled in an effective manner. There is a quantity and a quality aspect to stormwater management. The quantity aspect is generally subsumed under such guidelines as the following: "post-development peak runoff shall be equilibrated with pre-development peak runoff." These guidelines are very often incorporated into specific ordinances that are then adopted by the municipality.

The quality aspect of stormwater management usually reflects concerns with possible effects on the health of the aquatic ecosytem as a consequence of increased urban runoff. A variety of structural (e.g., detention basins) and nonstructural (e.g., density ordinances) measures is usually employed to mitigate the effects of development in a watershed. In some cases, the same measures may assist in both the quantity and quality aspects of stormwater management.

In this chapter, the issues that will be addressed will focus on possible institutional arrangements that have been tried in other states in order to provide effective stormwater management.

II. Stormwater Utilities

A body of technical information on stormwater management already exists that can provide local governments with the wherewithal to require that runoff from all new residential, commercial, and industrial developments must be maintained at predevelopment levels. The major problem with many of the stormwater control measures adopted has been that of maintenance. The lack of maintenance is directly linked to the lack of funding.

One mechanism for funding that has been growing in recent years has been the creation of a stormwater utility. This institutional device is empowered to levy user fees on all property owners within a stormwater district. The money collected is then used to maintain all of the stormwater-control devices that are then installed in the district.

From a hydrologic viewpoint, the most logical areal unit for a stormwater district is a watershed or portions thereof. There is a natural upstream-downstream relationship which serves to tie together the various political units at least as it relates to stormwater flow. However, watersheds invariably include multiple jurisdictions which means that it is probably easier politically to establish a district within an existing governmental entity, such as a city or county, than to establish a new district based on watershed boundaries.

The State of Maryland made a national survey of stormwater utilities in 1987 (Lindsey, 1988). The results of this survey, in brief, are as follows:

1. There are about 50 stormwater utilities in the U.S., 19 of which (38 percent) responded to the survey.

2. Utilities have been established in communities that range in size from 20,000 (Wooster, Ohio) to 685,000 (the City of Louisville and Jefferson County in Kentucky).

3. Several utilities serve multiple jurisdictions such as a city and a county (e.g., Louisville, Kentucky and Jefferson County). A few utilities are organized on the basis of watersheds (e.g., Everett, Washington).

4. Many of the utilities are within the public works departments of their respective municipalities.

5. All of the 19 utilities are responsible for the operation and maintenance of the stormwater systems.

6. The oldest utility was formed in 1973; most of the others were formed since 1983.

7. The costs of forming the utilities varied substantially from place to place. A large part of the initial costs had to do with the creation of the billing sytem. Most of the utilities reported that it took 1.5 to 2 years of planning before local governments voted to establish them.

8. Many of the utilities are located in western states, such as Oregon, Washington, and Colorado. There were no systems in the survey that were located along the eastern seaboard (Maine to Florida).

9. The total amount or percentage of impervious area on individual properties was used by most utilities as a means of assessing user charges. Some of these charges were expressed as "single family equivalents," or SFEs. These SFEs are units that equate runoff from all parcels to the average amount that is generated from a single family residential property.

10. Users were generally billed on a monthly basis. The monthly charges for single family residential parcels ranged from $1.25 to $4.40.

11. All of the utilities maintain public facilities, whereas private facilities are usually maintained by the owner of the property where the facility is located. Only a few utilities are required by the laws that govern them to inspect private facilities on a regular basis. These private facilities would be inspected only in response to complaints.

III. Discussion

A utility appears to be an excellent approach for providing a stable source of funds for maintaining a stormwater management system. The degree of imperviousness should satisfy the principle of equity among users, as it is based on a fairly well established association between impervious cover and runoff generation. The monthly charges are also reasonable and appear to represent a very small percentage of a typical family's monthly budget.

None of the utilities contacted in the survey was in the private sector. There appears to be no particular reason that a stormwater utility could not be

run by a private operator. After all, other utility operations in New Jersey and elsewhere are run by investor-owned companies, which handle such necessities in life as fresh water, electricity, and telephones. These utilities have to comply with regulations of agencies, such as the Board of Public Utilities, in terms of rates and service. A good argument could be made for a private utility to manage a stormwater district as well as a public utility.

The relative "newness" of a utility to manage stormwater must be noted. As the foregoing summary indicated, most of the utilities were formed after 1983. There is presumably a secular increase in the number of utilities in operation in the U.S. Clearly, additional information is needed in this area.

One of the the major concepts that comes out of the Maryland survey is the direct association between the amount of impervious cover and the size of the fee needed to manage the effects of this impervious cover. It is generally recognized that impervious cover increases as density increases. Higher density can then be tied into a higher fee structure, which is fair to all parties concerned.

On a small scale, a homeowners association can serve as a mini-stormwater district. In New Jersey, for example, homeowners associations are often established in major subdivisions as ongoing institutional mechanisms to own and maintain stormwater runoff control facilities such as detention basins, as well as other community-based recreational facilities. These agreements, which become part of the property deeds, must of course be approved by the local municipality and the Department of Community Affairs. The technical designs for the stormwater facilities themselves must also be approved by appropriate governmental agencies in terms of their hydraulic effectiveness.

The homeowners in such an association are assessed a fee to cover the

costs that are incurred in the maintenance of stormwater facilities. As a consequence of this fee assessment, the municipality and county do not have to bear the expenses associated with a maintenance program.

The counties in New Jersey may be in a favorable position to assist in the formation of stormwater management districts. For example, Somerset County is in the process of forming regional stormwater management areas within selected watersheds (interview with J. Skupien, P.E., Somerset County Engineers Office, February 17, 1989). The watershed selected is then disaggregated into smaller subwatersheds where appropriate runoff control measures can be instituted. Although the focus of the efforts so far appears to be on the technical designs and types of structures necessary to achieve the desired control of storm runoff, the important thing is that the county has taken a lead in preparing stormwater management plans on a regional basis.

IV. Recommendations

1. The NJDEP Division of Water Resources should obtain a legal opinion from the Attorney General's office as to the feasibility of having a stormwater utility operate in New Jersey.

The fact that so many of the utilities exist in the western states suggests, but does not stipulate, that there is some form of institutional impediment to utility formation in the eastern states. Of course, the regional difference could simply reflect a greater degree of institutional innovativeness on the part of western communities. At any rate, the matter has to be addressed.

2. The NJDEP Division of Water Resources should explore the possibilities for adopting a regulatory scheme for stormwater management entities.

NJDEP-DWR or Rutgers (under NJDEP guidance) could contact as many of the existing stormwater utilities in the U.S. as possible for background

information on their regulations and mode of operation. This information would be extremely useful to the state in its stormwater management program. Indeed, this information exchange could be included as one of the regular programs of the EPA "technology transfer" seminars.

3. User charges should be directly related to the amount of impervious cover associated with each property owner.

The association between impervious cover and runoff generation in an uncontrolled setting is well known. Therefore, this relationship would be the fairest way to assess users for stormwater services rendered. This procedure is very well established in many of the existing stormwater utilities.

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ONSITE WASTEWATER MANAGEMENT ENTITIES AS A WATERSHED MANAGEMENT STRATEGY

8

Theodore Shelton

I. Introduction

Management of onsite and small community wastewater disposal systems can be an important component of an overall watershed protection strategy. Onsite wastewater systems contribute a large hydraulic input and are a significant source of nonpoint source pollution to surface and groundwaters. Their proper functioning through a management entity approach is the focus of this section.

The data from the 1970 and 1980 censuses reveal that the actual number of dwellings not served by public sewers is increasing despite the 10-year reduction in the percentage of dwellings not served by sewers, from 25 to 20 percent. The construction grants program under the 1977 Clean Water Act for public sewerage systems is the major reason for this percentage decline. The actual number of operating systems is approximately 22 million in the U.S. (Engineering & Economic Research, Inc., 1988).

Experience has shown that most homeowners in unsewered areas know very little about the theory, the operation or even the location of their onsite wastewater disposal systems. Onsite systems generally get attention only when they fail. Symptoms of failure are backed-up household plumbing or surfacing of sewage in the yard. In extreme instances the health department can require the abandonment of a dwelling with a serious onsite wastewater system failure.

Poorly installed, operated, and maintained septic systems pose a serious threat to groundwater quality. There are many areas, served by septics,

throughout the country where high housing densities have degraded the groundwater and rendered it unusable for drinking and other purposes. We know that groundwater and surface water systems are interconnected. Impairment of groundwater quality by septic systems thus has direct impact on surface waters within a particular watershed.

In addition, potential exists for the transmission of disease by drinking waters contaminated by septic effluent. Outbreaks of hepatitis, viral and bacterial gastroenteritis, and typhoid have been reported in recent literature (USEPA, 1980). Nitrate concentrations above the maximum contaminant level set by the Safe Drinking Water Act, a common result of septic system leachate contamination, has the potential to produce methemoglobinemia (blue baby disease), which occurs when nitrate interferes with the oxygen carrying capacity of the hemoglobin in red blood cells.

Septic effluent also contains a wide range of toxic and hazardous chemicals. Every chemical used in the household has the potential to be disposed of in the septic tank. This includes pesticides, paint thinners, photographic chemicals, leftover drugs, dry cleaning chemicals, and solvents used as septic cleaning agents.

Currently the most widely used and recognized corrective measure for a group of failing onsite systems is to install sewers and build a central treatment plant. Due to recent large increases in installation costs of new sewer systems, this option is becoming less attractive. This is especially true in small rural communities. Another option, which is enjoying increasing interest, is the establishment of a management entity to oversee the rehabilitation, replacement, maintenance, and monitoring of onsite systems in the community. This alternative can be the most cost effective and environmentally acceptable

wastewater approach for small communities and urban fringe areas, and may contribute significantly to improvement of water quality within certain watersheds.

II. Definition of an Onsite Wastewater Management Entity

An onsite wastewater management entity is an institutional and administrative structure or arrangement that offers a strategy to control public health hazards, environmental degradation, and nuisances that might otherwise arise from wastewater generated in unsewered areas. It should be considered an important element of any watershed protection strategy.

A wastewater management entity provides technical assistance together with strong regulation and enforcement. Most management entities or programs are targeted at installation, operation, and maintenance of onsite systems (USEPA, 1980).

During installation, the management entity must limit installation to suitable sites and assure the proper design and construction of all onsite systems. It is during this period that management entities can be most effective in minimizing the potential threat to public health and water quality.

During the operating life of the system, the management entity must assure proper operation of an onsite system through periodic monitoring. While there are very few operational requirements for a septic tank soil absorption system, some of the onsite systems have more extensive requirements. An effective program imposes controls on operation whether the system's operation is straightforward or complex.

The management entity must provide for adequate maintenance of an onsite system, e.g., periodic pumping of septic tanks. It also must detect any onsite

system that fails to function properly. This may be done through systematic or random inspections. An effective entity takes the necessary action to assure that repair, replacement, or abandonment of failed systems is completed, and there is no threat to water quality or the watershed.

III. Review of Principal Areas of Control for Onsite Wastewater Management Entities

Management entities conduct programs that may take a variety of forms. A complete management program should have all or most of the following functions (Ciotoli, 1981).

A. Contain a planning and administrative component

The management entity must have an office and staff management capability that establishes office policies and procedures and maintains sufficient staff size to accommodate the workload.

In addition the entity may be involved in plan preparation for land use development, wastewater facilities, and water supply and residuals disposal. This function includes plan review coordination with other agencies, and integration of land use and wastewater management program needs and objectives.

Another function, which may be considered optional, is research and development. This includes feasibility studies of alternative institutional arrangements and cost effectiveness analysis of alternative wastewater treatment and disposal technology.

B. Promulgate codes and standards for site suitability, system design, and system performance

The NJDEP-Division of Water Resources has the appropriate authority to establish minimum standards for site suitability, system design, and system

performance. This is preferred over each municipality establishing its own standards. The advantages to this are: 1) more resources and experienced personnel at the state level to develop standards, 2) more efficiencies and economies of scale in the construction and engineering of systems, and 3) more uniformity in the training of personnel. The present system allows local boards of health to establish regulations that are more stringent than the state regulation.

C. Conduct site evaluations and review system designs

Site evaluation consists of guidelines and criteria, evaluation certification, and site suitability analysis. System design consists of standards and criteria, designer certification, system design, design review, and the issuance of a permit. These activities could be performed by any of the entities making up the management program.

As an alternative to performing site evaluations and system designs as part of the management program, these activities could be performed by site evaluators and system designers licensed or registered by the management entity. Licensure is important to assure the qualifications of personnel. It is also important that these licenses be subject to suspension or revocation. Random or preapproved site inspections by the management entity are necessary to assure compliance with established procedures and standards, especially in locations where site limitations are expected.

The management process is usually initiated by either the submission of plans for review and approval or by application for a permit to construct a system. Either requirement for plan approval or permit issuance for construction of a system provides the management entity with a convenient method of obtaining information about the site evaluation and system design, Site

suitability and design standards may be easily enforced by refusing to approve plans or issue permits.

D. Provide for construction supervision and installation review

This phase of the management activity consists of construction supervision, installer certification, record-keeping, and permit issuance. In this phase the management entity could choose to install all new systems themselves. In New Jersey, with its booming construction activity, this is probably not a viable option, although it could be desirable if ownership were to be retained by the entity. The more viable option would be for the management entity to control installation through inspections and permitting.

A program to inspect the onsite systems at each critical stage during construction is very desirable to prevent improper construction and premature failure of the system. The inspections may be performed by any management entity that has full responsibility for the total program. It would be most appropriate, however, for the management entity that has responsibility for the rehabilitation or abandonment of improperly functioning systems.

Licensed or registered inspectors must be used if the management entity does not perform the inspections itself. The NJDEP, in conjunction with Rutgers The State University, would be the most likely entity to develop a program to train inspectors in proper design and construction techniques for all acceptable types of systems. A similar program has been in progress for the past 7 years with the NJDEP and Rutgers Office of Short Courses and Continuing Professional Education. The target audience has been health officials and licensed professional engineers. This type of program would assure more uniform quality of inspections statewide.

To further guarantee uniformity and completeness of inspections, a checklist

for each type of permitted design needs to be developed. The checklist could be developed by experts in the field and would contain specific items to be examined. The inspectors would be required to certify that the checklist was complete after the inspector's personal inspection of the installation, and that all entries contained on the checklist were correct. To ensure that inspections are timely, the management entity may require the system installer to give notice as to when the construction activity is to begin.

Very often the system that is installed is quite different from the drawings originally approved because of changes necessary during construction. As-built drawings are extremely useful when inspection or servicing of a system is necessary. Thus, many feel that it is good practice to require as-built drawings and index these plans by street address, name of original owner, installer, and legal description.

E. Provide for operation and maintenance certification

The responsibility for the operation and maintenance of onsite wastewater disposal systems has traditionally been left to the owner. Unfortunately, many first-time homeowners moving from urban areas know little about using and maintaining this type of system. Others simply forget or loose track of the time since the last inspection, resulting in needless system failures, an unsatisfactory situation. As an alternative, management entities can assume this responsibility. The program adopted can be either compulsory or voluntary. If voluntary, the management entity can perform the maintenance or issue operating permits on receipt of an assurance that the proper maintenance was performed.

If the management entity is to perform the necessary operation and maintenance itself, it must: 1) provide routine and emergency operation/ maintenance of each system; and 2) determine if operation/maintenance is

voluntary or compulsory. In addition, if the entity is to have regulatory and enforcement powers, it must: 1) develop guidelines and schedules for routine operation/maintenance; and 2) establish operation/maintenance program and obtain legal authority for right of access to private property.

If the management entity is to only administer an operation/maintenance program, it must: 1) establish an operation and maintenance program; 2) determine if the operation/maintenance program is voluntary or compulsory; and 3) develop policies for regulation operation/maintenance activities. In addition, if the entity is to have regulatory and enforcement powers, it must: 1) develop guidelines and schedules for routine operation/maintenance and impose standards for hauling and disposal of residuals; 2) develop a system for notifying owners of required operation/maintenance and issue a regularly renewed operating permit after certification that proper operation/maintenance was performed; and
3) develop training, certification, or licensing program for those contracting to perform operation/maintenance activities.

Another important function of the management entity is to provide a standard for the operation and maintenance of each type of system used, stating the procedures to be used and the frequency with which they are to be performed. These standards would include those necessary to regulate the hauling and disposal of residuals generated by onsite systems as well. The NJDEP has well established regulations for the management of septage in the state, which include directing septic haulers to specific wastewater treatment plants.

An alternative to the management entity providing services would be an operating permit program. Compliance with operation and maintenance standards would be assured with this type of program. The type and frequency of

maintenance required for each type of system would be established by the entity. An operating permit allowing the owner to use the system would be renewed only if the required maintenance were performed. The system owner would be notified when the permit was about to expire and told what maintenance must be performed to obtain a renewal. The owner would be required to have the necessary maintenance performed by an individual licensed or registered to perform such services within a specified period. This individual would sign and date one portion of the owner's permit, thereby certifying that the service was performed.

It is important that the regulations establishing the permit program indicate that it is unlawful to occupy a home served by an onsite system unless the owner holds a valid operating permit. Thus if the permit were not renewed, the owner would be in violation of the regulation. This type of regulation also allows a straightforward enforcement procedure in the event of a violation.

F. Provide for rehabilitation assistance

System failures are difficult to detect because onsite systems are most frequently located on private property and below ground. If management programs are to effectively prevent public health hazards, environmental degradation, and nuisances, identification and correction of failures are a necessary part of the management program. The goal of the management entity is to detect and correct improperly functioning systems. The entity, through its administrative and technical activities, should develop procedures for identifying improperly functioning systems. This can be achieved through sanitary surveys, presale inspections during real estate transactions, or other means. This would require enabling legislation, as it involves private property rights.

G. Provide for inspection, monitoring, and enforcement

The entity, through its regulatory and enforcement activities, should develop performance standards and obtain legal authority for right of access to private property. In addition, it should be able to issue orders requiring rehabilitation or rehabilitate systems as part of operation and maintenance programs. The management entity must have the necessary authority to issue orders requiring the repair, replacement, or abandonment of improperly functioning systems if the systems are not owned by the entity. In New Jersey the local or county health departments have this authority. If the owner did not comply with the order to repair or rehabilitate the system, the management entity could require that copies of all violations be filed with the registrar of deeds or a similar official. The effect of such a filing requirement would be to give notice of the violation in the chain of title whenever an abstract or a title insurance policy is prepared. The buyer would then be alerted to the violation and hopefully would demand corrective action on the part of the seller.

If legislation to enter private property is not available, the following options may be viable: 1) obtain a service agreement with each resident. The service agreement would indicate the homeowner's and management entity's responsibilities and would allow the entity access to the onsite system for inspection purposes; 2) obtain easements to the onsite system; 3) purchase the onsite system (public ownership); and 4) require property owners with onsite systems to establish service contracts with private firms. The firms would report results of the inspections and septage hauling to a designated local entity.

H. Provide a public education/public relations component

An important function and responsibility of the management entity that is often overlooked is the public education/public relations component. The entity

needs to develop educational programs and information transfer methods that define the target audience (onsite systems owners, licensed professional engineers, contractors, etc.); determine the most productive educational methods (direct mailings of educational materials, training sessions, etc.); and develop a method for reporting system failures.

Program participants and the public need to be informed of maintenance and proper operating procedures and of the advantages of water conservation techniques. The entity needs to be able to respond to inquiries, complaints, or questions from the media; for these reasons this component is a necessity.

I. Contain a financing component

The entity should be able to determine the available sources of funding and apply for financial assistance, secure funds for system construction and initial upgrading, and establish a fee structure. Other components include billing and collection mechanisms, whereby fees are charged for services rendered, assessments are levied, and billings and collections are performed on a regular monthly or annual basis. Thus the ability to set and collect user charges and fees to finance debt service or to raise revenue for operation and maintenance is essential.

J. Provide for residuals disposal

The entity may develop procedures for residuals treatment and disposal that include determining acceptable residuals treatment and disposal locations, licensing, and training of persons involved in residuals transport. Other functions might include the development of a reporting mechanism to identify origin, method, and location disposal; volume of residuals; and inspection of hauling equipment.

IV. Institutional Options for Onsite Management Entities

There are several institutional options for designating a management entity. This section contains a description of the various types of management entities. Most of the material has been taken from Ciotoli, 1981, Management of On-Site and Small Community Wastewater Systems. These entities have a broad role to play in the planning, administration, regulation, financing, and operation of wastewater programs. Several federal agencies offer financial and technical assistance to state and local management efforts. States are responsible for the administration of funding, regulatory, and technical assistance programs for local governments. Local public bodies and private entities are responsible for planning and operating wastewater facilities and enforcing applicable regulations. The intent here is to develop an understanding of the structure and potential authority various entities can assume.

The precise roles and responsibilities these entities will assume in a wastewater program will depend on the preference, capabilities, and circumstances found in a given community situation.

A. Federal agencies

Federal agencies, particularly the Environmental Protection Agency (EPA), Farmers Home Administration (FmHA), and the Department of Housing and Urban Development (HUD), offer technical assistance and funding to states and local governments for implementing wastewater management projects. The availability of funds and staff from these agencies to provide assistance changes frequently. Persons involved in the wastewater management planning process should investigate all potential sources of federal funds and technical assistance by contacting regional and national representatives of these agencies, or by consulting the Federal Assistance Program Retrieval System (FAPRS) through the Office of Management and Budget (OMB). Inquiries regarding this system may be directed to OMB in Washington, DC, or the Agricultural Extension Service located at state land grant colleges.

B. State agencies

State involvement in implementing onsite and small community wastewater management programs to a large extent parallels that of the federal government by promulgating and enforcing regulations, and providing financial and technical assistance to individual communities. State agencies offer technical assistance in evaluating and designing wastewater systems; administer financing programs to build new systems and replace failing systems; set and enforce standards for system design, installation, and maintenance; and conduct research on system performance. Each state is organizationally different in regulating small wastewater systems, and in offering technical assistance and financing of these systems.

New Jersey has direct responsibility in administering EPA's construction grants program.

C. County governmental agencies

The size, purpose, and authority of counties varies from state to state according to each state's statutes. The role of county government in providing wastewater management services is diverse. A county can provide certain functions, such as onsite system regulation, within its geographical jurisdiction, or it can supplement and support existing city, town, or village wastewater management programs, with technical, financial, or administrative assistance.

Counties have at their disposal a wide range of financing mechanisms to raise revenues for small wastewater system planning, regulatory, and operational activities. In offering these services, counties can simply provide the service to its constituents through its normal operational mechanisms (e.g., a county department or agency), or it can create a special district (sometimes referred to as an "improvement district") to provide specialized services to a defined service area.

D. Municipal governmental agencies

Municipalities (generally including cities, towns, boroughs, and villages) are an important general-purpose unit of local governments. (Although townships are not considered incorporated municipalities in most states, they may possess authority similar to small municipalities for providing wastewater services.) As incorporated communities, municipalities operate under local charters that are either set forth or approved by state legislative action, or prepared under self-executing home rule provisions. The municipal charter and state municipal statutes generally outline the authority of these local governments in providing wastewater services. Similar to counties, municipalities provide a wide variety of services, depending on geographic size and resource base.

E. Special purpose agencies

Special purpose agencies are created to provide public services that are not provided or cannot be provided by local government. There are two different forms of special purpose agencies that can carry out wastewater management functions -- special districts and improvement districts.

A special district is an agency of government that operates outside the regular government to perform single or multiple services. The territory serviced by the district is flexible; it may consist of a single community, a part of a single community, a group of communities, or parts of several communities. State enabling legislation outlines the major governmental characteristics of the districts, such as service area function, organizational structure, and financial authority, as well as sets the conditions of their performance. The procedural steps required to create a special district are simple, although wide variation exists among state enabling legislation. The basic methods of forming a special district include:

1. The state legislature can pass a special act for the formation of a special district in a certain location, or generally permit such districts with given powers under specified conditions.

2. A local government (e.g., county) can create a special district by resolution of the governing body.

3. Property owners and residents or service area residents (without necessarily being registered voters or property owners) can petition (usually the governing body of a public agency) to form a district. The requirement for creating the district is typically a simple majority of the votes cast.

An improvement district, on the other hand, is a mechanism used by counties and municipalities to provide public services that benefit only those residents residing within the defined service area. Public improvements, such as providing wastewater management services, are provided through the fiscal resources of benefitted properties. The governing body of an improvement district is the governing body of the local government that created it. An improvement district can be created by the local government by resolution of the governing body, at the request of the local service area residents, or on the basis of a perceived need by local decision-makers.

F. Public authorities

A public authority is a corporate body, chartered by the state legislature, with powers to own, finance, construct, and operate revenue-producing public facilities. Public authorities are also referred to as commissions, public benefit corporations, municipal authorities, and sewerage authorities.

A public authority can be used in a variety of ways to construct, finance, and operate a public facility. The authority can:

1. Construct, own, operate, and finance improvements to provide public sewers to a municipality, group of municipalities, a county, or group of counties.

2. Finance and construct the public facility, and turn it over to the appropriate unit of government.

3. Offer financing for publicly owned improvements.

Another significant feature of the public authority (in some states) is that despite considerable freedom during the operational phase, the properties of the authority can revert to the creating local government when their indebtedness is amortized and paid. There is a tendency, however, for new obligations to be incurred, and thus, termination under this provision seldom occurs.

G. Nonprofit corporations

Nonprofit corporations can be classified as public or private entities; i.e., the corporation can be formed by a state or local government (public nonprofit corporation) or a developer (private nonprofit corporation). Special districts and public authorities can generally be classified as public nonprofit corporations. The authority of this type of entity would be contained in the applicable public utility law of that particular state, and in articles of incorporation approved by member jurisdictions. The rules governing the formation and operation of nonprofit corporations vary from state to state. However, these corporations may be subject to state public utility commission (or public service commission) regulations.

A public nonprofit corporation can be formed by cooperating communities for the purpose of providing a public service, such as wastewater disposal or water supply. The participating communities hold stock and shareholder rights in the corporation, and the entity functions autonomously. A private nonprofit corporation can be established to perform the same functions. However, the ownership is vested with the stockholders or property owners forming the corporation. Typical private nonprofit corporations include rural cooperatives and property owners' associations.

In a property owners' association, it is desirable to incorporate when the land is initially developed. This facilitates the delineation of utility easements and deed restrictions that provide continuous membership in the association in the event the property is sold. This is usually accomplished by requiring membership in the association to run with the land. Typically, such covenants and utility easement locations are recorded at the time of subdivision plat approval.

H. Profit (for profit) corporations

The private sector has an active role to play in the management of small wastewater systems. As noted in the preceding discussion, private nonprofit corporations, made up of property owners or community residents, can be set up to own, operate, and maintain sewerage facilities. Likewise, private enterprise, in the form of small private firms or private companies and utilities, can design, install, own, operate, or maintain sewerage facilities. Septage haulers, plumbing contractors, septic system installers, and private utilities are included in this institutional category.

Private (for profit) corporations or utilities that own, operate, and maintain sewerage facilities are regulated by a state public utility commission.

Various legal mechanisms can be used to assure continued acceptable service at reasonable rates for both private (for profit) corporations and private (nonprofit) corporations. While the Public Utility Commission does exert a certain degree of control over the adequacy of service and rates charged, other methods of protecting the consumer are usually applied to private corporations (both profit and nonprofit). Among these mechanisms are:

1. Trust deed.
2. Third party beneficiary contract.
3. Franchises from governmental authority.

These mechanisms are required to ensure that private organizations will:

1. Be financially secure.
2. Provide continuous and permanent service.
3. Be accountable to its customers.

Despite the potential problems with private organizations, the presence of a private utility or experienced private controller relieves the burden of providing wastewater services (such as septage disposal and facility operation) by local governments. Competition and profits will help to assure that adequate services are provided. Renewable competitive contracts or franchises will help to guarantee quality service and control costs (Ciotoli, 1981).

V. Review of Proposed or Operating Onsite Wastewater Management Entities in the U.S.

This section presents examples of onsite wastewater management entities and programs that are currently operating successfully in other parts of the

country. The purpose of these case studies is to show how other political jurisdictions have solved various onsite wastewater management problems using different types of management entities.

The following section is quoted from Polhemus, 1988, Final Report: Institutional Options for County Management of New On-Site Systems, by the Greeley-Polhemus Group, Inc.

FAIRFAX COUNTY, VA

General Description: Fairfax County, VA, is a major suburban jurisdiction near Washington, DC. Since 1950, the County has experienced rapid suburban growth associated with the growth of the Washington metropolitan area.

The wastewater management program in Fairfax County serves a population of about 600,000 with the majority on public sewers and about 80,000 people (approximately 25,000 on-site systems, and an additional 1,000 per year) in the management program. The principal components of this on-site systems management program are planning, design, and construction review of septic tank and drainage field systems through a comprehensive permit program. Management of this program is characterized by interaction among public agencies and private developers, lenders, and homeowners.

At the heart of this program is site and soils suitability. System design and suitability are determined by on-site borings made by private firms. These are reviewed by County employees. All building permits must be reviewed by the County.

Operation and maintenance are the responsibility of each homeowner. Private firms provide pump-out services on a free-market basis, controlled by County licensing. The only government intervention occurs if a system fails and represents a health hazard.

Description of Management Program: The on-site management program is administered by the County Department of Health, through a separate authority called the Environmental Health Division (EHD). The EHD administers the program by issuing permits to design, construct, and use individual on-site systems.

A crucial part of the program is the soils suitability analysis. Each developer is responsible to provide soil profile data on at least four auger borings per lot. EHD staff reviews these profiles and then specifies the location and depth of percolation test to be performed by the developer's contractor. Based on this information, the EHD

determines the site and specifications of the drainfield needed for development.

When a builder is ready to construct a home, a building permit application is submitted for review by the County building inspector and the EHD. The application can only be approved if a "certificate of adequacy" has been issued by the EHD based on the analysis of the soil profiles and percolation test data.

The EHD conducts an elaborate inspection program during construction. Staff members inspect the system at least six times to ensure construction is completed according to specifications. The EHD must approve the final construction before an occupancy permit is issued.

The County's direct involvement in on-site systems diminishes after the system commences operation. EHD provides on-site systems operation and maintenance pamphlets to homeowners. County policy requires that individual homeowners assume primary operation and maintenance responsibility of the systems because the homeowner retains ownership of the on-site system. Private haulers are contracted by the individual homeowners, and septage is disposed of at one of two County-approved disposal sites. The State Health Department financially supports about half of the costs of the program. The remainder of the costs are covered by the County General Fund. Permit fees are collected to raise part of the County's revenue share. These fees include site evaluation, subdivision reviews, soil evaluations, new system permits, inspections, repair, and often expenses.

Program Assessment: This program relies on well designed onsite systems. Each on-site system costs about $8,000 (1988 dollars), to be paid by individual homeowners, including design, septic tank and drainage field, and pumping equipment. The system is designed with two separate drainage fields and utilizes "alternate dosing," which allows for the use of one field while one is "rested." The budget for the County program in 1980 was about $300,000, of which 30-40 percent was covered by the permit fee system. Today, the annual budget is about $650,000. The result is a failure rate near zero, and an expected life expectancy of over 30 years for the systems.

The strength of the program is its efforts in the design and installation phases. Also, the public attitude is good. Recently, Fairfax County has been identified as having the highest per capita income in the nation. The EHD staff attributes citizen interest and public education as a key factor for this success. It is, however, believed that a County-sponsored operation and maintenance program could yield improvements, but public opinion is low for such local programs.

This, however, represents a major shortcoming for an on-site wastewater management program. Clearly, the Fairfax County program

does not follow a lifecycle approach. Therefore, many of the management services that the USEPA considers necessary to meet the minimum requirements are simply not addressed.

EL DORADO COUNTY, CA
Georgetown Divide Public Utility District

General Description: The Georgetown Divide Public Utility District (GDPUD) is located in El Dorado County, California. The GDPUD is responsible for managing wastewater systems within the Auburn Lake Trails Subdivision, a development of 1,807 lots ranging in size from 1/4 acre to 7 acres. The management system involved site evaluation, design and inspection related to new system installation, as well as periodic operation and maintenance inspections.

Description of Management Program: The GDPUD and the County Division of Environmental Health (DEH) are the two authorities involved in the management program. The following services are provided in this program:

1. Site evaluations for each lot to determine the suitability for on-site systems.

2. System design for each site.

3. System inspection to ensure proper installation.

4. Inspection and maintenance of operating systems.

5. Immediate correction of any system which does not function properly.

6. Watershed water quality monitoring to evaluate any possible effects of the systems on the area's water resources.

7. Preparation of sewer feasibility studies and operation and maintenance of sewer systems where needed.

8. Set and collect fees for wastewater management services.

9. Provide direct liaison and education to the homeowner concerning the maintenance of the individual on-site systems.

The procedure followed by the GDPUD and the County DEH in providing these services consists of numerous steps. In order to develop a lot, the GDPUD must issue a permit which contains an agreement allowing the GDPUD to maintain, operate, and repair the waste disposal facility. Upon receipt of the plot plan and agreement, the GDPUD will evaluate site conditions and design a sewage disposal system to serve the homesite. The design recommendations are sent

to the County DEH for review. A building permit can only be issued after the GDPUD and the DEH have issued final approvals for the sewage system construction.

During the construction and installation of the on-site system, the GDPUD conducts a number of inspections. Before the system can be completed, a final inspection must be conducted by the GDPUD and the DEH.

The operation and maintenance practices of the GDPUD include an inspection of observation pipes in disposal fields (which can include systems with two sand mounds, two evapotranspiration beds, three electro-osmosis units and three aerobic systems), turning diversion valves, and general site inspection at least twice a year. Replacement/repair of systems is the responsibility of individual homeowners. If a homeowner does not assume the responsibility. the GDPUD will do so and bill the homeowner. Charges can also be added to the district tax roll and thus become liens.

Operating revenue for the on-site management program is derived from four principal sources: (1) a monthly service charge, (2) a permit fee, (3) general tax revenues, and (4) a one-time initial fee paid by the developer.

Program Assessment: The GDPUD on-site wastewater management program is a good example of a total management approach that follows the lifecycle concept. The GDPUD and DEH are responsible for performing a broad range of functions, including design, inspection, maintenance, and regulation. Ownership of septic systems, however, is retained by the individual homeowner. The detailed site evaluations assure proper application of on-site systems to individual lots. This is supplemented by periodic examinations to assure proper operating. The program has been very successful due primarily to the full-time efforts and attention of GDPUD wastewater personnel and cooperation among developers, County officials, and homeowners. Also, the overall success of the program can be attributed to the authority given to the GDPUD and the development of GDPUD's program administration strategy.

EAST BRUNSWICK, NJ
(A Proposed Septic System Management Area Facilities Plan)

General Description: In response to rapid growth and increasing stress on existing wastewater treatment facilities, the Township of East Brunswick, New Jersey, and the East Brunswick Sewerage Authority (EBSA or "authority") joined together and conducted a study to determine the optimum solutions for the Township's wastewater disposal problems. This study was completed in 1982, and the final recommendations, which have not been implemented, called for the continued use of on-site systems throughout the Township, which was to be designated a Septic System Management Area (SSMA). These

recommendations also called for the following actions:

1. Rejection of conventional sewer systems
2. Elimination of discharge flow into the existing sewer systems
3. Continued use of on-site systems
4. Development of a Comprehensive Management Plan

Description of Management Program: The EBSA was selected as the most effective administrative agency to manage the on-site wastewater system program. The EBSA functions were enhanced by a unique inter-local agreement with the local Board of health authorizing the EBSA to provide review and inspection functions for on-site installation and operation and maintenance. The program required that all new systems would be owned by the EBSA, which would then be responsible for the design and installation of them. A mandatory inspection of on-site systems would be provided by the EBSA at least once every three years. When necessary, such inspections would result in requirements for cleaning and/or repair of systems. Cleaning of septic tanks could be obtained independently, or through the EBSA's "in-house" cleaning operation. Finally, the EBSA would provide repair standards, and property owners could arrange for repairs through an independent contractor or again through EBSA services.

Regarding systems that are already in existence, the individual would retain ownership of the system, however, it would be the homeowner's responsibility to see that systems are upgraded or repaired to meet siting and design standards. Under this program, the property owner would be given the following options:

1. Participate fully in all phases of the program from the start. The estimated charges would then be identical to sewered properties, about $125.00 per year initially, plus a $475 initial participation fee, and all repairs would be included.

2. Participate after two years but before the fifth year. Only 50 percent of the initial repairs would be paid.

3. Participate after the fifth year with a healthy system approved by the EBSA. No assistance with repairs would be provided.

These options allow the homeowner to decide the best way to get his system ready for the program. Once the system is approved by the EBSA, only the inspection service would be mandatory. On a voluntary basis, cleaning and repair services would be made available when needed. the property owner's responsibility would then include:

1. Permanent attachment of property to the septic management program through legal recording of the agreement as a permanent deed restriction.

2. Payment of the initial participation fee, either as a lump sum or amortized over five years.

3. Assurance of payment of the EBSA service charge for the services used.

4. Care with water use, according to EBSA standards.

5. Care with discharge of grease and solids, as measured periodically in the septic tank, based on EBSA standards.

6. Acceptance of EBSA inspection, cleaning, and repair operations, including use of property subsoil for expansion of on-site systems.

The responsibility of the EBSA would include:

1. Inspection of the system at least once every three years.

2. Education of the residents as to system use.

3. Cleaning of the septic tank every 3 to 5 years, depending on conditions found.

4. Repair of the on-site system by rehabilitation or expansion, if needed.

5. Provision of alternative systems, such as off-site cluster disposal, if on-site systems are infeasible.

6. Permanent operation, maintenance, and repair of property's waste disposal system.

In summary, the property owner would be permanently committing his property to a program of septic system management, and would be paying for insurance against future system maintenance and repair. The EBSA would be committing itself to permanent care of on-site systems as an extension of its community-wide waste disposal obligations.

Based on the management approach described, the following legislative needs were required:

1. Memorandum of Understanding between the local Board of Health and the EBSA as to undertakings.

2. Inter-local agreement authorizing the EBSA to participate in review of designs and inspection of construction of individual on-site systems.

3. New stringent design and construction requirements for on-site systems by Township Ordinance and parallel EBSA

regulation.

4. EBSA regulations and standards as to inspection, cleaning, and repair, and regarding limitations for discharge into on-site systems.

5. Amendment to the Township mandatory connection ordinance in order to limit participation in cluster systems within the SSMA and EBSA regulations on control and maintenance of such systems.

6. Township ordinances requiring participation in a management program by new homes, and requiring inspection and disclosure of conditions for resale homes.

7. A Township financing and an EBSA resolution to provide initial funding and reserves.

Program Assessment: One of the innovative aspects of this program is its ability to allow flexibility in the amount of homeowner participation required for both new and existing systems. Under this program, the homeowner would have the following options after the systems were put into operation:

1. Participate in the program to the full extent and receive permanent servicing and repair provided by the EBSA.

2. Participate in the program by accepting the mandatory inspection program and the cleaning services provided by the EBSA. Contract to private entities for repairs if necessary.

3. Participate in the program by accepting nothing but the mandatory inspection program and contract to private entities for cleaning services and necessary repairs.

It is unfortunate that this program was never implemented. The reasons for its failure centered on the lack of public support and the general attitude of the public toward the EBSA and its ownership of the individual systems. During several public meetings, residents continued to question the need for a public entity to enter private property with the authority to require cleaning services and repair. Ultimately, the plan failed because of poor public attitude and understanding of the purposes behind an on-site wastewater program. Nevertheless, the program does illustrate how a sewer authority could control the design and installation functions. The use of the inter-local agreement between the local Board of Health and the sewerage authority is something that could be considered for similar projects.

ACTON, MA
(A Single-Purpose Management Entity For Septage Disposal); (Calichman, 1982)

General Description: Acton, Massachusetts, is a small rural community which experienced rapid growth. The 3,500 people in 1950 doubled every 10 years with the 1980 population at 20,000. The majority of the population is served by some type of subsurface sewage disposal system. Large multifamily dwellings were built with septic systems that failed within four years. The failures were a result of inadequate state codes and created many direct public health problems. The disposal of septage was the town's most immediate and pressing problem. The town's solution to the problem was the construction of shallow lagoons with an effective depth of 3 feet used in series with sand drying beds. The basic concept and design was modified in various forms since 1975 to comply with state regulation and to enhance performance.

Description of Management Program: The management of the facility consisted of a full-time attendant under the highway department to control and operate the site 6 days a week. Out of town septage was not accepted. Emergency access is available at night and off days by obtaining a key from the police department. The fees were initially $2.00/1,000 gallons but have since risen to $8.00/1,000 gallons.

The procedure to pay for dumping privileges is handled through the Town Treasurer's office. This office supplies the haulers with coupons. Each coupon is good for 500 gallons of septage. The septage hauler presents the coupons to the attendant and also supplies a "trip ticket" showing the location in which the septage originated, amount pumped, the company doing the pumping and whether the pumping was routine maintenance or a problem.

The trip ticket is sent to the Board of Health to be included with the permanent records of the subsurface sewage disposal system. This trip ticket system has become a valuable tool in checking the frequency of pumping at a particular location and alerts the Board of Health staff to sewage problems.

The total volume of septage has decreased dramatically over the years that records have been kept. The record keeping consists of daily log sheet for the site which includes an entry for each load brought by the septage hauler, his name, amount discharged and where discharged. The daily logs are kept for each month, and the information is recorded on a monthly summary sheet.

Septage volume has decreased from a high in 1976 of 8,441,750 to 3,946,650 in 1980. Most of that reduction reflects the repairs of not only the large multifamily subsurface sewage systems, but also a high number of repairs to residential systems (242) over the same time period. The average gallonage per day dropped from 23,000 to almost

1,000.

Program Assessment: The discovery of volatile organic chemicals in groundwater by the Acton water district prompted additional groundwater studies.

Local officials cite the state's failure to issue all water well permits to Acton water district as the reason for closure of the lagoons in 1986. No final determination of the cause of the groundwater contaminants was ever made, but certainly the input from the septage lagoon cannot be dismissed. (Halley, 1988) Acton now transports its septage to Worcester, Massachusetts, where it has a contract for disposal at the Upper Blackstone Pollution Abatement Facility.

Thus single purpose management districts don't always make the right decisions when looked at from a historical perspective. The management entity did achieve its objective in locating those systems that were failing and was successful in achieving a great number of repairs. Today the local banks are a major enforcement tool. Banks don't make mortgage loans unless the septic system is up to code. This has resulted in few complaints to the local health department and ever fewer enforcement actions by the local health department.

SUSSEX COUNTY, NJ
(A Demonstration Program)

General Description: Sussex County is a rural area of about 527 square miles situated in the northwest corner of New Jersey. The physical geography is characterized by extensive ridge systems and highlands, as well as major valleys and sub-valleys. This rural nature provides a haven for recreational use, and its proximity to commercial/industrial centers provides availability of housing for the large percentage of commuters living in the County. Together, these features combine for high growth potential for the area.

This potential for high growth has been documented by the State of New Jersey (Office of Demographic and Economic Analysis), and is expected to continue for the years 1985-2000. These projections are based on 1970 and 1980 census data. The Sussex County population growth rate from 1970-1980 was 33%, compared to the overall State growth rate of 3%, and is projected at 18% from 1980-1990 (overall State rate at 7%), and 18% from 1990-2000 (overall State rate at 6%).

This significant growth rate has been placing increasing stress on the environment, which is protected primarily by individual on-site systems. It is clear that there is a continuing need for long-term wastewater planning and management. The rural nature and rapid growth experienced by Sussex County, however, has created a unique problem. According to the Sussex County 208 Water Quality Management Plan, the problem of water quality and quantity is

inseparable for the County. The region is located at the headwaters of several major tributaries to the Hudson, Delaware, and Passaic Rivers. During dry periods of the year, sufficient stream flow is not available to ensure a reliable water supply. Therefore, area residents depend on the region's abundant and vulnerable groundwater supplies.

Large-scale wastewater collection and treatment systems, used in many New Jersey communities, do not represent a good solution for wastewater management in Sussex County. Loss of groundwater recharge is one reason, the other is the likely high costs of installing conventional sewerage systems in the area, given its unique physiography. As a result, the region is best served with an alternative wastewater management program which focuses on the use of on-site systems (Polhemus, 1988).

Description of the Proposed Management Program: The goals of this program and study are to demonstrate the capability of local agencies to develop and implement a comprehensive septage management program. The state awarded a fixed price contract to accomplish this work, which was split between the county's staff, participating municipalities, and a consultant. The consultant's report, "Final Report: Institutional Options for County Management of New On-site Systems," (Polhemus, 1988) sets forth a variety of options. Option 7- Existing program with additional licensing for operation and maintenance was selected.

In this option, the existing Sussex County Health Department would continue to provide the siting, design, installation and related inspection efforts for new on-site systems and make the homeowner responsible for operation and maintenance. This option proposes a license for each new system that would be issued by the local Board of Health of a community. The license requires a homeowner to properly operate and maintain the system, including recommendations for control of disposal of wastes not suitable for on-site systems, and mandatory system pumping on a regular basis (perhaps every three years), or documentation that the system is working properly and pumping is not required at this time (an option for small or infrequently used systems). If these conditions are met, the license would be reissued on an annual basis.

In conjunction with the licensing of new individual onsite systems, septic tank pumpers would also be licensed, as a double check on system maintenance. As part of this license, septic system pumpers are required to complete forms when they service a system and to file this information with the managing agency (i.e. the Sussex County

Health Department). The County Health Department would be responsible for managing system installation and license data, presumably on the County data management system. Costs for administration could be passed through by pumpers. Violations would be identified by the County and reported to the homeowners and to the local municipalities for enforcement (presumably by the local Board of Health and local police).

The program has several legislative needs including:

1. New stringent siting, design and construction requirements for on-site systems.

2. New stringent operation and maintenance requirements for new construction homeowners (available at time of purchase).

3. Licensing program for new construction requiring regular system pump out and/or inspection needs.

4. Licensing programs for septic tank pumpers, including forms to be filled out, filing requirements, fee pass through, etc.

5. Ordinances establishing enforcement procedures and requirements.

Advantages of the program include:

1. County-wide approach with substantial homerule authority.

2. Uses existing institutional authorities and existing program.

3. Uses County expertise uniformly for all communities, standardizes the approach to on-site wastewater management, and achieves economics of scale.

4. Legally and administratively simplistic, allowing the extent of operation and maintenance to be determining by licensing with no delegation from other entities.

5. Places direct responsibility and financial obligation for system operation on homeowners.

The disadvantages of the program include:

1. Possible legal limitations of enforcement.

2. Possible revenue collection problems (Board of Health limited to $5.00 license fee) and need for fee collection and pass through by septic tank pumpers (Polhemus, 1988).

Program Assessment: As of September, 1988, the countywide program for new systems only, consultant's Option 7, was being refined and detailed with new ordinances and other requirements. Individual communities will then be asked to sign agreements. Preliminary indications are for a majority of communities participating.

The study has been broken up into a second part that will deal with existing as well as new systems. Three pilot communities have been selected with different institutional and environmental constraints. These include a lake community with an active lake association, a community that lies over a major aquifer, and an older established community on very small lots. Each of these will be the focus of a management program.

This program, when it is implemented, will be a first in New Jersey. It will utilize existing institutions and utilize a licensing program. It will evaluate the feasibility of implementation in a diverse range of communities and will provide for a measure of cost-effectiveness. Enforcement and revenue collection are areas of concern that only a period of operating experience can finally conclude.

THE NEW PROPOSED AMENDMENTS TO P.L. 1954, CHAPTER 199

The NJDEP proposed an amendment to N.J.A.C. 7:9, Standards for the Construction of Individual Subsurface Sewage Disposal Systems, in August 1988. The existing standards reflect essentially what was the knowledge or state of the art in 1954. In the current proposal, the standards have been completely revised. The new standards reflect current scientific knowledge and engineering practice in order to protect ground and surface-water quality and minimize the risk of malfunctions.

> The new regulations have been "broadened to include requirements for the operation and maintenance of subsurface sewage disposal systems to minimize risk of septic system malfunctions as a result of improper operation or lack of maintenance. The regulatory mechanism proposed at N.J.A.C. 7:9A-3.14 is the issuance of an operation license to owners of newly constructed or altered septic systems and the periodic renewal of licenses only after submission of evidence that septic tank pumping and other essential maintenance has been performed. Maintenance tasks can be carried out by private contractors with a minimum of direct government involvement. Standards for maintenance of the various septic system components as well as procedures for inspection and evaluation of sytem performance are provided in N.J.A.C. 7:9A-12. Public education relative to septic system maintenance would be served by distribution of operation and maintenance guidance manuals provided by the Department to all individuals who receive operation licenses (NJDEP, 1988).

Subchapter 12 - Operation and Maintenance, of the new regulation, is an important step forward. The subchapter states specifically what the system can be used for. No drainage from roofs, no restricted chemicals, no toxic substances, no nonbiodegradable materials are permitted. Specific inspection requirements are given, which include the requirement of annual inspections. The requirements for maintenance are equally specific, including detailed requirements for pumping (i.e., when the sludge layer is within 8 inches of the bottom of the outlet baffle).

These regulations, which were a long time in preparation, go a long way toward improving design, operation, and maintenance of onsite wastewater disposal systems in New Jersey. The burden of implementation, however, falls on the administrative authority (local or county boards of health). Without additional state funding, implementation may be slow or nonexistent. Can they undertake this additional requirement without more personnel? Persons with failing systems can still escape detection. Only when property is transferred will these systems be improved. The new regulations are a positive step forward for management of onsite wastewater systems. Their full implementation should lead

to less ground and surface water contamination and ultimately to improved stream water quality within New Jersey watersheds.

VI. Overview of Relevant State of New Jersey Laws (Polhemus, 1988)

In New Jersey, great caution has been demonstrated by the state before stepping into the area of on-site wastewater management. In order to expedite the successful implementation of the Sussex County program, a legal review was necessary to determine which type of institutional arrangement had the legal authority to successfully manage this program. The following review is based on the suggested management functions discussed earlier and on State of New Jersey legislation. Information contained in this section, in part, comes from the report: Summary of Legal and Institutional Basis for the Establishment of Septage Management Districts, Undated State Paper, author unknown.

A. Siting and Design

Historically, the local Board of Health (LBH) has been vested with jurisdiction over on-site systems. This authority is established by NJSA 58:11-23 et. seq. and NJSA 26:3-45 et. seq. The first cited statue indicates that the local board has the power to review the design and installation of septic systems. However, the state is given authority to establish "standards for the construction of individual subsurface sewage disposal systems" under NJAC 7:9-2.1, that is known as Chapter 199. Also, NJSA 58:11-36 clearly says that the "...State Commissioner of health who, having given due consideration to the same, shall promulgate standards for the construction of water supply systems and sewerage facilities...."

Further, under NJSA 58:11-32, the "board of health or state department shall have power to make...inspection and tests..." in order to monitor and approve site evaluations.

In addition, for new major subdivisions, the State Department of Environmental Protection (NJDEP) review is required for septic systems in developments of 50 or more single units and for systems that service more than one household.

Sewerage authorities (SA) and municipal utility authorities (MUA) are generally given the same authority under New Jersey law. In the area of siting and design, SA/MUAs are given limited authority. NJSA 40:14B-52 gives SA/MUAs the authority to enter property for site evaluations. However, the authority to issue or refuse permits for installation is given to the NJDEP and the DEP and the County Board of Health (CBH). Under NJSA 58:11-25, 26, "No building permit for the construction of a realty improvement shall be issued... until the board of health, having jurisdiction, shall have certified that...the

sewage facilities are in compliance with the standards for construction."

B. Installation

NJSA 58:11-33 gives the authority to enter property for inspection of septic systems under construction and to issue permits by stating "No septic tank, tile field, seepage pit or system...shall be covered from view until the same has been inspected by an authorized representative of the board of health...." The authority to stop work or demand correction or faculty installation is reserved for the NJDEP and the boards of health under NJSA 11-40, 41. Little, if any, authority is given to the SA/MUAs.

C. Operation and Maintenance

The authority to enter property to inspect approved systems during operation is limited for the boards of health. Under NJSA 26:3-46, the LBH and CBH "...shall examine into and prohibit any nuisance, offensive matter, foul or noxious odors...which, in its opinion, are injurious to the health of the inhabitants therein..." Thus, the Boards of Health have the authority to inspect and review failing systems, only. Ultimately, neither body has the power to implement a preventive program. SA/MUAs under NJSA 40:14A/B are given the authority to enter all properties and inspect on-site systems and can consequently order improvements and repairs. Therefore, SA/MUAs are capable of instituting preventive procedures that other agencies cannot. However, it is clear from the above discussions that both the LBH/CBH and SA/MUA have authority to enter property to repair and replace failed systems and, thus, have authority to require that failed systems be repaired or replaced.

D. Treatment and Disposal

SA/MUAs have authority to conduct septic tank/septic management operations involving the treatment and disposal of septage. Under NJSA 40:14A-7 and NJSA 40:14B-20, authority is given to SA/MUAs to plan, design, and construct treatment and disposal facilities. Also, SA/MUAs have power to assess adequate fees and service charges to cover the costs of such services. NJSA 4:14A-8 states that "Every sewerage authority is hereby authorized to charge and collect rents, rates, fees and or other charges..." In many locations in New Jersey, SA/MUAs own and operate disposal facilities that can currently, or with modification, accept septage. Further authority is given to SA/MUAs under NJSA 40:14A-23 to "...enter into a contract or contracts providing for or relating to the treatment and disposal of sewage." The authority of LBHs and CBHs is limited in this management function. NJSA 26:3-64 and NJSA 26:3A-2 give the Boards of Health power to "encourage the efficient delivery" of services that are needed for the public good. However, under NJSA 26:3-31, LBGs and CBHs may not assess more than a $5 annual fee to regulate the maintenance of septic tanks. This severely limits these

agencies' ability to finance operations.

E. Administrative Finance

As indicated previously, LBH/CBHs are limited to collecting no more than $5 per year from each homeowner to cover administrative costs for managing on-site systems. SA/MUAs, however, have adequate authority to assess fees and service charges to cover all costs associated with such a program. Furthermore, SA/MUAs have the authority to issue bonds and enter into contracts with private and government entities to provide revenue and support for administering on-site wastewater systems.

F. Summary of Institutional Entities and Associated Legal Authority in New Jersey

The focus of this section has been on identifying the legal authority of institutional entities needed to carry out the necessary management functions for a successful on-site management program. From this discussion, it is clear that the enabling statutes limit the managing agencies to the following:

A. Local and County Boards of Health
B. Sewerage Authority/Municipal Utility Authority
C. Special Authority

From this review, it also is clear that the county and local boards of health have sufficient authority to set design standards, inspect construction and installation practices, and stop work and demand correction of faulty installation. However, such agencies are limited in the operation and maintenance function since they can inspect and review only failing systems. Also, neither body has the power to institute a preventive program or contract for and construct treatment and disposal facilities. Finally, the boards of health are severely limited in their ability to recover costs and generate revenue.

Sewerage authorities and municipal utility authorities have extensive power to institute a preventive program. Such agencies have the authority to enter properties and inspect on-site systems and can, consequently, order improvements and repairs. They also possess the authority to develop an administrative structure to acquire adequate revenue to construct treatment and disposal facilities. The only single serious limitation with these agencies is the lack of review power for the siting, design, and installation of single dwelling on-site systems, which lies with the board of health, as does the final permitting responsibility.

New Jersey law does give authority to counties and municipalities to enter into interlocal agreements between sewerage authorities/municipal utility authorities and county and local boards of health to delegate the needed authority. Such an agreement could allow the development of a special authority with the delegated powers

necessary to perform the management functions of design review and inspection procedures for individual septic systems.

VII. Summary

A properly maintained and correctly operated onsite wastewater disposal system can provide the owner with efficient, nonpolluting, and economic wastewater treatment. However, property owners who take the "out of sight, out of mind" approach to the operation of their onsite wastewater systems will threaten the state's watersheds and its ground and surface water supplies with contamination. In addition, property owners will eventually be faced with expensive system repairs or replacement.

Currently the most widely used and recognized corrective measure for a group of failing onsite systems is to install sewers and build a central treatment plant. Due to recent large increases in installation costs of new sewer systems, this option is becoming less attractive. This is especially true in small rural communities. Another option, which is enjoying increasing interest, is the establishment of a management entity to oversee the rehabilitation, replacement, maintenance, and monitoring of onsite systems in the community. This alternative can be the most cost effective and environmentally acceptable wastewater approach for small communities and urban fringe areas, and may contribute significantly to improvement of water quality within certain watersheds. Thus it can be an important and integral part of a watershed protection strategy.

An onsite wastewater management entity is an institutional and administrative structure that provides technical assistance together with strong regulation and enforcement. Most management entities or programs are targeted at installation, operation, and maintenance of onsite systems (USEPA, 1980).

Management entities may conduct programs that contain all or most of the following functions (Ciotoli, 1981):

1. Contain a planning and administrative component
2. Promulgate codes and standards for site suitability, system design, and system performance
3. Conduct site evaluations and review system designs
4. Provide for construction supervision and installation review
5. Provide for operation and maintenance certification
6. Provide for rehabilitation assistance
7. Provide for inspection, monitoring, and enforcement
8. Provide a public education/public relations component
9. Contain a financing component
10. Provide for residuals disposal.

There are a variety of institutional options for designating a management entity. The precise roles and responsibilities these entities will assume depend on the preference, capabilities, and circumstances found in a given community situation. The options discussed include:

1. Federal agencies
2. State agencies
3. County governmental agencies
4. Municipal governmental agencies
5. Special purpose agencies
6. Public authorities
7. Nonprofit corporations
8. Profit (for profit) corporations

Wastewater management entities are currently operating successfully in: 1) Fairfax County, VA; 2) El Dorado County, CA; 3) East Brunswick, NJ (a proposed Septic System Management Area Facilities Plan); 4) Acton, MA (a Single Purpose Management Entity for Septage Disposal); and 5) Sussex County, NJ (a Demonstration Program).

The legal authority institutional entities need to carry out successful management programs is discussed in the section entitled "Overview of Relevant State of New Jersey Laws" (Polhemus, 1988). From this discussion, it is clear that current enabling statutes limit the managing agencies to 1) local and county boards of health; 2) Sewerage Authorities/Municipal Utilities Authorities; and 3) special authorities under the proposed amendments to P.L. 1954, Chapter 199 recently proposed as N.J.A.C. 7: 9A-1.1 et seq. Communities and counties in the state can take a communitywide approach to operation and maintenance of onsite wastewater disposal systems. The concept of a management entity that can take a variety of forms, as indicated in the body of this text, is possible. The management entity may reduce costs by economies of scale in inspections, pumping, disposal of septage, and abandonment of systems. It could require an operating permit that is periodically renewed with each required inspection or pumping. The permit could be issued by the local administrative authority (county or municipal health department) or other management entity. When repairs or replacement are needed, the management entity should approve all work. If the property owner cannot afford the necessary repairs, the management entity could provide a revolving loan program secured by a lien on real property.

Onsite disposal systems are a proven method of treating wastewater only if they are kept unclogged and free of toxic chemicals. Water used to carry away

sewage returns to the watershed via the groundwater. It is recycled to be used again by others in the watershed, a strong reason for property owners and management entities to work together to protect and preserve water quality for future generations.

VIII. Recommendations

1. The NJDEP Division of Water Resources should move as expeditiously as possible to adopt N.J.A.C. 7:9A-1.1 et seq., Standards for the Construction of Individual Subsurface Sewage Disposal Systems (P.L. 1954, Chapter 199).

Subchapter 12 - Operation and Maintenance contains performance standards that could force the creation of a management entity by the administrative authority with jurisdiction.

2. The NJDEP Division of Water Resources should explore measures to require all septic systems in watershed sensitive areas to be part of an onsite wastewater management entity.

This recommendation would prevent large numbers of failing septic systems in watershed areas where they could have significant water quality impacts. Thought should be given to a revision of Subchapter 12.1C of the new Chapter 199 regulations. In addition, it would seem prudent to require the owners of any onsite wastewater system to become part of a management entity upon transfer of title. This would eventually bring all systems under the operation and maintenance umbrella.

3. The NJDEP Division of Water Resources should endorse and actively promote the concept of management of onsite wastewater-management entities as part of a non-point-source control strategy for watershed management.

With the adoption of new Chapter 199 regulations, the administrative authorities (local and county boards of health) will be looking for guidance on how to implement Subchapter 12 - Operation and Maintenance. Thought should

be given to a statewide training program, model ordinances, manual of practice, and some grant monies for this audience. Communities need assistance in selection of the best management entity among various options. This is crucial for success of the program.

4. The NJDEP Division of Water Resources should form an Office for Onsite Wastewater Management Programs within its present structure.

The Office of Onsite Wastewater Management Programs would be a clearinghouse for information in New Jersey. The office would receive information from newly formed management entities and distribute the information to interested parties. The office could provide information, consulting services, and model ordinances to municipal and county government. It could provide statewide leadership and guidance on this issue.

5. The NJDEP Division of Water Resources should take a leadership role in the development of educational programs and materials on operation and maintenance of onsite wastewater disposal systems for statewide dissemination.

This recommendation would relieve the management entity of the responsibility of developing its own educational programs and materials, ensuring complete coverage of the topic and avoiding duplicative effort. Rutgers Cooperative Extension is an agency that could assist in these tasks. A bulletin is currently available on "Septic System Care" and "Water Conservation." These are a good first start in this effort.

Additional subjects need to be addressed, including how to mitigate existing problems, which would explain technically what works and what doesn't work. Educational programs are a key to proper operation and maintenance of onsite systems.

6. The NJDEP Division of Water Resources should develop additional programs to address the problem of currently failing onsite systems.

The new Chapter 199 regulations leave the issue of currently failing systems to the local administrative authority. The administrative authority should be coaxed into actively identifying existing failures and taking the remedial actions necessary to solve the problem. Again, this is a function that could be delegated to an onsite wastewater-management entity.

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PUBLIC EDUCATION AND PARTICIPATION FOR WATERSHED MANAGEMENT

9

Michael T. Olohan

I. Introduction

The planning and application of public education and public participation strategies and outreach techniques is a crucial component of any successful program to influence public behavior and increase public awareness of the need for effective watershed management. It also can be an important factor in a comprehensive watershed management plan.

An effective public education and participation program for a watershed should increase awareness and heighten the visibility of interrelated environmental issues affecting a watershed (Sorenson, 1985). It may also inform and familiarize residents with diverse yet interconnected watershed management issues, such as nonpoint source pollution, stormwater management, detention basins, buffer strips, conservation practices, and the impacts of runoff from farms and homes, as well as the use of fertilizers and pesticides, and the impacts of common household chemicals that may be improperly applied and discarded.

Public education and participation programs should be focused on increasing environmental sensitivity, integrating awareness and values of natural resource systems, and eliciting definitive types of public participation from the targeted audiences that will achieve specific, measurable policy or program results. This must include an appropriate use of information dissemination (or educational) channels prior to the implementation of the proposed environmental study, plan, or program strategy (1987 Puget Sound Water Quality Management Plan).

Involving and informing these representative interest groups will include contact with individuals, community groups, elected officials, and businesses through a planned program of newsletters, educational displays, direct mail, media interviews, personal contacts, audio-visual presentations, public meetings and forums, press releases, advisory groups, petitions, public tours, and information activity tie-ins with established community institutions and events.

Numerous environmental public education and participation initiatives have been undertaken in New Jersey by public regulatory agencies. These include programs such as the New Jersey Department of Environmental Protection (DEP) Division of Water Resources' "Water Watch" program; DEP's Nonpoint Source Education Working Group; and Rutgers Cooperative Extension's Navesink River Water Quality Improvement Project public information program (an Environmental Protection Agency/DEP-subsidized cooperative effort).

Outside New Jersey, public participation and education initiatives, such as the Chesapeake Bay Program, which involves four states; the Puget Sound Water Quality Management Plan; the Wisconsin Department of Natural Resources Sixmile-Pheasant Branch Priority Watershed Plan; and Florida Department of Environmental Regulation State Water Use Plan, have developed and implemented watershed-based nonpoint source pollution public education and participation programs.

These programs constitute only a small sampling of educational and public participation outreach programs evolving in New Jersey and throughout the United States. Since the early-1970s, increasing numbers of public regulatory agencies and resource management entities have begun education and participation programs to achieve a variety of short- and long-term goals. The goals have varied and included: to focus issue awareness, generate public

support, enhance credibility, raise revenues, solicit input, and integrate sound environmental planning and local citizen concerns into public policy. Other goals and objectives may also be the focus of these programs. From these examples, it is safe to conclude that public regulatory agencies rely heavily on either public education or public participation programs as key opportunities to focus and mobilize public interest to create either an informed, involved, or empowered constituency.

In addition to these types of adult outreach programs, early childhood education is critical to a child's future appreciation and understanding of natural ecosystems and their functioning.

However, due to distinct differences between style and substance of these programs and adult outreach efforts, this report will not spotlight or review specific K-12 education programs, but examine them as an integral part of the ongoing agencies' outreach programs featured herein.

II. Definition

Public education and public participation programs for watershed management involve the dissemination, exchange, and refinement of issue-specific and policy-specific information designed to achieve specific measurable program objectives. However, distinct differences in objectives and techniques distinguish both outreach processes. Generally, agency public education programs should involve a multifaceted, multilevel, interdisciplinary approach that relates the importance of specific -- and interrelated -- environmental concerns to a public that may often be unaware of or already have taken sides on a certain environmental issue prior to the education program. It may also include an informal or formal K-12 education outreach strategy.

Following up on an educational initiative or preexisting level of public

awareness, outrage, or concern about an environmental issue, an agency public participation program can attempt to utilize techniques that achieve objectives ranging from information exchange and building support and credibility to achieving representative interest group participation and sharing environmental policy making, implementation, and enforcement powers. Therefore, public education or informed awareness is an integral part of an effective public participation program. Public education and participation programs can be independent, but must mutually complement each other to be truly effective. Although one program may operate successfully without the other, informed participation requires both components (Duxbury, 1985).

III. Principal Levels and Categories of Public Education/Participation Programs

Levels of Public Education/Participation

Citizen Power
Power Sharing
Consult 2
Consult 1
Inform
Agency Power

The levels of public education or public participation techniques as delineated above (see Appendix A for more detail) are part of an overall system to identify the expected outcomes of various agency-public interactions. These mechanisms might range from the basics, such as newsletters, public meetings, planning sessions, and advisory committees, to teleconferencing, computer hookups, citizen monitoring and planning, funding for citizen groups to consult technical experts, and the formation of volunteer environmental groups, citizen investigations, advocacy canvassing, and initiative and referendum balloting. These activities detail a few of the education and participation mechanisms available in agency-initiated public education/participation programs.

As natural resource decision-making becomes more attuned to the established and evolving audiences seeking education and participation opportunities, public sector agencies charged with protecting and preserving our air, water, and land may soon be forced into integrating public education and public participation programming into both their short- and long-term planning, regulation, and implementation priorities.

Without programs and opportunities for knowledge and input, the audiences affected by the public agency's decisions will be indifferent, unresponsive, and/or opposed to the agency's plans, regulations, permits, or priorities. No decision will satisfy every involved or interested segment of the public, but an opportunity for up-front conflict mediation will go a long way to making the final decision balanced and publicly acceptable (Pizor and Holler 1987).

Situations charged with political, economic, and public controversy are often the genesis of an agency public education or public participation effort. Unfortunately, this reactive type of program is rarely more than a band-aid to the underlying emotions, but may not be possible to avoid, especially when addressing watershed-based pollution. Watershed-based pollution problems and solutions usually involve politically sensitive land-use controls, behavioral changes, and highly variable technical/engineering solutions. Education is necessary to smooth the way for watershed pollution targeting (Sorenson, 1985).

Styles of Public Education/Participation

Unstructured
Structured
Active
Passive

James J. Glass (1979) pointed out that techniques must be matched to objectives to implement a successful participation program. While Glass also

recognized that agencies use education/participation mechanisms for a variety of reasons, including enhancing public trust, soliciting public comment, and improving services delivery, he categorized the types of techniques available to agencies as listed above.

Unstructured techniques may include drop-in centers, neighborhood meetings, agency meetings, and public hearings with the main objective being information exchange, according to Glass.

Structured approaches are defined by Glass as advisory committees, review boards, and task forces specifically geared to education and support building.

"Active" process approaches, such as nominal group process, analysis of judgment policy, and policy value analysis can be used by agency personnel to extract problem-specific information from citizens and assist agency decision-making. However, this information is not representative of the spectrum of publics with a stake in the resource problem, policy, or decision.

A "passive" process approach, is a "representational approach" that may include a citizen survey, or the delphi method. Both of these are referred to as "passive process" techniques. These techniques are labeled passive because the public has no direct contact with the agency nor active participation in a public meeting or hearing with the opportunity for direct input. Instead, these two techniques are backed by proven mathematical and statistical methodologies that enable their findings to be representative of the community at large if structured correctly.

All four of these technique categories provide a clear indication of the style of the public education/public participation programs being examined. This is critical to determining if the chosen techniques appropriately match the program's objectives. In addition, this typology of styles provides an early

indicator of program consistency and acts to further define the level of the program as identified on the ECRP Ladder. Moreover, it reinforces the integral relationship between the program's techniques and objectives.

IV. Ten Elements of an Effective Public Education/Participation Strategy

Public education programs are designed to increase awareness and distribute, integrate, clarify, and apply environmental information effectively. Such programs should generally precede or accompany some form of public participation initiative. Therefore, an effective public education and participation strategy should include most of the following operating components. An effective program will:

* Determine short- and long-range program goals via planning/public involvement.
* Identify affected and targeted publics.
* Solicit equal agency and public input.
* Identify public education objectives and techniques.
* Identify public participation objectives and techniques.
* Appropriate staff and funding.
* Coordinate internal and external agency actions.
* Negotiate a timetable for program implementation.
* Implement, sustain, and follow up the planned outreach techniques.
* Evaluate the program's effectiveness. Reexamine goals, objectives, techniques, funding, and staff needs by specific, measurable quantitative and qualitative criteria.

These 10 criteria for designing and evaluating a public education/participation program were extrapolated from the research exploring the art and science of public education and public participation management.

These 10 elements will provide specifics for agency decision-makers to

identify the short- and long-term economic, political, and environmental ramifications and costs of such a program. Each element could easily be made into a chapter of its own with specific guidance to achieve its implementation. This guidance will soon be available from either Rutgers University's Environmental Communication Research Program or the state DEP Division of Science and Research. A more lengthy explanation is not the focus of this chapter. However, references are provided later for further research into related areas.

Thus, the preceding three sets of evaluative criteria -- from the ECRP's Ladder of Citizen Involvement to Glass's typology of public participation styles to the 10 Elements of An Effective Public Education/Participation Strategy-- are useful in judging the critical aspects of any effective public education and public participation program. Though these criteria will provide a broad evaluation of most types of public education/participation strategies, more specific evaluation/ assessment criteria will surely evolve as communications technologies become more sophisticated and widespread. Thus, the preceding criteria provide important indications of the genesis, direction, and structure of the following plans/strategies. Recommendations for the State DEP follow the review of these seven programs.

V. A Review of Water Quality Public Education/Participation Plans/Programs

After an extensive review of ongoing, watershed-based, nonpoint source pollution outreach programs, the following seven initiatives were selected for more critical examination:

* New Jersey Department of Environmental Protection (NJDEP) "Water Watch" Program

* NJDEP State Nonpoint Source Education Plan

* Rutgers Cooperative Extension Navesink Information Program
* Chesapeake Bay Communication/Participation Programs
* Puget Sound Water Quality Management Plan
* Wisconsin Department of Natural Resources Sixmile-Pheasant Watershed Plan
* Florida Department of Environmental Regulation State Water Use Plan

The programs cover a wide range of targeted watersheds -- from a 95-square mile watershed in northeast Monmouth County, New Jersey, to a 64,000-mile watershed covering four northeastern states and the nation's largest and most productive estuary -- the Chesapeake Bay.

Each program review features a brief background of the outreach effort, a program description and a capsule evaluation of the effort based on the three previously mentioned sets of criteria.

By highlighting a diverse and diffuse group of watershed-based outreach programs, it is hoped that water quality professionals will extract and apply the workable techniques found here to enhance developing or ongoing watershed pollution control and prevention efforts.

NJDEP "Water Watch" Program

Begun in October 1987, the New Jersey Department of Environmental Protection (NJDEP) "Water Watch" program attempts to involve local citizens directly in understanding, protecting, and preserving water bodies used for drinking, swimming, fishing, and other forms of recreation.

The program originated from the DEP Division of Water Resources' (DWR) recognition that state and local agencies "cannot be everywhere to prevent the potential serious abuses of water sources such as illegal 'midnight dumpers'" that

occur regularly, according to Water Resource News, a DEP DWR publication.

Moreover, the program coordinator pointed to a 1986 public opinion poll by Rutgers University that found that 75% of 800 citizens surveyed across the state believed they could not help solve any type of local environmental problem. This finding provided increased urgency to establishing a "Water Watch" program.

Program Description

Initiated by Division of Water Resources Public Participation Coordinator Judy Morgan in October, 1987, to address the need for local involvement in water pollution control, the program is based on similar Maryland, Texas, Kentucky, and North Carolina efforts. It assists local groups in "adopting" and monitoring a lake, stream, pond, or other neighborhood waterway. Eight groups were signed up when the program began.

The program provides free education materials on nonpoint source pollution, including The Clean Water Book: A Guide to Reducing Water Pollution In Your Home and Neighborhood. Moreover, it provides a Water Watch manual that lists a number of options for projects that groups can initiate and a Field Guide that describes basic stream monitoring techniques.

As of February, 1989, 67 groups were participating statewide in the program. Water Watch group activities include visual monitoring of waterways and educational programs, many of which involve litter-cleanups. In addition, coordination and contact with local health departments and environmental commissions is also taking place among several groups. Activities of these groups range from expediting lake dredging and sampling dissolved oxygen to stream walks and the mapping of stormwater outfalls.

The program offers local Water Watch groups:

* Nonpoint pollution educational materials
* Networking opportunities

* A periodic newsletter/update
* Increased visibility as part of a state government program
* A contact accessible for internal DEP troubleshooting

Implementing the DEP's focus on nonpoint source pollution control, local Water Watch groups put the educational tools to reduce nonpoint pollution in the hands of residents, according to part-time Program Coordinator Judy Morgan. Morgan is Public Participation Coordinator, DEP Division of Water Resources.

Some of these outreach tools/techniques include:

* Suggestions for watershed activities
* Bumper stickers
* Flyers, fact sheets
* Suggestions for publicizing local events
* Overall guidelines for the program
* Publicity and media outreach guidance

DEP's Water Watch program currently has a part-time coordinator only, but additional staff resources are being sought. Its future growth and success, however, is contingent upon increased DEP staffing and funds.

The program utilizes the resources of DEP's Division of Water Resources Enforcement Element, and the Bureaus of Monitoring Management and Water Quality Planning. The DEP Office of Public Participation is also integrally involved. "One purpose of Water Watch is to see how citizens can best be involved in the protection of water resources in New Jersey -- the country's most densely populated state," said its part-time coordinator. With pressing environmental issues such as the clean-up of Superfund hazardous waste sites, toxics reduction, sludge disposal, wetlands protection, and nonpoint source pollution, "the soundness of New Jersey's environmental decisions will rest greatly on the extent of active, informed, and responsible participation by citizens," Morgan said.

Water Watch will be further defined in 1989. It will focus prominently on promoting activities that raise awareness of nonpoint source pollution and its

impacts. Some programs will be implemented in cooperation with county health departments that have received funding to begin nonpoint source control education programs. Mapping stormwater outfall pipes in coastal areas may be one activity, according to Morgan.

Due to Water Watch's brief 14-month lifespan, it may be inappropriate to compare it with other watershed-based nonpoint source education programs of longer length. However, its quick adoption and acceptance by community residents and activists throughout the state attests to its immediate need and importance in mobilizing community action.

DEP should immediately consider increasing its staff and funding levels. From the program's rapid growth, it is obvious that residents view a Water Watch group as a powerful local entity to monitor, maintain and protect water quality as well as assist local, county and state agencies in enforcing water quality laws and regulations.

Evaluation

The Water Watch program appears to operate in the "Government Power" to "Consult 2" range on ECRP's Ladder. It is basically an information/education outreach effort to encourage the adoption of strong local environmental ordinances, hazardous waste collection days, recycling, source reduction and modes of direct citizen action and input into the municipal decision-making process. The program does provide an ongoing dialogue with DEP and responds to citizen questions and input, but it may lack the necessary in-depth planning, timetable, public input, and institutional commitment critical to survive a switch in departmental priorities. It does attempt to match outreach techniques to general objectives but lacks specific agency criteria by which to evaluate the outcomes. However, and most importantly, Water Watch takes a wide-ranging,

inclusive approach to involving local citizens in water quality protection, nonpoint source control and watershed management and is slowly disseminating water quality information to a diversity of groups and individuals. While falling short on several of the "Elements of An Effective Program," Water Watch nonetheless fills a previously gaping hole in local public outreach from DEP on water quality issues.

NJDEP State Nonpoint Source Education Plan

Background

In October 1987, the state Department of Environmental Protection (DEP) began the Nonpoint Source Education Working Group, consisting of representatives from the DEP Division of Water Resources, DEP Division of Hazardous Waste Management, Office of the Commissioner, Division of Hazardous Site Mitigation, Mercer County (N.J.) Planning Department, Rutgers Cooperative Extension, New Brunswick, and the New Jersey Alliance for Action, a business coalition. The Working Group's goal was to draft a nonpoint source education plan to be incorporated into the final nonpoint source assessment and management plan that DEP would submit to EPA by August 1988. Its members were actively involved in all areas of nonpoint source watershed management--from influencing water policy at the state level to local implementation of nonpoint source control measures, such as agricultural and urban best management practices (BMPs).

Program Description

The Working Group determined that five specific audiences need to be targeted to fully address the spectrum of the nonpoint source problem. These include: a) adults, b) media, c) elected officials, d) formal education (K-12), and

e) businesses/industry. The plan places emphasis on how individuals contribute to water pollution problems through their lifestyles and activities. It also emphasizes simple, inexpensive methods to solve nonpoint source pollution problems.

Each section delineates goals, objectives, and activities to reach that specific target public. The team members wrote individual segments and later prioritized activities by fiscal year for implementation. Activities range from brochures and public presentations to seminars, ordinance development, disseminating technical documents, organizing local volunteers for monitoring, videotapes, comic books, workshops for high school teachers, newsletters, news releases, field demonstration, tours, interactive exhibits, and "hot line" access to nonpoint source experts. Each activity is tied to a specific goal related to involving or informing the targeted audience.

The following section, drafted by NJDEP DWR Environmental Specialists Brian McLendon and Keith Robinson, targets elected officials and sets out the rationale for this component.

Goals - To educate local public officials and employees concerning the importance and benefits of implementing nonpoint source control activities. In New Jersey local government, primarily municipalities, exercise significant control over land development activities, zoning and other planning functions and enforcement of building or health codes. In the long-term government is also expected to play an important role in nonpoint source/stormwater management. Because of this role, educating local officials and employees in the benefits of nonpoint source controls should be an important component of a total nonpoint source education effort.

Objectives

1) Promote the water quality, recreation, water use and aesthetic benefits benefitsof nonpoint source (nps) controls.

2) Establish a coordinated effort of NPS control at all levels of government.

3) Encourage counties to expand their environmental management responsibilities that have been empowered to them through the County Environmental Health Act to include NPS control.

4) Create an NPS network within the NJDEP that will be responsive to the needs of local governments.

Activities

- Prepare an educational brochure for widespread distribution to local officials. A generalized awareness education brochure specifically for local elected officials describing what nonpoint sources are, how they impact water quality, which programs the State is using for nps management, the State's overall strategy for nps control, the benefits of nps management, interfacing with Water Watch programs, possible funding sources for necessary work, and how to get additional information and special presentations (both general and technical). Such brochures could also be tailored to specific areas/waterways in the State (coastal waters).

- Develop presentation packages for local council meetings, special meetings for elected officials, etc. These presentations will stress the importance of local initiatives in controlling nps/stormwater. Presentations would encourage local officials to support Water Watch activities.

- Conduct education seminars on details of developing nps/stormwater management programs/activities. Seminars could be developed for local administrators, township/county engineers, planners, code enforcement officers, and health officers that would show how to manage nps/stormwater, their identification, what activities the State/federal government are performing, and what assistance programs are available. Such seminars would be held in conjunction with government interest groups (Authorities Association, League of Municipalities, engineers society, planners association, etc.).

- Preparation or gathering of technical resource documents for distribution to interested officials. Would include documents such as the Guide to Stormwater Management Practices, Urban BMP's Guide, or new documents could be prepared as necessary. The NJDEP could purchase a large number of these documents for free distribution to local offices.

- Develop a model NPS ordinance which municipalities/counties could incorporate into planning ordinances. Ordinance may include stormwater management, stream corridor/buffers, additional soil erosion control over Chapter 251, maintenance and inspection of control structures, dog litters laws, local education of residents, etc.

- As needed, special education seminars would be held for local governments adjacent to waterways identified by the Department as a statewide priority for the control of nps to protect important water uses or resources. Provide technical assistance as requested. Make it be

known that the State/county would be willing to have engineers, planners available to assist local governments in addressing problems related to nps pollution/stormwater management.

Evaluation

Activities proposed in the plan seem to range from the Consult 1 level to Agency Power, indicating government-controlled educational programs. Nonetheless, as Glass's model illustrates, if objectives are tied to techniques, the chances of program success are increased. According to this criterion, the DEP nonpoint source education program appears poised for success. However, funding of the activities through existing agency funds or federal grants may not be sufficient to operate the proposed programs effectively. At present, Section 319 Clean Water Act funds have not yet been appropriated by Congress for any nonpoint source programs. This lack of a stable funding source makes nonpoint source education programs likely to be axed when cost-cutting begins, as current federal pollution policies make clear.

However, the detailed breakdown of the nonpoint source education program into its specific components enables the DEP to effectively address highly targeted subsegments of the target audiences. The Nonpoint Source Education Plan incorporated all elements of an effective public education or participation program, except for determining funding and equally seeking public and agency input.

Public meetings will be scheduled to inform and involve the public in early 1989, but this points out the entire plan's contradictory messages -- promoting public education and involvement while excluding both from its make-up. However, time restrictions such as EPA's August deadline made the plan's schedule for preparation tight. This effectively limited extensive public participation outreach efforts.

Overall, water quality information was collected from New Jersey's 16 soil conservation districts, 21 county planning agencies, the state DEP Division of Fish, Game and Wildlife, and health agencies throughout the state.

Navesink River Water Quality Improvement Project

Background

In September, 1986, Rutgers Cooperative Extension initiated a public information and education program to target 74 farmers/agricultural landowners in the 95-square mile Navesink River watershed in northeast Monmouth County, New Jersey.

A $50,000 grant from the New Jersey Department of Environmental Protection (NJDEP) secured from the federal Environmental Protection Agency was awarded to Rutgers Cooperative Extension for the information program. "It is intended that this educational program be a cooperative effort among federal, state and local government agencies," states the contract between Rutgers Cooperative Extension and NJDEP.

According to the consulting contract, the information program was to involve NJDEP, USDA Soil Conservation Service, the Agricultural Stabilization and Conservation Service, New Jersey Department of Agriculture, and local health agencies.

In addition to targeting 74 agricultural landowners, the information program's original goals included:

* a planned schedule of public information activities, such as personal farm contacts, newsletters, audio-visual presentations; newspaper, radio, and television coverage, fact sheets, and other outreach techniques

* assisting in the organization and set-up of two demonstration farms: one for animal waste control and the other for sediment and nutrient control

* targeting the suburban horse owner

* addressing standardbred and thoroughbred breeders and owners association members

As the public information program contract noted, "The role of (the participating) agencies needs to be clarified, and put down in writing as necessary. No one agency can be expected to "carry the ball" on its own and be very successful in a nonpoint pollution control program."

To conduct the public information program, a public relations practitioner, Michael T. Olohan, was hired. His professional credentials included valuable experience as a reporter and editor with a weekly newspaper, advertising copywriting proficiency, printing and production knowledge, direct mail marketing expertise, and public relations writing and marketing skills.

Targeted Publics

The USDA Soil Conservation Service (SCS) Navesink Watershed Plan estimates there are 74 farmers in the watershed who work on 8,600 acres of cropland and 4,900 acres of pastureland, 15 percent and 8 percent of the watershed, respectively. Because the horse farm operations have not been a targeted audience of either Rutgers Cooperative Extension of Monmouth County or the SCS, Freehold, little information existed on them. However, reliable information on crop, vegetable, nursery, and sod farmers, such as addresses and past conservation practice use, has proved helpful in targeting information.

In addition to targeting agricultural landowners, the information program was expanded to include domestic pet owners, boat and marina operators, and homeowners to begin a more holistic approach to addressing the complex puzzle of nonpoint pollution in the Swimming River Reservoir and Navesink River.

Information Program Activities

Since September, Rutgers Cooperative Extension public education and public information activities have included:

* Developing a mailing list of agricultural landowners and a media list for information dissemination.

* Maintaining regular contact with local and regional print, radio, and TV outlets and consulting with agricultural leaders and local officials to explain and promote Navesink Project benefits.

* Issuing press releases to focus attention on the cost-sharing available, landowner cooperation, boat waste impacts, and the BMPs installed in the watershed.

* Personally visiting farms in the watershed and distributing fact sheets, voluntary cooperator agreements, and newsletters describing the project.

* Giving audio-visual presentations to a variety of agricultural, community, political, and environmental groups to increase project awareness, understanding, support, and participation.

* Writing, editing, producing, and distributing a quarterly newsletter that provides up-to-date project news and usable information to over 1,500 people.

* Appearing on five cable TV interview shows that reached an estimated 100,000 watershed residents.

* Organizing a well-publicized public forum in Colts Neck for all agricultural landowners and farmers to receive detailed information about the project, cost-sharing available, and BMP on-farm benefits.

* Initiating media coverage of the project and its positive effects on agriculture, responsible land use, and improved water quality.

* Producing and distributing six fact sheets: one on BMPs, one on farm animal waste management systems, one on hazardous household products, one on boater sanitary devices, one on boat waste impacts, and one on horse manure management methods. All are available free from Rutgers Cooperative Extension.

* Direct mail contact with 40-50 horse farm operations in both the upper and lower watershed. This includes telephone and in-person follow-up visits to farms to encourage installation of best management practices to control soil erosion and reduce farm waste bacterial and nutrient runoff.

* Working with New Jersey Sea Grant Extension agent John Tiedemann to promote and assist boater education efforts. Includes press releases, fact sheets, posters, promotional stickers, marina visits, and on-site demonstrations of proper sanitary waste disposal techniques and pump-out unit use.

* Contacting and urging local watershed political leaders to publicly support the Navesink Project. So far, Howell, Rumson and Middletown, along with the County Board of Chosen Freeholders, Environmental Council,

Planning Board, and Water Resources Association have endorsed the project.

* Developing and distributing a comprehensive series of public service messages and a local nonpoint source advertising campaign to Monmouth County newspaper, radio, and TV outlets describing nonpoint pollution using copy and visuals that command attention.

Evaluation

The Navesink River public information program falls between the "Inform" to "Consult 2" range. This range includes outreach techniques from newsletters and press releases to informal meetings and public hearings. The program's thrust was educational from its inception, and was never intended to solicit public input for decision-making. Techniques were not matched to objectives for individual activities, but a program strategy developed to tie in information activities with agency activities, local events, meetings, organizations, and DEP's statewide nonpoint source educational efforts.

The information program has operated for 2 years and shown steady progress in a variety of areas, including: farmer cooperation, interagency coordination, local grassroots participation, media coverage, coordination of environmental and civic group support, agricultural agency cooperation, and pet and homeowner awareness. However, due to its voluntary nature, a long-term educational program is needed to sustain and reinforce the attitude, behavioral, and land-use changes now occurring.

Chesapeake Bay Communication/Participation Programs

Background

In December, 1987, Pennsylvania, Virginia, Maryland, the District of Columbia, the Chesapeake Bay Commission, and the Environmental Protection Agency authorized the 1987 Chesapeake Bay Agreement. The new agreement, expanding on the 1983 pact, promises intensified coordination and accountability.

The agreement addresses six major areas:

* Living Resources
* Water Quality
* Population Growth and Development
* Public Information, Education, and Participation
* Public Access
* Governance

(Source: State of Maryland Communication Plan for Public Information, Education and Participation)

The following summaries examine the four Chesapeake Bay communication plans for public information, education, and participation and present findings of significance for similar statewide efforts. Where applicable and helpful, the plans are evaluated based on the three typologies previously detailed. This includes the ECRP Ladder of Citizen Involvement, James J. Glass's techniques-objectives matching, and the 10 elements of an effective outreach strategy.

1. 1988 Pennsylvania Chesapeake Bay Communication Plan

Program Description

Half of the Chesapeake Bay's drainage basin lies within Pennsylvania covering an area the size of Maryland. Agricultural runoff impairs the Susquehanna River, which supplies half of the Chesapeake's fresh water. To facilitate farmer cooperation the Pennsylvania Department of Environmental Resources (DER) designated the Pennsylvania Association of Conservation Districts Directors (PACDD) as the Bay education contractor in 1984.

The Bay Education Subcommittee is a subcommittee of Chesapeake Bay Advisory Committee of the Pennsylvania State Conservation Commission. Since 1984, the Commission was given administrative authority for the Bay Program. The education effort in Pennsylvania is supported by 1) a state-funded Bay Education Office, 2) a Bay Education subcommittee, and 3) grassroots delivery of

the program messages through county conservation districts and the Mini-Grants Program. Approximately, 10 percent of Pennsylvania's Bay Education Office budget is channeled to local groups through the Mini-Grants Program. The maximum grant is $500.

In addition to the Mini-Grants Program, the Bay Education Office has been involved from 1984-1987 with creation and production of:

* three portable exhibits
* Susquehanna River Trivia quiz board display
* four fact sheets
* five technical notes
* eight project sheets
* two brochures
* two television public service announcements
* a month-long radio contest on 25 stations
* six-month series of radio public service announcements
* eight newsletter issues
* two Chesapeake Bay Clean Water Farm Award Contests
* a Chesapeake Bay essay and poster contest
* two years of Mini-Grant funding to local organizations
* state bay program slide-tape presentation.
* two Pennsylvania Bay Program progress reports
* two major conferences on Pennsylvania and the Chesapeake Bay

In addition an average of 30 information requests and 6 speaking requests are handled monthly. Various federal and state agencies funnel requests and coordinate outreach activities through the Bay Education Office.

The 15 target groups of the communication program include farmers, citizens and homeowners, educators, media, agribusiness, local government, federal and state legislators, sportsmens' groups, agricultural lenders, realtors and homebuilders, boat dealers, garden stores and lawn services, colleges and universities, and Bay Program agencies and organizations.

The factors used to select target audiences included: 1) current and future priorities of the Bay Program, 2) funding levels and program priorities of the cooperating agencies, and 3) expressed interest in Bay education.

Priority messages were developed to integrate major program themes and to

customize the outreach effort for each specific audience. For example: the message to agricultural lenders was "proper nutrient management controls farm production costs," while citizens were told "local water quality is affected by land-use practices in your community".

In an attached appendix, the plan details the messages to be delivered, the outreach medium (i.e., workshops, computer networks, tours, demonstration plots, and publications) and the timetable for implementation. An example of the outreach plan for recreational boaters follows:

AUDIENCE:

RECREATIONAL BOATERS

MESSAGES:

A) The Chesapeake Bay's survival depends on clean water from the Susquehanna River.

B) The Susquehanna River is a valuable recreation asset for Central Pennsylvania.

C) Boating practices on the river and bay affect water quality.

D) You and your boating group can become involved in environmental problem solving.

PRODUCTS, PRODUCERS, AND DELIVERY DATES:

AUDIO-VISUAL

1. Expanded promotion of Bay Program speakers and audio-visual materials to boating groups in central Pennsylvania by BAY EDUCATION OFFICE in fall, 1988.

   MESSAGES: A--C--D
   PUBLICATIONS

2. Targeted articles and prepared ads in boating publications by BAY EDUCATION OFFICE during winter 1988-89.

   MESSAGES: A--B--C--D
   EVENTS, WORKSHOPS AND CONFERENCES

3. Participation in and sponsorship of boating and river events during summer 1988-89-90 by BAY EDUCATION OFFICE and cooperating agencies and groups.

   MESSAGES: A--B--C--D
   PARTICIPATION

4. Expansion of Bay Education Mini-Grants promotion to boating groups in the Susquehanna River Basin by BAY EDUCATION OFFICE by June 1988.

   MESSAGES: D

The Plan also identifies 11 new outreach initiatives including:

* the training of citizens for Bay Education Teams
* watershed awareness signs
* demonstration farms for field days and tours
* elementary and intermediate school education activities
* vocational agriculture bay education activities
* conservation profile sheets of exemplary farms
* wetlands and water quality conference
* interagency bay program conference
* educational video productions (4) on farm issues
* local officials slide show on erosion and sedimentation
* ag lender workshops on nutrient management

In addition, the plan calls for a yearly evaluation of the Bay Education Subcommittee in conjunction with public input, but provides no details or guidelines of this process.

Evaluation

The overall Communication Plan's activities tend to fall in the "Inform" to the "Consult 2" range on the ECRP Ladder, providing information, asking for structured input, and seeking meaningful citizen input. The program contains most essential operating elements, though it lacks a specified mechanism for evaluation. The state-funded Bay Education Office has produced a substantial quantity of "educational products and services" from 1984-1987. Included among these is a computer information network that distributes the program newsletter and materials to county Extension offices, the Department of Education, and the State Conservation District bulletin board. The Pennsylvania program includes most of the elements critical to a successful program and even a few

innovations, such as training Bay Education Teams, and agricultural lender workshops on nutrient management. Most notable, the Mini-Grant program provides a high level of power-sharing by directing funds to grassroots organizations to implement local watershed protection plans and strategies.

2. State of Maryland Communication Plan for Public Information, Education and Participation, April 1988

Program Description

Maryland's plan has two objectives: 1) to inform citizens of their role in reducing pollution affecting the Chesapeake, and 2) to expand public involvement efforts to increase opportunities for public participation. The plan aims to involve 1 million of Maryland's 4.5 million residents in the Bay clean-up by demonstrating how personal actions may affect water quality.

Lead state agencies are designated by individual activity. For example, the Department of Natural Resources is responsible for the Pilot Submerged Aquatic Vegetation Planting Program, while the department and local governments are identified as implementing agencies for the Stream Blockage Removal Program.

The agencies and activities are matched under easily referenced headings including "What You Can Do at Home and Work," "Spreading the Word," "What You Can Do at Play," and "What You Can Do in Your Neighborhood/Community Group." It briefly mentions business/industry participation without specifics but details media outreach and public outreach efforts.

The plan proposes a Chesapeake Bay Communications Director to work with local governments, community organizations, and private citizens' organizations to assist their Bay public education efforts.

The plan targets six major groups:

* general public

* farmers
* property owners
* recreational users
* youth
* educators

Its program matrix listing agencies, activities techniques and timetables focuses on public education, direct hands-on education projects or local citizen action efforts, along with technical assistance for farmers, local government, and landowners. The plan details the five citizen advisory committees working with the departments of Natural Resources, Environment, and Agriculture. Lists of these committee members are made available to citizens to aid in obtaining additional bay-related information.

It also lists eight areas for measuring progress, including:

* Public participation in specific projects
* Attendance at bay events
* Media coverage
* Publications distributed
* School children involved in bay projects
* Lessons learned from the project
* Follow-up actions stemming from the project (i.e., change of a habit, local policy, program, or practice)
* Evaluation of program effectiveness. Identify weak areas for the future

Moreover, the plan proposes funding to local grassroots efforts, such as stream adoption and monitoring by Boy Scouts, high school clubs, civic groups, and businesses. The funds may be available through the private sector, local governments, or the Chesapeake Bay Trust.

A proposed Director of Chesapeake Bay Communications, along with a staff of one entry level public affairs specialist and one clerical position, is recommended to implement the plan. Also, the permanent establishment of a communications policy advisory group is recommended in the plan.

Evaluation

Maryland's plan includes an assortment of outreach and input mechanisms that offer citizens an opportunity to span the gamut of participation as defined by ECRP's Ladder of Participation. It also offers a well-balanced selection of structured, unstructured, active, and passive outreach techniques. The plan also contains most of the 10 elements of an effective program, but lacks a timetable for specific, ongoing activities. However, the plan's inclusion of elements for funding, staff, and program evaluation lays a strong foundation to improve the cohesiveness as well as the sustainability and justification for the long-term expenditures required for the program (i.e., Communications Director, publications, etc.).

3. Virginia

Program Description

Virginia's Chesapeake Bay Management Program began in 1984 with the goal of obtaining public support through public information, education, and participation programs. In the 1988 Virginia Bay Communication Plan, the state identifies the three major target audiences and the 12 state agencies/institutions and the 20 private organizations that are conducting outreach efforts. The plan sets goals and general commitments. It also establishes the Council on the Environment as Virginia's lead agency in ensuring plan compliance. The Council has also established a State Communications Committee to assist in ensuring plan compliance. The plan describes ongoing activities and provides matrices that highlight the agencies/organizations involved as well as the target audiences and methods of outreach used.

The objectives of Virginia's Bay Communications Plan are as follows:

- To promote greater understanding among citizens about the Chesapeake Bay system, the problems facing it and policies and programs designed to help it, and to foster individual responsibility and stewardship of the bay's resources

- To provide increased opportunities for citizens to participate in decisions and programs affecting the bay.

In addition, the commitments identified and developing among the 32 agencies and organizations involved are broadly described below:

- Conduct coordinated education and information programs to inform the general public, local governments, business, students, community associations, and others of their roles, responsibilities, and opportunities in the restoration and protection effort, and to promote public involvement in the management and decision-making process.

- Provide for public review and comment on all implementation plans developed pursuant to this agreement.

- Develop by March 1988 state and federal communication plans and by May 1988 a unified baywide communication plan.

- Promote Chesapeake Bay restoration efforts by establishing an annual baywide series of Chesapeake Bay Watershed Awareness events, to include a Governor's Cup Fishing Tournament.

The plan notes "without the (participation) opportunities offered by state government, in combination with those offered by private organizations, the numerous and varied constituencies in the state would be difficult to reach and have fewer chances to participate in decisions that affect us all." The Council on the Environment and Department of Conservation and Historic Resources decided to target three audiences: the general public, school age children (K-12), and members of the farming community. These groups were targeted because they were "not part of a regulated community" and not included in the information-education-participation process accessible to other interest groups and associations.

The plan spells out precise reasons for its targeting. "First, the general voting-age public is critical in Virginia's overall bay cleanup efforts since they

can directly influence the availability and amount of public funds for important programs. This group also constitutes the full range of bay "users" and, through daily actions, directly and indirectly influences the health of the bay. Second, school-age children have been identified as the key to the bay's future. These young people will be bay "users" and, more importantly, political decision-makers whose actions and choices will determine the future of the bay in the decades ahead. As the third audience targeted, farmers have been participating in an increasing number for the past four years. Agricultural runoff is a major problem in the bay watershed and as a large, unregulated constituency, the farming community has been targeted with a number of educational and cost-share programs.

Better tracking and coordination of existing public information, education, and participation activities will also help the state promote the protection, conservation, and wise management of bay watershed resources, according to the Plan.

In addition to the three targeted groups, the plan's matrices identify 21 additional target audiences that are reached -- the agencies/organizations that reach them -- and the type of outreach activity used.

These activities include 22 broad categories that the plan defines earlier. They range from public service announcements, field demonstrations, meetings, conferences, and publications to media contact, school outreach, implementation/ research grants and networking/referral services.

The additional audiences reached by the 32 groups participating include homeowners, industry, developers, watermen, educators, garden/lawn services, legislators, local government, sportsmen groups, boaters, marina operators, tourist industry, agribusiness, chemical distributors, research/technical community,

realtors, financial community, media, forest industry, civic groups, fish industry, and conservation/citizen groups.

To monitor these diverse and disparate constituencies and activities, the Council on the Environment created and assigned the following tasks to the new State Communications Committee:

1) assist in the establishment and maintenance of an inventory of all ongoing bay activities, target audiences, messages, and dissemination methods;

2) study the effectiveness of activities and their compliance with the public information, education, and participation goals and commitments in the Bay Agreement; and

3) recommend improvements, new avenues and appropriate mechanisms for public involvement, including liaison and coordination where practicable with public involvement programs and efforts in the other bay jurisdictions.

Evaluation

Due to the diversity of agencies/organizations involved with Virginia's varied outreach efforts, it is difficult to assess clearly the connection between the regulatory agencies, target audiences, and techniques used. Nonetheless, it seems to range on the ECRP Ladder from complete government power to the Consult 2 level. Again due to the number and the variety of agencies, audiences, and outreach methods used, it's impossible to pin down the program as a whole. It is "unstructured" in the sense that most techniques are oriented toward information exchange but some programs are also "structured" in that they involve committees and task forces focused on education and support building. Last, the plan appears to have completed the first 5 elements of an effective program, leaving the second five items incomplete. Overall, Virginia's plan is moving forward to reach its goals, but lacks the specific deadlines, agency commitments, funding appropriations, and measurable quantitative and qualitative benchmarks that should be used to assess a program's accomplishments

adequately.

4. District of Columbia

Program Description

The District of Columbia Communication Plan for Public Information, Education and Participation is focused on the Anacostia watershed and the link between the Anacostia, Potomac, and Chesapeake Bay. The outreach program "will encourage actual participation in the restoration and protection of the Anacostia and Potomac Rivers."

The plan targets four broad audiences:

1) the general public;
2) waterway users: boaters, fishermen;
3) commercial landscapers and nurseries and
4) youth/seniors.

The following objectives are specified:

* To foster public, private and media awareness, responsibility, and stewardship of the Anacostia and Potomac rivers.

* To provide increased opportunities for the public, the private sector, and the media to participate in decisions and programs affecting the Chesapeake Bay and its tributaries.

* To promote opportunities for public appreciation and enjoyment of the Chesapeake Bay and its tributaries.

To achieve these objectives, the plan specifies the Advisory Neighborhood Commission (ANC), an established mechanism, for providing information to the public. Techniques include:

* Monthly/Quarterly Newsletters
* Brochures
* Slide/Video Presentations
* Seminars
* Workshops
* Lecture Series
* Community Meetings
* Public Hearings

The plan also points to newspapers, TV and radio as other outlets for "optimal communication." Information packets will also be distributed to businesses, banks, and savings and loans, department stores and retailers, and transportation/transit operations, states the plan.

Proposed activities to provide information and education to citizens include:

* Actively inform neighborhood residents and organizations in the community about proposed environmental programs or EPA action which affects them. Solicit their ideas and reactions to these issues and inform the appropriate department about community views and concerns regarding environmental programs and actions.

* Conduct quarterly seminars/workshops on critical environmental issues or activities in schools and community meetings.

* Prior to holding public hearings pertaining to environmental issues, community meetings will be held to encourage discussion and feedback.

* Schedule and make presentations in schools, churches and other educational institutions to inform citizens what they can do at home or in the workplace to protect our rivers.

* Produce documentary on the District's environmental program.

* Develop an information package to increase public awareness of the Chesapeake Bay Program, to inform citizens of their contributions to water quality and pollution in the bay.

* Implement an "adopt a lot" or stream program. This activity would give students/senior citizens hands-on experience and an ongoing role in environmental conservation projects in their community.

A section on public review (i.e., public announcement of plans, placing draft plans in designated libraries and direct contact with local groups) is included in the plan along with a suggestion for quarterly evaluation reports. Progress reports are to be included in the Mayor's Quarterly Chesapeake Bay Report.

The program evaluation criteria includes media coverage, publications distribution, youth/senior involvement, volunteer response to clean-up efforts, and attendance at events as measurements of increased awareness and the overall impact of each activity coordinated by a cooperating entity.

Evaluation

The District of Columbia outreach program provides mechanisms for input and hands-on involvement. It also proposes the use of other media such as electronic message boards, outside-bus transit boards, kiosks, display windows, and automatic voice message teller machines to get its message across. The plan attempts to match objectives to techniques. However, the plan provides no specifics by which to assess the outcomes of the particular techniques or the overall effectiveness/impact of the education/participation opportunities it creates.

It addresses its audiences and objectives with generic, vague prescriptions that fail to define the specific agencies responsible for implementation, a timetable for each activity/technique, and expected outcomes. It also appears to offer few new education/participation opportunities not already offered by agencies or institutions currently operating. While the plan falls into ECRP's government-controlled side, it includes 7 of the 10 program elements.

State of Washington Puget Sound Water Quality Authority

Background

In 1985, the Washington State Legislature restructured the Puget Sound Water Quality Authority (PSWQA) and authorized it to "develop a comprehensive plan for water quality protection in Puget Sound to be implemented by existing state and local government agencies" (RCW 90.70.001).

Program Description

In the "Education and Public Involvement" action plan adopted September 16, 1987, the PSWQA noted that most state agencies, city and county governments, and tribal councils were not allocating funds or staff to public involvement. It noted the four prerequisites of public involvement that were not

on governments' agenda. These included: 1) timely, understandable, and complete notice of pending actions; 2) access early in any decision-making process; 3) ease of access to the process; and 4) response to citizens on how comments or recommendations were used.

The plan recognized that there were no education or participation programs operating that focused strictly on making water quality issues understandable to the public. "Selected interest groups such as marine businesses or farmers received technical information and education but other outreach components such as interpretive centers, household hazardous waste collection days and adopt-a-stream efforts were generally underfunded and of limited duration and scope," the plan said.

The plan's goals were to increase understanding of the Puget Sound's resources and the short- and long-term effects of human activities upon them. Moreover, the plan was to facilitate public involvement in local and state Sound-related decisions.

The plan includes nine program elements:

1) long range strategy
2) funding for model education/involvement projects
3) public involvement policy
4) PSWQA activities
5) PSWQA technical assistance on public involvement
6) information on water quality issues
7) ecology coordination and mailing list brochure
8) funding for teacher training
9) PSWQA library support

The program costs $1.25 million in 1988 and 1989, approximately $500,000 in 1990 and 1991 and $120,000 in 1992. Funding for each element is broken down by state agency and local governments per each fiscal year.

An example of the plan's description of model project funding ($644,000 per year) follows:

EPI-2 FUNDING FOR MODEL EDUCATION AND PUBLIC INVOLVEMENT PROJECTS

PSWQA shall provide funding for a short-term program (1987-89) until the long-term strategy is developed. The program will focus on projects that could serve as models for public involvement and education, community cleanup, or citizen monitoring of water quality or biological resources. Groups eligible for funding will include citizen and environmental organizations, tribes, local governments, and educational institutions. Projects eligible will include existing and new programs as well as proposed activities related to any topic addressed in the plan and any area of Puget Sound. PSWQA shall issue guidelines, call for proposals, and select participants.

Target Date: PSWQA issues guidelines by July 1, 1987. Initial funds awarded by October 1, 1987.

As part of the 1987 Puget Sound Water Quality Management Plan, a 12-member advisory group and a group of seven work teams were created to develop the public education and involvement long-range strategy. These groups produced eight reports:

* Formal education (K-12)
* Formal education (Postsecondary Institutions)
* Nonformal education
* State Agencies and Interpretive Centers
* User Groups
* Media
* Action Programs
* Public Involvement

The PSWQA developed three or four alternative long-range plans from those reports working with the Public Education and Involvement Advisory Group. Public comment was solicited at five night meetings in March 1988.

The Public Involvement Work Team report contains recommendations for: 1) the Authority, 2) state and local agencies, and 3) the public. To summarize the plan, here's a brief overview provided by the Advisory Group. The Authority is requested to:

* Publish a public involvement manual which includes guidelines and criteria for public involvement;

* Require state and local agencies to prepare public involvement work plans;

* Assist state and local agencies and tribes in expanding their own clearinghouse and public information capabilities;

* Support the development of a cadre of trained public involvement specialists;

* Review the status of compliance with the public involvement Section 101(e) of the Clean Water Act.

State and local agencies are urged to:

* Work with the Authority to improve public information and involvement related to Puget Sound;

* Coordinate with one another to bring issues as well as programs to audiences and to make better use of joint meetings and workshops;

* Use public involvement work plans that identify constituencies, staff and budget resources;

* Provide public involvement training for agency staff.

The report includes a four-page outline for the public on how to be more effectively involved, including suggestions on understanding the issues and understanding the opportunities and limitations that certain laws and processes provide. Some of the more unusual or creative options for increasing public education/participation opportunities include:

* A group of consulting or full-time public involvement experts that would be cost-shared by agencies to increase program implementation success.

* Develop procedures to increase public involvement in the National Pollutant Discharge Elimination System (NPDES) process.

* Review enforcement actions for failure to implement public involvement activities under Section 101(e) of the 1972 Clean Water Act.

* Write work plans for public involvement that define outreach objectives, the program involved, or the regulatory process under development or revision.

* Public involvement capabilities should be attached to the highest practical level of decision-making in the agency.

A separate appendix describes 17 criteria for a public involvement program. Some of these include: 1) early citizen involvement in planning process of any proposed action; 2) never asking citizens to ratify or accept a decision that has already been approved by agency officials; 3) a written agreement should be adopted by the participants; 4) an extensive public information effort must be

conducted; 5) a nontechnical presentation of information; 6) meticulous follow-up to citizens' concerns and questions; and 7) a final summary that defines the program's outcome in terms of affected audiences, program policy inputs, positive and negative impacts, the extent and the genesis of support for or opposition against the agency decision.

Evaluation

The PSWQA Public Involvement Work Team Report falls between the "Consult 2" to "Power-Sharing" rungs on ECRP's Ladder of Citizen Involvement. It provides the basis for meaningful citizen input and fosters/funds the program for 80 percent (four of five years) of the PSWQA's existence -- providing over $1 million for grants to local education and involvement programs. It fails to specifically match techniques to objectives, but does provide a five-page review of involvement techniques with definitions, advantages, and disadvantages listed.

Techniques range from site visits and Delphi exercises to ombudsmen, environmental impact statements, and citizen suits. The Puget Sound Water Quality Management Plan includes all elements of an effective plan and provides immense detail and background on eight related areas of public education and involvement. "While education and public involvement activities are sometimes very distinct activities...the two frequently are inseparable and work toward the same end. Public policy decisions require participation by citizens who have been educated about the issues," states the 1987 PSWQ Management Plan.

The plan's Education and Public Involvement report provides an in-depth, action-oriented strategy for targeting every audience and activity responsible for causing nonpoint source pollution throughout the Sound's immense watershed -- a drainage basin populated by 2.9 million people. Its eight reports provide a comprehensive program to complement and expand on any type of ongoing

watershed management planning or implementation efforts.

Wisconsin Department of Natural Resources Sixmile-Pheasant Watershed Plan

Background

The Sixmile-Pheasant Branch Priority Watershed Plan was prepared jointly by the Dane County Soil and Water Conservation District, the Dane County Regional Planning Commission, and the Wisconsin Department of Natural Resources in 1981. Funding -- $3,500,000 -- for this plan comes from the Wisconsin Nonpoint Source Water Pollution Abatement Program. The 93-square mile watershed is primarily agricultural, with cash grain farming predominating near the urban areas and dairying near the headwaters. Based on a 75 percent participation rate, and BMP cost-sharing from 50-70 percent, the state expects to contribute $1,600,00 over the plan's seven year implementation period.

The State Nonpoint Source Water Pollution Abatement Program was initiated in response to Section 208 water quality management planning and focuses on watersheds "where water quality conditions are critical and pollution abatement is practical," according to the plan. The state program used six criteria to identify priority watersheds, including: 1) the severity and the practicability of control of the water quality problems; 2) the significance and impacts of the nonpoint sources contributing to the problems; 3) practicability of controlling the nonpoint sources; 4) demonstrated landowner and land user willingness to participate in the program; 5) the capability and willingness of local agencies and units of government to participate; 6) and the public use of the lakes and streams.

Criteria 4 and 5 above may both be influenced by an advance public education or public participation program. In states where funding may be based

partly on local/regional awareness of a problem, an upfront outreach program will pay dividends not only in increasing local understanding and cooperation, but in securing funds for nonpoint program operations.

Program Description

The five target audiences of the Sixmile-Pheasant Branch Priority Watershed Plan are:

* 230 farm owners/absentee landlords
* farm operators
* 57,000 urban dwellers
* land developers
* elected officials

The purpose of the outreach program was to communicate "with all important audiences and actors in the watershed," notes the plan. Outreach techniques included one-on-one contacts, mass media, direct mailings, tours, demonstrations, and displays.

Six cooperating agencies provided coordination, funding, and technical assistance, while two cities and two villages in the watershed were the "designated management agencies." Carrying out the public education and participation efforts were the University of Wisconsin-Extension, Dane County Soil and Water Conservation District, Dane County Regional Planning Commission, City of Madison, and City of Middleton. "Assistance will be provided by Soil Conservation Service and Department of Natural Resources. Activities in Madison will be coordinated with the Madison Commission on the Environment and in Middleton with the Water Resources Management Commission," states the plan.

Increased emphasis on newspaper articles, radio programs, and regular newsletter distribution were priorities over the first 3 years of the 7 year watershed plan. In addition, school meetings and community and civic organization outreach were also priorities over the first 36 months.

A matrix depicting outreach methods, frequency, and the coordinating agency responsible is also provided.

Evaluation

The Sixmile-Pheasant Branch Priority Watershed Plan appears to fall in the Consult 1 - Government Power range on ECRP's Ladder of Citizen Involvement. It provides little opportunity for substantive citizen input. However, in selection of the nine priority Wisconsin watersheds, the choice of the Sixmile-Pheasant Branch was reviewed by nine regional committees -- providing an opportunity for input into the final plan. Unfortunately, techniques do not seem to be matched to objectives in the plan.

While specific agencies are designated for implementation, emphasis appears focused more on quantitative results (i.e., number of visits, newsletters, newspaper articles, etc.) than on qualitative changes (i.e., changed attitudes, farming practices, mobilized public opinion, etc.).

Annually, the designated management agencies, regional planning commission and the Department of Natural Resources (DNR) compare project progress to the plan's proposed goals. The agencies make recommendations for improvement in weak areas and highlight successful individual efforts or agencies. The plan notes that if progress is "significantly inadequate" DNR "may curtail" cost-sharing or local grant funds in "a particular political or geographical area, or for a particular task." This provision provides a financial incentive to implement all aspects of the watershed program. Obviously, however, withholding funds for public education/participation programs will not have the "visible" or immediate impact that denying funds for a sewage plant might have. Nonetheless, Wisconsin's plan is adequate although further follow-up with agency officials is necessary to define specific, positive aspects of the public involvement program

that might provide insights useful to other public agencies.

Florida Department of Environmental Regulation State Water Use Plan

Background

In 1984, the state of Florida began an integrated planning process initiated by the State and Regional Planning Act of 1984, Chapter 186, Florida statutes, that was passed by the Florida legislature. This planning process created three strategic, direction-setting documents that were to serve as the basis for additional statutory, budget, and appropriations regulations where necessary to achieve their objectives by 2005. Because nonpoint source water pollution is directly related to water use decisions, the State Water Use Plan was examined to discover what types of public education/public participation programs were used to educate and involve local populace in watershed management issues.

Program Description

The current foundation for formal citizen involvement rests in Chapter 119, F.S. (citizen access to public records), Chapter 120, F.S. (public notification of administration rule-making), Chapter 286, F.S. (provides for open government proceedings), and the Florida Constitution, which sets forth the ethical standards and public disclosure provisions that guide public officials. In addition, each state agency, including Department of Environmental Affairs, Department of Environmental Regulation, and Department of Natural Resources, has formal or informal procedures for notifying the public of planned changes in agency operating procedures or policies.

Among suggestions often discussed for increasing citizen awareness and participation are: (1) improving information dissemination from the agencies, including upgrading efforts to involve the public in meetings and conferences,

and exploring more effective use of displays and exhibits, speaker bureaus, publications, and hot lines; (2) developing a plural planning process, which would submit alternative plans to the public; (3) better utilizing advocacy groups and encouraging advocacy planning; (4) employing larger numbers of workshops and involving staff; (5) periodically involving the public in priority setting exercises; and (6) using game simulations to demonstrate to the public the difficult choices facing the agencies.

Objectives:

(A) By 1992, involvement of the public on land and water issues shall be increased. (State Plan Policy 6)

Measure: Percent of population exposed to public information programs.

Operating policies:

(a) Encourage the public to participate in governmental decision-making. (all).

(b) Provide opportunities for the general public to participate in the overall assessment of the effectiveness of state agencies and their programs (all).

Evaluation

While the Florida State Land Development Plan indicates a 20 percent increase in citizen involvement by 1991 as a goal, the Florida State Water Use plan cites no specific measurable increases by which to evaluate its success.

Moreover, while its suggestions cover a wide range of public education and participation opportunities, it details no specific funding commitments, goals, or objectives. In addition, it seems to fall between Consult 1 or Consult 2, ranging from a "limited input" approach to public participation to the outside chance for substantive input. For example, activity #5: "Periodically involving the public in priority-setting exercises" would rank as a power-sharing activity on the ECRP Ladder of Participation due to its potential for mobilizing citizens and

government to solve water-quality problems together. However, due to a complete lack of specific program element descriptions, it's difficult to judge this program's potential for substantive citizen-government interaction.

Creative attempts at education and participation opportunities with innovative mechanisms such as "priority setting exercises" and "game simulations" sound intriguing. Due, however, to the technical complexity of most watershed management issues, these games can serve only as a supplement to an in-depth discussion of the issues, problems, and solutions involved.

VI. Summary

A successful state-wide watershed management program requires a consistent, integrated ongoing public education and public participation effort to be effectively implemented. This conclusion is amply supported by the previous 10 watershed-based outreach programs reviewed in this report.

In Nonpoint Sources: Agenda For The Future, a discussion paper prepared by the U.S. EPA, public awareness is placed first in its 1989-1993 strategy. The report notes: "It is much easier to build public consensus for action when people feel they are protecting a particular water resource -- especially one that is near and dear to their hearts...grass-roots support and local coalitions are vital to motivate states and local government."

Moreover the proposal states, the EPA plans to encourage states and local governments to "adopt targeted watershed management approaches that provide a common basis for citizen support and action."

Innovative county and local outreach initiatives that promote techniques such as land conservancy, greenways, river corridor management, conservation easements, sale/transfer of development rights and the use of natural and

artificial wetlands to achieve water quality objectives are needed to build public and private support for watershed management.

Some innovative outreach approaches used in the programs reviewed include: computerized bulletin boards, mobile information centers, citizen training programs, full-time public involvement specialists, ombudsmen and local watershed outreach entities. Moreover, other creative approaches include grant funding of local information efforts, mandated public participation requirements prior to local, county and state decision-making on watershed business, and a written contract or agreement among participating agencies requiring public input into watershed-based activities.

Other effective education and participation techniques that might be adopted:

- Develop work teams to prepare short-term and long-term public education and public participation plans.
- Prepare and publish a public involvement manual for county and local agencies.
- Require local public education and public participation watershed plans as part of local master plans and county areawide water quality plans.
- Encourage planning by local environmental groups and propose alternative watershed plans for the public to evaluate.
- Establish a permanent, full-time position for citizen information requests and watershed outreach coordination and follow-up.

As these options make clear, public education and participation must be a part of any effective watershed management program. But as the Puget Sound Water Quality Authority found in its evaluation of outreach efforts, most governmental agencies have allocated no staff or funds to public involvement. The Puget Sound Water Quality Authority identified four prerequisites for a meaningful public participation program. These include: timely, understandable and complete notice of pending actions; access early in any decision-making

process; ease of access to the process; and response to citizens on how comments or recommendations were used.

This lack of institutional commitment on state, county and local levels (including no long-range staff and funding appropriations) is a major obstacle to cohesive, pro-active public education and public participation efforts. The types of temporary educational programs now in place to protect watersheds must be continued, expanded and integrated with other programs while new revenue sources for future programs are cultivated or created at the local watershed-basin level.

As the EPA emphasizes in Nonpoint Sources: Agenda For The Future:

> The first hurdle we face is lack of understanding. The general public simply does not recognize that there is an extremely important connection between individual activities, land use practices and local water quality. The key is to make people understand that they "own the problem" and that their individual and collective efforts can make a difference.

Informed and active public participation in watershed management activities will improve the quality of governmental decisions. From designating watershed-sensitive lands to implementing buffer strips, dual-purpose detention basins, storm water management districts, best management practices and on-site wastewater management entities, public education and participation is needed to involve residents in protecting, supporting and taking ownership of their local water resources.

VII. Recommendations

1. The NJDEP Division of Water Resources should encourage and gradually mandate long-term, watershed-based public education/participation programs.

Due to the diffuse, complex nature of existing and potential pollution sources that may affect a watershed, a long-term outreach effort is critical to

increasing public awareness, understanding, involvement, and support to control those sources degrading the water. Modifying public attitudes and behavior to reduce/prevent activities and land uses that will create pollution requires a long-term, pro-active, and highly visible outreach strategy. Reversing years of neglect requires a long-term public education/participation commitment.

2. The NJDEP Division of Water Resources should designate a specific local or regional entity to disseminate watershed information/data to the area's residents, as well as provide citizen feedback to the agency.

By formalizing ties to an already existing, credible local entity, the Division of Water Resources will multiply the effectiveness and reach of its public education/participation initiatives. Local networking may also diffuse agency program information faster and cheaper than traditional channels (i.e., newsletters, public meetings, advisory groups, hotlines, news releases).

3. The NJDEP Division of Water Resources should establish short- and long-term public education/participation goals for each watershed management plan implemented under its approval.

Short- and long-term goals are a critical element of the seven programs examined. These goals may range from developing a pro-active, holistic approach to education in high priority watersheds to integrating representative interest group concerns into management of the watershed. Guidelines and procedures for developing and implementing these goals should also be promulgated.

4. The NJDEP Division of Water Resources should require a watershed education plan to be developed jointly by the municipalities and county(ies) affected, with mandated public input requirements.

By making residents in the watershed aware that a specific body of water is affected by activities that involve a range of local and political jurisdictions through both the county and municipal planning processes, the education plan that evolves will be able to build on an enhanced level of citizen concern for

and understanding of watershed management and protection.

5. The NJDEP Division of Water Resources should establish a stable source of funding or mandate watershed-based funding "options" that will enable the regional entity (previously designated under Recommendation 2) to sustain the public education/participation program over the long term.

Without a dedicated, stable source of revenue, the public education/participation program may be eliminated when federal/state program funding levels fluctuate or political priorities intervene. An ongoing, regional outreach effort complements all components of a watershed management strategy from targeting specific nonpoint/point pollution sources to enforcement of existing water-quality regulations.

6. Representatives of the municipal enforcement/government agencies (i.e. police, fire, public works, parks) should be made aware of watershed management techniques through DEP-initiated and sponsored workshops.

With proper training, municipal employees should be able to report on existing or suspected point and nonpoint pollution sources in the local watershed area. Local employees are also often a visible, accessible source of information (especially police and fire personnel) in the local community. A booklet from Rutgers Cooperative Extension, The Role of Police In Environmental Protection, Extension Bulletin 420, might be consulted for an overview of one public service agency's potential for improving environmental protection locally.

7. The NJDEP Division of Water Resources should develop a policy and designate or create an internal mechanism to coordinate watershed-based outreach initiatives both inside and outside DEP.

Watershed management necessitates continuous coordination and communication among a multiplicity of affected and potentially affected publics. This requires early identification of and contact with these interest groups. A flexible yet mandatory DEP process for distributing educational materials,

expediting information requests and maintaining communication among groups is essential. DEP's Environmental Outreach Program (i.e., Office of Public Participation, Communications and Public Education and Intergovernmental Affairs) might be tapped to develop this institutional networking mechanism.

8. The NJDEP should develop a policy requiring all watershed outreach programs to integrate a two-level outreach approach that includes public education and public participation components.

Effective public participation in watershed management, (including decision- and policy-making and implementation) requires interested and informed publics. The efforts to contact and inform the affected publics must go beyond a newspaper public notice, press release or occasional task force meeting. It must provide the background, history, research, technical regulatory and enforcement data and contacts necessary for the affected audiences to make an independent evaluation of the proposed agency plan, action, policy, regulation or strategy.

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APPENDIX A

LADDER OF CITIZEN PARTICIPATION*

Citizen Power	**Citizens act without communicating with agency**	- canvas and petitioning - lobby; draft legislation - file lawsuits - demonstrations; protests - volunteer environmental groups - citizen investigation - citizen research development and implementation of programs - initiative and referendum
Power-Sharing	**Citizens and agency solve problems**	- data-sharing - 24-hour environmental response team accessible to residents - ombudsman - neighborhood enforcement - funding of citizen groups to hire technical consultants and/or implement projects - citizen oversight and monitoring - meetings called jointly by government and citizen groups - watershed entities run by citizens
Consult 2	**Agency asks citizens for meaningful input and intends to listen**	- citizen training and workshops - opinion polls - cost-sharing - informal meetings - on-going dialogue - some public hearings - hotline; 800 number - focus groups
Consult 1	**Agency asks citizens for limited input and would prefer not to listen**	- most public hearings - most requests for responses to formal proposals - mandated meetings - 'listening' sessions
Inform	**Agency talks; citizens listen**	- posters, ads - some public meetings - press releases, conferences, editorial meetings: newsletters, brochures - slide talks - official warnings

Agency Power	**Agency acts without communicating with citizens**	- permits - regulations - some investigations - legal and enforcement actions - fines

* This ladder has been adapted to more closely represent the variety of agency-citizen interactions occurring over environmental programs, priorities, planning and decision-making.

SUMMARY

George H. Nieswand

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This report contains specific recommendations for watershed management strategies for New Jersey that are intended to help safeguard the continued availability of adequate and safe water supplies for the citizens of the state. The development of these recommendations was guided by a concern for the use of appropriate legal authorizations, institutional structures and educational programs to effect the adoption and implementation of technologically sound and politically feasible intervention strategies that could influence and impact actions and activities within a watershed in order to provide a first line of defense in assuring the sustained availability of safe drinking water and the environmental quality of surface waters for the citizens of the state. The directional goal for these recommendations was a reduction in the exposure of surface waters to polluting land uses, activities, treatments and spill incidents.

The focussed efforts that produced this report were preceded by an extensive review of the existing body of literature on watershed management and practices in New Jersey and other states. Based on this review and an understanding of the New Jersey context that establishes the imperative for the development of effective watershed management strategies for the state, it was decided to concentrate on a selected number of technical issues that were identified as representing key intervention opportunities having the potential for substantial positive impact in protecting surface waters from nonpoint sources of pollution.

As a consequence, the efforts of the study team were organized around eight subject matter chapters:

- Watershed Management Activities in Other States
- Water Supply/Water Quality Sensitive Lands
- Best Management Practices for Watershed Management
- Buffer Strips in Watershed Management
- Dual-Purpose Detention Basins in Watershed Management
- Stormwater Management Districts as a Watershed Management Strategy
- Onsite Wastewater Management Entities as a Watershed Management Strategy
- Public Education and Participation for Watershed Management

Each of these chapters concludes with a series of specific recommendations concerning watershed management strategies for New Jersey.

Summary Recommendations

What follows is a series of summary recommendations accompanied by a listing of the specific recommendations contained in each chapter:

* Considering "Watershed Management Activities in Other States" it is **recommended that an Office of Watershed Management be established within the NJDEP Division of Water Resources to serve as an identifying, focussing, coordinating and spokesman entity for watershed management activity in the state.**

  Specific recommendations:

  1. The NJDEP Division of Water Resources should establish an Office of Watershed Management within the Division of Water Resources.

  2. The NJDEP Division of Water Resources should adopt a management by objective approach to watershed management.

  3. The NJDEP Division of Water Resources should consider a basin approach to the organization of watershed management activities.

* Considering "Water Supply/Water Quality Sensitive Lands" it is **recommended that the NJDEP Division of Water Resources adopt and promulgate a ranking of water supply/water quality sensitive lands to be used in focussing and prioritizing watershed management activities.**

  Specific recommendations:

  1. The NJDEP Division of Water Resources should issue a technical paper on the nature and importance of water supply/water quality sensitive

lands for watershed management.

2. NJDEP Division of Water Resources should adopt and then promulgate a ranking of water supply/water quality sensitive lands, as follows:

3. The NJDEP Division of Water Resources should assume a lead role in delineating all of the land areas in the state with the recommended rankings on maps at a scale of at least 1:24,000 (1 inch to 2,000 feet).

* Considering "Best Management Practices for Watershed Management" it is **recommended that the State of New Jersey require the implementation of urban/suburban and agricultural BMPs on all lands identified as being water supply/water quality sensitive.**

Specific Recommendations:

1. The State of New Jersey should require all municipalities that have water supply/water quality sensitive lands within their jurisdiction to have all development employ the most appropriate BMPs.

2. The NJDEP Division of Water Resources should support an ongoing program to evaluate the effectiveness of existing and emerging BMPs.

3. Serious consideration should be given to the use of multiple and linked BMPs in those areas of the state that rank high in water supply/water quality sensitivity.

4. The NJDEP Division of Water Resources should support a research project on the relationship between agricultural BMPs and their effect on water quality.

5. The State of New Jersey should require municipalities that have farms located within water supply/water quality sensitive lands to adopt ordinances that require BMPs to be employed.

6. Any farm owner who wishes to qualify for farmland assessment should be required to employ BMPs.

7. The NJDEP Division of Water Resources should establish a clearinghouse on technology transfer for all forms of BMPs.

* Considering "Buffer Strips in Watershed Management" it is **recommended that a parameter based model for buffer strip width determination be developed for use in New Jersey, and that in the absence of such a model, buffer strips protecting surface water supplies should be maintained at a minimum of 300 feet from the waters edge.**

Specific recommendations:

1. Buffer strips should be pursued as a watershed management strategy.

2. Buffer strip widths should be derived from a parameter based model.

3. In the absence of a parameter based model, buffer strips protecting surface water supplies should be maintained at a minimum 300 feet from the waters edge.

4. Every effort should be directed toward the preservation of all upland forest buffers; particular conservation emphasis should be placed on those which are contiguous to the stream corridor areas.

5. As opportunities arise for land reclamation, every effort should be made to restore the area to its natural vegetation.

6. Buffer strips for watershed management should be designed and evaluated on a site-specific basis.

* Considering "Dual-Purpose Detention Basins in Watershed Management" it is **recommended that dual-purpose detention basins be included as an integral component of a comprehensive watershed management program recognizing their ability to effectively trap nonpoint source pollutants.**

Specific recommendations:

1. Dual-purpose detention basins should be pursued as an integral component of a comprehensive watershed management program.

2. Dual-purpose detention basins should be designed to minimize and facilitate maintenance requirements. Local governments should be given the authority to perform necessary maintenance on privately owned systems when the owners fail to fulfill their maintenance responsibilities. Maintenance oversight (i.e., periodic on-site inspection) should be rendered by the New Jersey Department of Environmental Protection. Easements guaranteeing access for maintenance and inspection purposes should be required whenever dual-purpose detention basins are located on private land.

3. The autonomous federal, state, and local agencies and professions involved in flood and erosion control, nonpoint source pollution control, land management, and environmental planning should be integrated at both the planning and operational levels.

4. Funding alternatives should be investigated for sustaining on-going research and monitoring of dual-purpose basin performance in New Jersey's watersheds.

5. The detriment to groundwater should be considered in the design and operation of dual-purpose detention basins.

6. The NJDEP Division of Water Resources, should improve its outreach mission as a technology transfer for information, advice, and technical assistance to local communities.

* Considering "Stormwater Management Districts as a Watershed Management Strategy" it is **recommended that the NJDEP Division of Water Resources seriously explore the feasibility of establishing a utility to provide for effective statewide stormwater management.**

Specific recommendations:

1. The NJDEP Division of Water Resources should obtain a legal opinion from the Attorney General's office as to the feasibility of having a stormwater utility operate in New Jersey.

2. The NJDEP Division of Water Resources should explore the possibilities for adopting a regulatory scheme for stormwater management entities.

3. User charges should be directly related to the amount of impervious cover associated with each property owner.

* Considering "Onsite Wastewater Management Entities as a Watershed Management Strategy" it is **recommended that the NJDEP Division of Water Resources explore measures to require that all septic systems in watershed sensitive areas be part of an onsite wastewater management entity and that this be supported by the establishment of an Office for Onsite Wastewater Management Programs within the Division.**

Specific recommendations:

1. The NJDEP Division of Water Resources should move as expeditiously as possible to adopt N.J.A.C. 7:9A-1.1 et seq., Standards for the Construction of Individual Subsurface Sewage Disposal Systems (P.L. 1954, Chapter 199).

2. The NJDEP Division of Water Resources should explore measures to require all septic systems in watershed sensitive areas to be part of an onsite wastewater management entity.

3. The NJDEP Division of Water Resources should endorse and actively promote the concept of management of onsite wastewater-management entities as part of a non-point-source control strategy for watershed management.

4. The NJDEP Division of Water Resources should form an Office for Onsite Wastewater Management Programs within its present structure.

5. The NJDEP Division of Water Resources should take a leadership role in the development of educational programs and materials on operation and maintenance of onsite wastewater disposal systems for statewide dissemination.

6. The NJDEP Division of Water Resources should develop additional programs to address the problem of currently failing onsite systems.

* Considering "Public Education and Participation for Watershed Management" it is **recommended that the NJDEP Division of Water Resources encourage and gradually mandate long-term, watershed based public education/participation programs as an integral part of a comprehensive watershed management program for the state.**

Specific recommendations:

1. The NJDEP Division of Water Resources should encourage and gradually mandate long-term, watershed-based public education/participation programs.

2. The NJDEP Division of Water Resources should designate a specific local or regional entity to disseminate watershed information/data to the area's residents, as well as provide citizen feedback to the agency.

3. The NJDEP Division of Water Resources should establish short- and long-term public education/participation goals for each watershed management plan implemented under its approval.

4. The NJDEP Division of Water Resources should require a watershed education plan to be developed jointly by the municipalities and county(ies) affected, with mandated public input requirements.

5. The NJDEP Division of Water Resources should establish a stable source of funding or mandate watershed-based funding "options" that will enable the regional entity (previously designated under Recommendation 2) to sustain the public education/participation program over the long term.

6. Representatives of the municipal enforcement/government agencies (i.e. police, fire, public works, parks) should be made aware of watershed management techniques through DEP-initiated and sponsored workshops.

7. The NJDEP Division of Water Resources should develop a policy and designate or create an internal mechanism to coordinate watershed-based outreach initiatives both inside and outside DEP.

8. The NJDEP should develop a policy requiring all watershed outreach programs to integrate a two-level outreach approach that includes public education and public participation components.

These recommendations are offered as a means by which New Jersey can continue to effectively move towards its goal of safeguarding the continued availability of adequate and safe water supplies for the citizens of the state.

There Is No Choice

Considering the recent history of land use changes that have taken place in New Jersey, considering the expectations for continued growth and development well into the 21st century, and considering the inherent implications for the condition of the state's watersheds and the quality of the state's waters, the development and implementation of effective watershed management strategies for New Jersey are a must if the continued availability of adequate and safe water supplies is to be safeguarded for present and future generations.

Watershed management on a statewide basis must be supported by policy, law and institutional structure that is comprehensive, well organized, clearly focussed and effectively coordinated. It must be approached and developed as a sustainable priority for the state. There is no choice.