

WHOLE BASIN MANAGEMENT: POLICY IMPLICATIONS FOR DELAWARE

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**Whole Basin Management:
Policy Implications for Delaware**

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EXECUTIVE SUMMARY

In 1996, in an article written for *Outdoor Delaware* (Kinerney, Butch. Fall 1996), the Delaware Department of Natural Resources and Environmental Control (DNREC) recognized the need for a change in its strategy and orientation toward statewide environmental management activities. A new approach, called Whole Basin Management (WBM), is being initiated by DNREC to address environmental problems in terms of their ecological relationships and implications for all media— air, water, and land.

DNREC's initiative closely follows two streams of policy research. These are Integrated Resource Planning and Ecosystem Management. Integrated Resource Management incorporates aspects of social and physical science, as well as industrial and economic interests, into natural resource management plans. Ecosystem Management helps to create management initiatives which are anticipatory rather than reactionary to environmental problems. These approaches can be distinguished from previous strategies in water resource management by the following conditions (MacKenzie, 1996: 7):

- a focus on ecological integrity;
- a perception of the ecosystem as somewhat self-sustaining;
- the use of natural ecological boundaries; and,
- a holistic orientation towards resource management.

Goals of WBM

1. **The efficient use of resources**
2. **Coordination of all government agency activities**
3. **Cooperation between governmental and nongovernmental entities**
4. **Enhanced citizen participation**
5. **Environmentally benign economic goals**
6. **Economically sound environmental goals**
7. **Cultivation of an environmental ethic.**

WHAT IS INTEGRATED RESOURCE PLANNING AND ECOSYSTEM MANAGEMENT?

Watershed: *a topographically delineated area that is drained by a stream system. They can vary in size from micro-catchments to large river basins.*

Integrated Resource Planning: *the process of formulating and implementing a course of action involving natural and human resources in a watershed, taking into account all the social, political, economic, and institutional factors operating within the watershed, the surrounding basin and relevant regions in order to achieve specific social objectives.*

Ecosystem: *a natural order that includes the interaction of living and non-living parts to produce a stable system.*

Ecosystem Management: *the management of natural resources within the spatial area identified as an ecosystem for meeting human needs. Strategies incorporates an understanding of ecosystem characteristics and the interconnectedness of all living and physical aspects of the resources and its environment.*

There exists a need for this type of comprehensive water resource planning and management as illustrated by the declining health of aquatic ecosystems and the increasing human health threats from polluted water supplies. Whole-Basin Management (often called watershed management) is emerging (or re-emerging) as a synthesis of Ecosystem Management and Integrated Resource Planning. It is heralded as a proactive approach to solving the multiple, and complex environmental problems which reveal themselves through water resource degradation and contamination. Unfortunately, several barriers to WBM exist. These are (Caldwell: 1988, 2):

- a general lack of understanding of ecosystem concepts and the ecological perspective;
- priority given to use values over environmental values;
- localized and short-term perceptions of environmental responsibility;
- fragmentation of jurisdiction between levels of government, and a lack of coordination between science and governance.

A coordinated operational policy is needed to address these barriers. This policy must provide a long-term perspective to the approach and a basis for coordinated institutional action to support implementation.

Finally, the implementation of WBM requires successful performance of four concurrent tasks (Caldwell: 1988, 17):

1. Assessment of the environmental conditions of the system;
2. Development of the scientific or technical means of solving the problems discovered in the assessment;
3. Analysis of the legal and institutional impediments to implementation;
4. Building of constituency and popular support for WBM implementation.

Further, current institutions are not organized to take living systems into account and therefore need to change. The size, complexity, and novelty of the management task implied in WBM requires flexible and expandable institutional arrangements that enable experience and scientific advances to contribute to effective governance (Caldwell: 1988).

Realizing WBM will be a challenge for Delaware, the benefit of comprehensive improvement in environmental quality makes a strong state effort worthwhile.

Environmental Management in Delaware

According to the Department of Natural Resources and Environmental Control (DNREC), 66% of the rivers and streams in Delaware do not support swimming use, while 29% do not support fish and wildlife use. Accumulated pollutants and enriched nutrients are also major concerns since a variety of pollutants washed from the land and the air deposit in water.

In the past 10-15 years, it has been repeatedly recognized in Delaware that environmental management must adopt an ecosystem perspective. The “Delaware Environmental Legacy Report of 1988” recognized the need to “devise a system capable of formulating policy that will prevent environmental degradation rather than react to it.” It called for a “Holistic Approach to Environmental Management” (Delaware’s Environmental Legacy: 1988, 158). Since the 1988 report was published, several watershed programs have been launched in the state. A few seek to address watersheds holistically.

Existing Watershed Programs in Delaware

(1) The Governor’s Task Force on the Future of the Brandywine and Christina Rivers

This task force was convened by Governor Castle in 1992, and reconvened by Governor Carper in 1994, to create a vision and implementation plan for the rivers. Much of the 1994 report targets environmental issues, however, the implementation plan of 1995 focuses on the economic development of the Wilmington waterfront and the establishment of the Delaware Riverfront Development Corporation. The plan seems to have lost most of its original environmental focus.

(2) The Christina River Basin Water Resource Management Committee

In 1994, The Delaware River and Basin Commission, concerned with the lack of coordination of water quality management policies between Delaware and Pennsylvania, established a voluntary, bi-state committee for water resource management on the Christina River basin. This program is addressing the interactions between land use and water quality.

(3) Delaware Estuary Program

At the request of the governors of Delaware, Pennsylvania, and New Jersey, the Delaware Estuary was admitted into the National Estuary Program, in 1988.

(4) The Delaware Inland Bays National Estuary Program (NEP)

The Inland Bays Estuary Program was established to address the dilemmas facing these interconnected estuaries. In 1994, Governor Carper and the U.S. EPA accepted the Inland Bays Program incorporating it into the NEP.

Delaware's Whole Basin Management Program

Whole Basin Management (WBM) is DNREC's new ecosystem management approach to tackling Delaware's complex environmental dilemmas. It aims for better coordination and efficiency in management activities of agencies working in each watershed.

The WBM strategy divides the state into five basins encompassing the state's 41 watersheds. Staff members from each DNREC division form a team to assess, monitor, and develop a five year, eight phase implementation plan for each basin. Early phases involve basin planning, assessment, and monitoring. Below is a review of public participation, comprehensive analyses of issues, evaluation of management options, development of resource protection strategies, and implementation of the final plans. This process has already commenced in the state's Northern Piedmont Basin, which was designated the highest priority basin. The Chesapeake and other basins will be addressed later.

DNREC hopes to achieve success in dealing with Delaware's environmental dilemmas by eliminating redundancy and without a vast infusion of additional resources. The draft plan promises that WBM will be effective in coordinating the management activities and permitting processes of the Department's five divisions. Much of this effectiveness stems from the efforts at improved information sharing among divisions. These measures should aid the progress of WBM.

Through this approach, management activities and permits can be tracked and monitored along watershed lines, and their effects can be measured in relation to one another. Integration of all management activities, however, continues to present a problem. Many environmental programs managed by DNREC land and water divisions show reasonable potential for coordination, but coordination between "air" and "water", and "air" and "land", is more difficult. Another concern about the WBM plan is its failure to address issues of policy fragmentation between levels of government. WBM is only the first step toward an ecosystem approach. If WBM is performed in concert with Growth Management, its potential effect is greatly increased.

State by State Review of Watershed/Ecosystem Management Programs

Many states and localities in the U.S. are experimenting with integrated watershed and ecosystem management. Some represent successful models born of experience, experimentation, cooperation and determination. Others are just beginning the process of implementing comprehensive management plans.

WBM Programs in Florida, Maryland, Massachusetts/New Hampshire, New Jersey, North Carolina, Pennsylvania, Washington, and Wisconsin are described in Section III of this report. These eight Whole Basin Management programs are reviewed to assist Delaware in organizing an effective program. Each of the states' watershed management activities were analyzed for seven key elements: the focus of the program, the goals set; the legal and institutional structures in place; the timing, mode and quality of participation of stakeholders; interagency coordination; environmental indicators used; and the program strengths and achievements. (See Table 2 of this report for a summary of the findings.)

Recommendations for Delaware's WBM Program

Environmental sustainability can be achieved through the use of WBM to support the state's economy and quality of life. But new policies and processes may be needed to fully realize the goal of sustainability. Through an analysis of Delaware's past and current policies in this direction and an in-depth review of the WBM programs and experiences in eight pioneering states, we are able to offer the following recommendations.

- 1. Coordination of environmental management plans among all government agencies is essential to successful WBM. This requires:**
 - a. Establishing interagency meetings with the intent to coordinate agency missions;
 - b. Establishing data collection, sharing and management standards, and protocols between all agencies;
 - c. Encouraging flexibility in program management;
 - d. Expanding Whole-Basin Teams to include representatives of stakeholders in each basin;
 - e. Developing Geographic Information Systems (GIS) capabilities to assess land use, water-quality, habitat analyses, etc.;
 - f. Creating a forum for coordination, conflict resolution and consensus for each basin team.
- 2. A statewide environmental awareness program is needed to promote the concept of Whole-Basin Management throughout the public, private, and non-profit sectors.**
- 3. Statewide environmental indicators are a valuable tool to provide the basis for comprehensive assessment of the state's environmental strengths and weaknesses.**

4. Leadership from the Governor and Legislature is needed to encourage coordination of environmental management activities throughout the state.

I. Introduction

The Delaware Department of Natural Resources and Environmental Control (DNREC) has adopted a Whole Basin Management (WBM) Framework for its State-wide management activities. This approach deviates from conventional DNREC efforts which are organized around administrative and political boundaries. The frame of reference now shifts to river basins, their constituent sub-basins, and further divisions of watersheds. The resulting environmental management boundaries differ from those defined by growth patterns and administrative acts.

In 1996, in an article written for “Outdoor Delaware” (Kinerney, Butch. Fall 1996), titled: “Oh How They Can Harmonize”, the department recognized the need for a change in its strategy and orientation because its staff discovered inefficiencies in its methods of permitting and enforcement. A variety of associated reasons also appear to have motivated this change.

Water undergirds the natural environment. Therefore the watershed is an obvious geographical basis for policies directed to conserve the environment while maintaining the quality of life for human beings who rely on its preservation. DNREC’s proposed strategy reflects the emphasis of the Environmental Protection Agency (EPA) and of several environmental action groups at national, state, and local levels, that is, environmental conservation. A recent change in the roles of the EPA and state environmental agencies is also responsible for DNREC’s move toward setting forth state environmental priorities and taking remedial action to address them.

WHAT IS INTEGRATED RESOURCE PLANNING AND ECOSYSTEM MANAGEMENT?

Watershed: a topographically delineated area that is drained by a stream system. They can vary in size from micro-catchments to large river basins.

Integrated Resource Planning: the process of formulating and implementing a course of action involving natural and human resources in a watershed, taking into account all the social, political, economic, and institutional factors operating within the watershed, the surrounding basin and relevant regions in order to achieve specific social objectives.

Ecosystem: a natural order that includes the interaction of living and non-living parts to produce a stable system.

Ecosystem Management: the management of natural resources within the spatial area identified as an ecosystem for meeting human needs. Strategies incorporates an understanding of ecosystem characteristics and the interconnectedness of all living and physical aspects of the resources and its environment.

The watershed approach has been the standard in the management of water resources for the last three decades. Notwithstanding, there exists a need for comprehensive water resource planning and management as illustrated by the declining health of aquatic ecosystems and the increasing human health threats from polluted water supplies. Watershed management is re-emerging as a synthesis of ecosystem management and integrated resource planning. In the 1970's an ecosystem approach was advanced to reconcile urban development with environmental responsibility (Smith, 1972). This approach has now evolved into an anticipatory, proactive approach to solving the multiple and complex environmental problems which reveal themselves through water resource degradation and contamination.

An ecosystem approach to watershed management includes principles not commonly addressed in traditional policy approaches. In the context of a watershed determined by surface flows, the ecosystem approach includes all relevant relationships within and from outside the watershed boundaries (Caldwell: 1988). A fundamental problem is that living systems are more than the sum of their parts. Current institutions are not organized to take this into account and therefore need to change. The size, complexity, and novelty of the management task implied in an ecosystem approach requires flexible and expandable institutional arrangements that enable experience and scientific advances to contribute to effective governance (Caldwell: 1988).

The purpose of this report is to analyze watershed and ecosystem programs in 8 states and provide recommendations to the Delaware General Assembly on the potential for implementation of DNREC's Whole Basin Management Plan. Watershed plans like WBM are now receiving more attention and increased funding nationwide. Since Delaware is currently in the early stages of plan development, this is a prudent time to learn from the experience of other states.

II. Objectives of Whole Basin Management

Watershed management initiatives, like WBM seek to address environmental problems in terms of their ecological relationships and their implications for air, water, and land. However, several obstacles must be overcome to achieve improved environmental quality in this comprehensive manner. The Delaware Department of Natural Resources and Environmental Control is refocusing the management efforts of its five divisions (Air and Waste Management; Fish and Wildlife; Parks and Recreation; Soil and Water; and Water Resources) toward programmatic integration. DNREC hopes to achieve this by (Draft Plan: 1996):

WHAT IS WHOLE-BASIN MANAGEMENT?

Whole Basin Management involves the monitoring, assessing and managing of all biological, chemical and physical environments in areas on the basis of drainage patterns. The objectives of this type of approach are to improve relations, maximize resource usage, enhance coordination, promote public outreach and interaction, and integrate efforts within and outside the governmental units, to the maximum extent practicable, when evaluating any given basin.

1. Comprehensively identifying problems that affect a single basin or watershed;
2. Enhancing coordination within the department after evaluating and combining the goals, needs, constraints, and practices of its five divisions ;
3. Improving relations within the department and its divisions;
4. Integrating the efforts of State agencies, interstate agencies, and local governments;
5. Increasing public outreach and interaction.

DNREC's initiative closely follows two streams of policy research. These are Integrated Resource Management and the Ecosystem Approach. Integrated Resource Management incorporates aspects of social and physical science, as well as industrial and economic interests, into natural resource management plans. The Ecosystem Approach to environmental problems helps to create management initiatives, which are anticipatory rather than reactionary. It places humans within the biotic system and acknowledges their dependence upon it. Most previous policies assume a separation of humans from nature (Caldwell: 1988, 11). Though these approaches may cause public leaders to act against the interests of local and bureaucratic officials, failure to take such an approach ultimately holds those public leaders accountable for a decline in environmental health. These approaches can be distinguished from previous strategies in water resource management by the following conditions:

- a focus on ecological integrity;
- a perception of the ecosystem as somewhat self-sustaining;
- the use of natural ecological boundaries;
- a holistic orientation towards resource management;

(MacKenzie: 1996, 7)

These conditions respond to the need for integration of environmental management to address environmental problems comprehensively, rather than dividing them into media-specific programs. They make use of the increasing body of scientific evidence which shows connectivity between all media within the natural environment. Finally, they address the effect of human impact upon any ecosystem and its potential to disrupt the functioning of that system. Watershed programs place agencies closer to achieving goals of sustainability, which are increasingly advocated by researchers, academia, and even federal funding programs.

A. Concept of Sustainable Development

The concept of sustainable development, advocated in the report of the World Commission on Environment and Development (WCED, 1987), was regarded as a major theme in the United Nations Conference on Environment and Development in Rio de Janeiro, 1992. Although broadly discussed, no agreement was reached on a definition of sustainable development beyond or better than the one in WCED report—“development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

Policy Objectives of Sustainable Development (WCED)

1. Reviving growth
2. Changing the quality of growth
3. Meeting essential needs for jobs, food, energy, water, and sanitation
4. Ensuring a sustainable level of population
5. Conserving and enhancing the resource base
6. Reorienting technology and managing risk
7. Merging environment and economics in decision making

An important aspect of this concept is the inclusion of a concern for future generations within the present process of development. It aims to reach a balance between environmental protection and economic development in a sustainable manner; it involves the continuing supply of resource for future generations; it requires the promotion of values that encourage consumption standards that are within the bounds of the ecological possible and to which all can reasonably aspire; and it demands the conservation and enhancement the natural resource base.

Integrated Water Resource Management

In addition, the concept of sustainable development stresses the integrated approach to the management and the planning of natural resources. Such integration should take into account all socio-economic as well as environmental factors in order to maximize sustainable productivity and use. Accordingly water should be regarded as an integral part of the ecosystem. Thus, integrated watershed management should incorporate social, economic, and environmental considerations as well as long-term planning needs based on the principle of sustainability. By examining all uses of watershed in an integrated manner, it helps to minimize conflicts and makes sustainable development possible.

Institutional Structures/Mechanism

Capacity-building is a prerequisite to an integrated approach to resource management. It is apparent that technical solutions alone will not be enough to fulfill the goals without considering the importance of capacity-building for integrated and sustainable development of resource management. Such capacity-building should at least include the following four elements:

- Creating an enabling environment with appropriate policy and legal frameworks;
- Institutional strengthening and development, including local community participation;
- Human resources development, including the strengthening of material systems and water use interests;
- Awareness building and education at all levels of society.

In addition, such integrated management planning should result from a participatory dialogue of major stakeholders.

B. Indicators of Sustainable Development

Indicators of sustainable development are important because they can present information on the state of the environment. Also, based on such information, the progress of sustainable development can be monitored and measured. However, gross national product (GDP), which has long been used as measurement of the progress of a country, is not an adequate indicator of sustainability since the GDP does not take into account the exhaustion of natural resources, and the degradation of the environment. Thus, the development of indicators of sustainable development is urgently needed to provide solid-base information for decision making.

Table 1: Selection Criteria for Environmental Indications

The choice of indicators for state of the environment reporting will be guided by the following criteria:

- 1. Serve as a robust indicator of environmental change**
- 2. Reflect a fundamental or highly valued aspect of the environment**
- 3. Be either national in scope or applicable to regional environmental issues of national significance**
- 4. Provide an early warning of potential problems**
- 5. Be capable of being monitored to provide statistically verifiable and reproducible**
- 6. Data that show trends over time and, preferably, apply to a broad range of environmental regions**
- 7. Be scientifically credible**
- 8. Be easy to understand**
- 9. Be monitored regularly with relative ease**
- 10. Be cost-effective**
- 11. Be as aggregative as possible (that is, amenable to combination with other indicators to produce more general information about environmental conditions)**
- 12. Have relevance to policy and management needs**
- 13. Contribute to monitoring of progress towards implementing commitments in nationally significant environmental policies**
- 14. Where possible and appropriate, facilitate community involvement**
- 15. Contribute to the fulfillment of reporting obligations under international agreements**
- 16. Where possible and appropriate, use existing commercial and managerial indicators**
- 17. Where possible and appropriate, be consistent and comparable with other countries and state and territory indicators**

III. State-by-State Review of Watershed/Ecosystem Management Programs

Many states and localities in the U.S. are experimenting with watershed and ecosystem management. Three states, Maryland, Florida, and North Carolina, stand out because of their state-wide coordinated efforts. These programs are well known and effective. They represent successful models born of experience, experimentation, cooperation and determination.

Most states though, are just beginning the process of implementing comprehensive management plans. In six states, Pennsylvania, New Jersey, Massachusetts / New Hampshire, Washington, and Wisconsin, local initiatives, cross-boundary initiatives and agency re-organization initiatives are examined for the lessons they offer to Delaware's program.

As indicated previously, the eight programs reviewed here were analyzed for seven key elements: the focus of the program, the goals set; the legal and institutional structures in place; the timing, mode and quality of participation of stakeholders; interagency coordination; environmental indicators used; and the program strengths and achievements. Finally, with each program any relevance for Delaware's WBM plan is reviewed (Table 2).

Why does Delaware need to coordinate plans with its border states?

Since Delaware is a small state, many of its environmental problems originate from sources in its neighboring states.

In order for DNREC to successfully tackle the issues concerning the Christina River Basin, the Delaware Estuary, the Inland Bays, and its share of the Chesapeake watershed, it should start to compliment the environmental efforts in Maryland, New Jersey, and Pennsylvania. For this reason, these three states are examined in the study.

Table 2: Comparison of State Watershed/Ecosystem Management Programs

STATE	Focus of Program	Goals set	Legislative/ Institutional Structures	Quality of Participation Among Stakeholders	Interagency Coordination	Established Environmental Indicator System	Programs Strengths and Achievements	Lessons for Delaware
Florida	Administrative Reorganization	Diffuse	Based on State Legislation	High Involvement	Considerable Coordination (State, Local)	NO	Significant Organizational Accomplishments	Useful Organizational Model
Maryland	Environmental Issue Based (Chesapeake Bay)	Specific	Based on Federal and State Legislation	High Involvement	Considerable Coordination (Federal, State, Local)	YES	Significant Organizational and Environmental Accomplishments	Useful as an Organizational and Ecosystem Management Model; Also as a Border State, its Programs should be Examined
Mass./ N.H.	Environmental Issue Based (Merrimack River)	Specific	Voluntary Cooperation (Federal, State, Local)	Moderate Level of Involvement	Fragmented	NO	Program Still in Development	Model for Public Involvement Process
New Jersey	Environmental Issue Based (Wallkill River)	Diffuse	Voluntary Cooperation (Federal and State)	Little Involvement	Some Coordination (Federal and State)	YES	Program Still in Development	As a Border State, its Program should be Examined
North Carolina	Administrative Reorganization	Diffuse	Based on Federal and State Legislation	Moderate Level of Involvement	Considerable Coordination (Federal and State)	YES	Program Still in Early Phases	Useful Organizational Model
Pennsylvania	Administrative Reorganization	Specific	Voluntary Cooperation (State and Local)	Moderate Level of Involvement	Fragmented with Some state guidance	NO	Program Still in Early Phases	As a Border State, its Programs should be Examined
Washington	Environmental Issue Based (Puget Sound)	Specific	Based on Federal and State Legislation (Federal, State, Local)	Moderate Level of Involvement	Considerable Coordination (Federal, State, Local)	YES	Significant Organizational Accomplishments	Useful as an Organizational and Ecosystem Management Model

Wisconsin	Administrative Reorganization	Diffuse	Voluntary Cooperation (State and Local)	Currently Developing an Outreach Program	Currently Fragmented	NO	Program Still in Early Phases	Useful, and Still Developing Organizational Model
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A. Maryland: “Tributary Strategy to restore the Chesapeake Bay”

1) Focus of Program

The restoration of the Chesapeake Bay is a joint effort undertaken by Maryland, Virginia, Pennsylvania, and the District of Columbia. It commenced in 1983, when the Governors of Virginia, Pennsylvania, and Maryland, and the mayor of the District of Columbia signed the Chesapeake Bay Agreement committing their jurisdictions to work cooperatively to clean up the Bay. For the state of Maryland, it is the most important environmental initiative ever undertaken, since nearly 95% of the state’s land area drain into the estuary.

2) Goals set

The unifying goal of the Chesapeake Bay Cleanup program is a 40% reduction of nutrients, primarily nitrogen and phosphorus, into the estuary, from 1985 levels, by 2000. These nutrients seriously degrade the ecology of the bay, by encouraging the growth of algae blooms. These blooms deplete the bay of oxygen, causing a state of hypoxia, which in turn disrupts the ecological balance of the estuary. As a result of the 1992 Amendment to the Bay Agreement, nutrient reduction targets were allocated among the states. Based on these allocations, Maryland must reduce nitrogen and phosphorus loads entering the Bay by 22.7 and 2.11 million pounds , respectively, per year by 2000.

3) Legal/Institutional Structures

- *Maryland Tributary Strategies*

The Maryland program is the joint effort of the state Departments of the Environment, Natural Resources, Agriculture, and Office of Planning, and the Chesapeake Bay and Watershed Management Administration. The Department of Natural Resources is the lead agency for this initiative. The first step in developing strategies was to divide the state into ten tributaries. These tributaries are defined by watershed patterns, not political boudaries. Some encompass as many as four counties, or parts of counties. Once the ten tributaries were defined, the state established “Tributary Teams”. Each state agency was then required to provide direct assistance in terms of staff support, to at least two of the ten Tributary Teams.

In addition, Maryland has established a complex infrastructure to support the state’s Tributary effort involving modeling, monitoring, and tracking progress.

- *Chesapeake Bay Program*

The Chesapeake Bay Program is a unique regional partnership working on the restoration of the Chesapeake Bay since 1983. The Bay Program partners include the states of Maryland, Virginia, Pennsylvania, and the District of Columbia; the Chesapeake Bay Commission, a tri-state legislative body; the EPA; and advisory groups.

The Chesapeake Bay Program's highest priority has been the restoration of the Bay's living resources. In the 1987 Agreement, the Chesapeake Bay Program partners set the goal to reduce nutrient levels by 40% from 1985 levels by the year 2000.

In the 1992 Amendments, the partners agreed to set a cap at the 2000 nutrient levels, and to attack the nutrients at their source, upstream tributaries. Consequently, Maryland, Virginia, Pennsylvania, and Washington, D.C. began developing their tributary strategies.

Maryland developed its own Chesapeake Bay Partnership Agreement in 1993. All 23 counties, the City of Baltimore, and the state were included. This Partnership Agreement outlines the tributary strategy and confirms a pledge for success by all participants.

Maryland has many progressive environmental laws which lend support to the program. Foremost is the Critical Area Law. It requires vegetative buffer zones and severely restricts development in areas immediately surrounding the Bay. Also, Maryland has a 1992 Economic Growth, Resource Protection, and Planning Act which emphasizes the importance of watershed planning and the protection of streams through forest and grass buffers.

4) Timing, Mode and Quality of Participation

In 1993, at the beginning of the tributary strategy process, the state was divided into ten tributary basins, and three public meetings were held to discuss the strategies in each tributary. During a two year series of "give and take" meetings, citizens commented on the process for developing the strategies. They discussed point, and nonpoint, source control options to be included in the strategies, and how the options should be implemented. The public input was heavily weighted in all phases of plan development and helped to ensure that the strategies were workable, fair, cost-effective, and recognized the environmental priorities of the citizens and local governments in each watershed. The Tributary Teams were made up of local officials, industry, environmental groups, citizens, and state officials. The objective of these Teams was to jointly identify the problems found in each tributary, and evaluate the best strategy for achieving the mandated reductions.

Once the 40% nutrient reduction goal is met, it is to be capped. Thus future growth and development must be managed in a way that does not cause additional nutrient pollution. This will require ongoing commitment and communication with all local interests, as well as the development of new technologies and growth management options.

One of the greatest concerns to the Tributary Teams is the available funding for strategy implementation. While much funding is available from federal, state, and county programs (especially for agricultural programs), and the Department's Water Quality Revolving Loan Fund, there is still a need for additional funding. In 1994, a "Blue Ribbon Panel" of financial experts from the investment community, academia, governmental agencies and private interests (farmers and developers), convened to prepare a report identifying funding options and potential private sector support for strategy implementation. Some of the recommendations included:

- an annual fee on septic systems;
- new bonding authority to provide low interest loans for Bay-related projects;
- sophisticated lease-back arrangements on municipal sewage treatment assets.

5) Interagency Coordination

Since the design of the tributary strategy is to include governmental and non-governmental representatives on the tributary teams, coordination is accomplished through reaching consensus on important issues. Members of the teams are appointed by the Governor and include representatives from counties, towns, agriculture, environment, business, and industry. These tributary teams have been asked by the Department of the Natural Resources to:

- develop and revise implementation plans to reach nutrient reduction goals;
- identify barriers to implementation and recommend how to overcome them;
- coordinate implementation across the broadest range of stakeholders;
- monitor implementation and track progress;
- involve and educate the public;
- review progress and ensure that it is going forward in a fair and flexible way.

6) Environmental Indicators

Living resources will serve as indicators of improvements in environmental quality. The program has already set quantitative targets for the restoration of Bay grasses as a primary indicator of improving water quality. Other indicators, such as an "index of biotic integrity" are being developed for upstream areas. Fish surveys may help to indicate overall ecosystem health.

7) Program Strengths and Achievements

The Chesapeake Bay Program is founded in state law. This has allowed it to overcome legal entanglements, and it is bolstered by the Critical Area Law, the 1992 Economic Growth, Resource Protection, and Planning Act, and other environmentally progressive laws.

The Tributary Strategy's emphasis on local participation allows innovation. Appropriate plans may then be tailored to each tributary's unique condition, while simultaneously accomplishing the state's goals for the estuary.

As of 1996, nitrogen levels in water have decreased by 23% and phosphorous levels in water have diminished by 38%. These gains owe much to a ban on phosphates in detergents, upgrades to wastewater treatment plants, and improved nutrient management practices on agricultural land. The Chesapeake Bay Program is still a long way from attaining its goals for the estuary. There remain deficiencies in the state's ability to effectively orchestrate management. Nevertheless, the progress made by the state of Maryland in facilitating cooperation among various state agencies, local governments, and the public, has been impressive.

8) Lessons for Delaware

Maryland, owing to its Chesapeake Bay policies, is regarded as a leader in ecosystem management nationwide. Its programs recognize the need to address issues of land-use, growth, and development concurrently in order to ensure a healthy and sustainable Chesapeake Bay for future generations, this in turn sustains Maryland's vitality. It also recognizes the need to involve and bring together its citizens, business leaders, and community leaders for the rehabilitation of its valuable resource. If the vitality of Delaware's resources are to also be sustained in the face of rapid growth, Maryland's example of integrated ecosystem management should be examined to foster the best policies for the changing environment.

B. Florida: “Ecosystem Management” and “Comprehensive Surface Water Management”

1) Focus of Program

The Florida Department of Environmental Protection (DEP) responded to an environmental paradigm change reflected in the EPA’s endorsement of “Ecosystem Management” by developing its own ecosystem program. The program reflects the growing awareness that resource managers need to look at entire systems in order to preserve parts of them. The state “Ecosystem Management Initiative” provides the overarching focus to watershed management programs in the state. The aim of the program is to coordinate DEP activities with those of sister agencies and private parties thus encouraging the development of citizen-government partnerships.

The Southwest Florida Water Management District is an active participant in the state initiative and is applying the ecosystem management approach at the watershed level.

2) Goals Set

The goals of the Ecosystem Management Initiative are:

- **Place-Based Management:** to organize management activities in Ecosystem Management Areas so that they are focused on the natural system rather than on individual media (air, water, etc.)
- **Common Sense Regulation:** to implement flexible alternatives to the traditional regulatory process.
- **Cultural Change:** to improve public-government interaction and promote stewardship of the environment as a cultural value.
- **Capacity Building:** to develop the tools and resources necessary to the implementation of ecosystem management.

The goals of the Comprehensive Surface Water Management are:

- To identify and prioritize existing and potential surface water issues within the Water District relating to water quality, flooding, water supply and natural systems.
- To develop strategies for remedial or protective actions to address the surface water issues identified in goal #1.
- To implement the strategies in goal #2 and monitor their effectiveness.

3) Legal/Institutional Structures

In addition to federal policies regarding water management, Florida has a State Water Policy (1993-62(17)-40, FAC) which sets the policy and program mandates for a variety of surface water management activities, including management goals and pollution reduction goals. Watershed programs in Florida are administered by special water districts. These districts are regional bodies which interact with both local and state-level agencies. The districts have taxing authority and their budgets are approved by the Governor.

Under the State Water Policy, the Water Districts developed 20 year comprehensive plans covering their regions and missions. The Southwest Water Management District developed the Comprehensive Surface Water Management Plan (CSWM). This plan outlines the Water District's contribution to ecosystem management.

The state ecosystem initiative actively incorporates representatives from all levels of government as well as diverse industry and citizen groups into Ecosystem Management Teams. The teams work to ensure coordinated activities between stakeholders. The pilot project of the Ecosystem Management Initiative is the Hillsborough River and Bay Ecosystem Demonstration Project, which was authorized by legislation introduced at the Governor's request.

Also important is the state's Comprehensive Growth Management Plan. Each county regulates land use within their boundaries, but it must be in accord with the state-approved comprehensive plan. Development is recognized as a key factor in watershed protection, especially for flood control in Florida. More information on this plan can be found in the 1996 SET Report: "Growth Management in Delaware: Planning for Delaware's Future."

4) Timing, Mode and Quality of Participation

The watershed management program, CSWM, was developed to complement the state ecosystem plan, therefore its pilot project builds from the Hillsborough River Watershed. In both projects, the district and state workgroups share staff so that data collection, analyses, and interpretation for the projects will be coordinated and complementary. This helps ensure that both projects are effective and efficient. Additionally, there is a Hillsborough River Greenways Task Force. This is an active coalition of public and private agencies and organizations dedicated to developing solutions, and facilitating action plans to address issues of concern. This task force was in place and operating well before implementation of ecosystem management had begun. Its participants representing business, government and citizen interests. The task force developed a consensus-driven process for cooperative action and its members had experience serving on state-level ecosystem management committees. The state, recognizing the value of this participation, cited the task force as a leading factor in selecting the Hillsborough River as the ecosystem demonstration pilot site.

The Task Force promotes several initiatives which have been included in the Hillsborough River Watershed Draft Plan including:

- The creation of an Integrated Linear Infrastructure Plan which would develop common corridors for transportation, communication and utilities so that land-use planning will be done on an ecosystem scale;
- The creation of a continuous corridor, including contiguous buffer areas, of integrated upland and wetland habitats for wildlife, to improve water quality and quantity, and to provide areas for recreational use;
- Restoration and/or enhancement of habitat associated with existing and proposed land uses to improve the overall function of the corridors;
- Development of ecologically sustainable water supply options.

The state and water district plan works with land protection agencies such as the Nature Conservancy, the Trust for Public Lands, and the Florida Communities Trust. This is done to coordinate land purchases in environmentally strategic and significant areas. This effort is supported by “Preservation 2000”, a 10 year, \$3 billion land acquisition program approved by the Florida legislature in 1990. This program strengthens land acquisition programs by forging partnerships with public and private agencies and makes funds available for land acquisition and conservation purposes.

Other participants in the management activities on the Hillsborough River Watershed include the Tampa Bay National Estuary Program and the Hillsborough Interlocal River Planning Board, the latter created by a special act of the Legislature.

All stakeholders in the watershed participate on the Ecosystem Management Implementation Strategy teams, and efforts are made by the teams to integrate and complement, rather than duplicate, the existing initiatives of participating agencies.

5) Interagency Coordination

In Florida, there has been a statewide water planning effort in progress for over two years. This effort included several convention meetings between the five water management districts and the state DEP, in order to achieve consistent statewide definitions, modeling techniques, and other ways of doing business. It also examined why standardization is not possible for a variety of water-related issues. It was recognized that staff sharing helps to coordinate efforts between the state and the district on ecosystem projects. Also, efforts are being made towards cooperative funding proposals and projects.

In the case of the Hillsborough River Watershed, the state DEP plays the lead role in regulation of the water quality, but has delegated stormwater management, water use permitting, and environmental permitting to the district. Also, the county government of Hillsborough County, assumes some of the permitting responsibility of the state. In addition, the Tampa Bay is a part of the National Estuary Program (NEP), so there are federal interests involved as well. The NEP is not designated for “permanent” support by the EPA and implementation of the program is driven by local stakeholders.

In developing an ecosystem management plan for the Hillsborough River Watershed, the Hillsborough River Greenways Task Force prepared a Coordinated Conservation Plan for land protection in the basin. However, Florida’s DEP has recommended the National Estuary Program as the lead agency in development of the ecosystem plan due to their more extensive experience in evaluating the area.

The ecosystem management teams work on a voluntary consensus basis.

6) Environmental Indicators

The state Ecosystem Management Initiative calls for the development of an indicator system to identify key issues in a particular ecosystem; to quantitatively measure trends and progress; to provide a foundation for the information-based decision making in the ecosystem. No formal indicator system has yet been developed, but general indication of improvements in environmental quality will reflect the identified priority problems on the watershed.

Water quality problems in the Hillsborough River Watershed include nutrients (Nitrogen and Phosphorous), total suspended solids, metals (including mercury, lead and copper), pesticides (agricultural insecticides, herbicides, and fungicides), and bacteria (those which cause gastrointestinal disease in potable water supplies). Most of the concerns lie with nonpoint discharge since there are only 7 NPDES permit holders in the watershed.

Additional indicators may include the amount of land being managed, either publicly or privately, as conservation areas.

7) Program Strengths and Achievements

The Florida Ecosystem Management initiative was selected as a finalist in the Kennedy School of Government (Harvard) *Innovations in American Government* award program. It also received the Editor's Choice award from the Environmental Council of the States.

The program provides for regulatory relief alternatives that achieve better environmental results at less cost; a mechanism for citizens to help solve local environmental problems; integrated environmental program across media; and integrated programs across political and administrative jurisdictions. Two examples of the achievements under this program are: (1) An early project dealing with alternatives to traditional permitting (Berry Corporation permit), was chosen by the EPA as one of the first XL projects in the country. (2) The CF Industries, in another regulatory alternatives project, reduced permitting time from four to two years, saved the company over a million dollars, and produced significantly better results than would have been achieved through traditional permitting.

Currently, over 30 Ecosystem Management Area teams have been established around the state to foster citizen/government partnerships and generate grassroots support and participation in the environmental protection activities at the ecosystem level.

8) Lessons for Delaware

Much of the coordination and action on the Hillsborough Demonstration Project has come from the Task Force. It is a community based organization in which the government participates, but does not play a directing role. The state and water management district have recognized the value of citizen input as a central tenet to successful environmental management. Notable for Delaware is that the ecosystem teams are established for coordination purposes, not for addressing an outstanding environmental problem, as was the case in Maryland. As in Delaware, it is recognized that the coordination of management activities can improve the effectiveness of natural resource planning. However, Florida has recognized the need to involve citizens, businesses and other state agencies in the beginning of the planning process.

C. North Carolina: “Basinwide Approach to Water Quality Management”

1) Focus of Program

The North Carolina Division of Water Quality (formerly the Division of Environmental Management: Water Quality Section), initiated basinwide management planning in 1990. As expressed in the program description, basinwide planning seeks to improve the efficiency and effectiveness of all water quality activities, while ensuring equality and consistency across basins. Overall, the program seeks to reduce the array of water quality problems making them more manageable and defined both geographically and temporally. The over-arching objective of basin-wide management is to implement a fully integrated approach to water quality assessment and management incorporating ecological principles of watershed management including: (1) chemical-specific monitoring and regulations, (2) biocriteria, bioassessments and biosurveys, (3) water quality modeling, (4) whole effluent toxicity permitting and testing, and, (5) compliance and enforcement activities.

2) Goals Set

The program goals are to:

- Identify and restore full use to impaired waters;
- Identify and protect highly valued resource waters;
- Manage problem pollutants within each basin to protect water quality standards while accommodating reasonable economic growth.

3) Legal/Institutional Structures

In compliance with the 1987 Clean Water Act (especially sections 303 and 319), North Carolina developed basinwide planning at the state-level. The program is centrally administered by the North Carolina Division of Environmental Management, Water Quality Section. Additionally, the state has several legislative mandates of its own which direct the North Carolina Environmental Management Commission to develop water supply and quality standards and programs, including the state’s Oil Pollution and Hazardous Substance Control Program.

Institutionally, the program is developed and administered by the state agency through its central, and 7 regional offices. Development of the basinwide management program was conceived and carried out in-house by the Division of Water Quality (DWQ). It was not the result of legislative action.

4) Timing, Mode and Quality of Participation

To begin the process of developing a basinwide plan, the North Carolina DWQ identifies sampling needs and canvasses for information. Information from other agencies, the academic community, and local interest groups may be gathered through informal channels or organized workshops. The information considered necessary includes: economic growth and development in the basin, land use, soils, geology, water needs, uses, and problems, etc. Once, data assessment and model preparation is completed by the DWQ, water quality goals and objectives are determined and a basinwide management plan report is prepared. The draft plan is prepared and distributed to local governments and other interested groups for comment. When the comments are incorporated into the plan, the final draft is submitted to the North Carolina Environmental Management Commission for approval. The plan for a given basin is completed and approved before the scheduled deadline for basinwide permit renewals in that basin. The plans are then evaluated, based on follow-up water quality monitoring, and they are updated at five year intervals.

In the White Oak River Basin, three public workshops were held at different locations in the basin. These were to familiarize stakeholders with the plan and to solicit their comments. The basin has a population of 194,802 and the workshops included 81 participants. Workshops were co-sponsored by the North Carolina Cooperative extension Service, the North Carolina Coastal Federation, the North Carolina Divisions of Coastal Management, and Soil and Water Conservation, the North Carolina Sea Grant College Program Marine Advisory Service and the DWQ. Several priority issues were identified in these workshops and were subsequently incorporated into the plan, with strategies for their implementation. Some of the priorities include:

- need for land use planning and growth management;
- need for increased public education and involvement of stakeholders;
- protection of existing high water quality and resources (especially wetlands and nursery areas).

Since 1994, a total of 33 workshops and 22 public meetings have been held in 15 river basins. Almost 2,000 people have attended the workshops and meetings.

5) Interagency Coordination

The purpose of the program is to coordinate the permitting of discharges, integrate existing point and nonpoint source regulatory programs, and prepare water quality management plans on a basin-level in the 17 identified river basins in the state. It is not a regulatory program, but a watershed-based management approach to improving the efficiency, effectiveness and consistency of the state's surface water quality program. There is minimal interdepartmental coordination necessary to compile the basic components of the basinwide plans since the water quality program is centrally run through one state environmental division. There are several distinct branches of the DWQ which contribute to the basin plans. These are the Operations Branch (issuance and enforcement of permits), Environmental Sciences Branch (monitoring and data collection), the Technical Support Branch (computer modeling and impact assessment), the Planning Branch (draft plan development). The DWQ is placing a strong emphasis on coordination with other agencies including local governments; the U.S. Department of Agriculture's Natural Resources Conservation Service; the North Carolina Cooperative Extension Service; the NC divisions of Coastal Management, Water Resources, Soil and Water, Land Resources, Marine Fisheries, Parks and Recreation, Environmental Health and others. Involvement with these agencies will be necessary to implement the nonpoint source component of the basin plans.

The only oversight mechanism identified in the plan is the state Environmental Management Commission. This group must approve any plan by the DWQ before it can be implemented.

Another issue of significance in North Carolina, is the inclusion of the Albemarle-Pamlico Sound in the EPA's National Estuary Program. A study of the Sound was commissioned and a Comprehensive Conservation and Management plan was devised which recommends the development of a Regional Council for each of five river basins in the Sound watershed. The Regional Councils consist of citizens and local government officials. They advise and consult with the general public, interest groups and all levels of government on the implementation of environmental management programs in the basin. The councils have no regulatory authority. North Carolina has established similar Regional Councils for additional basins and is considering establishing them for four more basins soon.

6) Environmental Indicators

Based on the CWA concept of *total maximum daily loads* (TMDL's), the DWQ attempts to identify the total waste or pollution loading, from point and nonpoint sources that a water body can assimilate while maintaining its water quality classification and standards. Attention is most closely paid to biological oxygen demand and nutrient loading. The inherent difficulty of determining nonpoint TMDL's requires the DWQ to incorporate a wide margin of safety in areas with high nonpoint source discharge. Biological indicators may show the most reliable changes in a system.

Some biological indicators used in all basins include:

- benthic macroinvertebrates;
- fish community structure;
- fish tissue analyses, analyzed for metals contaminants and some pesticides;
- algal growth potential.

7) Program Strengths and Achievements

The program is providing greater organization to the permitting process, both spatially and temporally, through its five year review process. More strengths and achievements will reveal themselves over time, as the basin plans will be regularly revised and updated. The program builds in a component of adaptive management in this way.

The DWQ is beginning to recognize the need for increased public participation by implementing a pilot program of citizen water monitoring on one basin. Also, they are beginning to examine the ways in which they can coordinate field resources with other environmental agencies, so as to maximize time constraints of traveling and data collection, while improving relations and information sharing with the other agencies.

DWQ states in its policies that the earliest plans, which were developed after 1992, will not completely fulfill the demands of the program. However when the plan is due for assessment and renewal after five years, corrections can be made and the plans can be updated to include new EPA regulations and standards. Where appropriate, growth management, and “spillover” problems are addressed in the basin plan.

8) Lessons for Delaware

The EPA has advanced the North Carolina watershed management program has an organizational model to be emulated by other states. The program’s five year review process allows adaptability, and ensures that any ecological or geographical changes can be sufficiently managed and planned for. A similar review process could be considered for Delaware. Also, since the state is starting to recognize the need for public involvement and increased coordination with other agencies, Delaware officials could benefit by observing how North Carolina attain this directive.

D. Pennsylvania: “Christina Basin Watershed Initiative”

1) Focus of Program

The Pennsylvania Department of Environmental Protection (PaDEP) has recently created the Bureau of Watershed Conservation, including a Division of Watershed Support, to facilitate a watershed approach within the state, and to coordinate the various local watershed programs that already exist within Pennsylvania. This bureau has only been in existence since December, 1996, and is still in the early stages of development. Local agencies have been largely responsible for watershed planning, with Pennsylvania’s DEP regional offices focusing on particular watersheds to explore how watershed programs should be implemented. The Southeast Regional Office has focused considerable attention on the Christina River Basin. However, the recent reorganization that has taken place within PaDEP should promote overall watershed management on a statewide basis.

The Christina River Basin supplies drinking water to much of Chester County, PA, as well as to neighboring Delaware. Rapid residential and commercial development of the area, especially around Downingtown Pike, has threatened the health of the watershed, though the purity of the drinking water is reported to be satisfactory by the state, because it is treated prior to use.

2) Goals Set

The specific environmental goals of PaDEP’s individual watershed programs vary in each watershed. Goals of the Southeast Regional Office, established in conjunction with federal authorities and local stakeholders, for the Christina River Basin are to:

- Reduce bacteria levels;
- Reduce zinc, PCB, and Chlordane levels in aquatic life;
- Develop a combination of point and non-point source controls;
- Identify Total Maximum Daily Loads for specific pollutants in the basin;
- Restore wetlands and other critical habitats;
- Protect high-quality scenic and recreational areas threatened by development contamination;
- Identify sources of pollution in urban and agricultural runoff;
- Monitor stormwater pollutant loads;
- Conduct an Outreach program that includes demonstration projects to educate the public;
- Develop a watershed management program recommending ways to control nonpoint pollution sources that promote achievement of approved water quality standards;
- Coordinate activities with other involved agencies that affect the entire watershed.

3) Legal/Institutional Structures

Federal watershed management policies have guided many of Pennsylvania's watershed strategies. The state gave the Christina River Basin watershed priority in its attack on non-point source pollution. This was prompted by the EPA's Section 319 Nonpoint Source Program. The Delaware River Basin Commission (DRBC) has also targeted this watershed, and expects it to achieve compliance with the goals of the National Estuary Program (NEP) owing to its relationship with the Delaware Estuary.

In Pennsylvania, Chester County has been designated as one of the Commonwealth's Conservation Districts. The county has therefore been assigned a lead role in the Christina Basin Watershed Initiative. In addition, Chester County is required to develop stormwater plans for each of the watersheds within its boundaries, including the Christina, in order to comply with the state's Stormwater Management Program. The Christina Basin Water Resources Committee (CBWRC) was established by the DRBC and EPA to address water quality concerns throughout the watershed. Subsequently, a subcommittee was formed by the CBWRC to identify pollutants emanating from non-point sources.

The strategy adopted by the Southeast Regional Office of PaDEP allows the Department to carry out responsibilities delegated to it by various federal acts such as the Stormwater Management Act (Act 167 of 1968), the Clean Water Act (P.L. 92-500), and the Coastal Zone Management Act of 1972 (P.L. 92-583). PaDEP's new Bureau of Watershed Conservation's Division of Water Use Planning is responsible for the coordination of local, state, and federal authorities in the assessment of water resource needs within Pennsylvania, protecting public health and safety, and developing basin water budgets. By the establishment of a new agency assigned specifically to water use issues, it is hoped that water management efforts undertaken by PaDEP will not be needlessly duplicated by any of its own divisions, nor other agencies as well.

4) Timing, Mode and Quality of Participation

The CBWRC has solicited recommendations by local environmental groups, such as the Delaware Nature Society and the Brandywine Conservancy, so that public environmental interests can be considered in any plan for the watershed. Public workshops have recently started to take place in both Delaware and Pennsylvania to educate the public about the development and water-quality improvement plans proposed for the Christina Basin.

5) Interagency Coordination

Coordination among interstate and intrastate agencies is not confined solely to the creation of the CBWRC. The Chester County Conservation District, PaDEP, and their partners in Delaware and the Federal government, have made it a priority to coordinate basin monitoring and modeling to ensure consistency in environmental objectives and analytical methods between EPA, and the states of Pennsylvania, and Delaware.

6) Environmental Indicators

In order to measure the progress of the Christina Basin Watershed Initiative in improving water quality throughout the basin, various environmental factors will be evaluated by PaDEP, including temperature, and levels of pH, ammonia, bacteria, and metals toxicity in targeted streams. However, no specific achievement levels have been established by the CBWRC or PaDEP.

7) Program Strengths and Achievements

The Christina River Basin Initiative allows the states of Pennsylvania and Delaware to collaborate on water policy in the watershed, instead of working against each other. Through this initiative, the two states can begin sharing information, instead of performing redundant assessments. This also allows them to use their resources more efficiently, through regional cooperation. The purpose is so to establish interstate coordination so that the rivers remain reliable sources of drinking water for generations to come.

8) Lessons for Delaware

The Commonwealth of Pennsylvania is in a state of transition with regard to its watershed management strategies. Many varied localized watershed programs exist in the state. This allows for innovation, but may also result in redundancy. Unlike Delaware's countywide system of government, the forty townships and boroughs located in Pennsylvania's share the basin, and address their individual concerns. The diverse nature of Pennsylvania local politics is a complex issue. Some degree of statewide coordination may be necessary. However, the Christina Basin Watershed Initiative in Chester County is particularly unique because its geography necessarily involves cooperation with other jurisdictions, such as the state of Delaware, the federal government, and the DRBC. Delaware's WBM program should take into account the dynamics of this initiative, so that the state can cooperate with Pennsylvania in resolving the region's water quality problems.

E. New Jersey: "The Wallkill River Watershed Management Plan"

The state of New Jersey, Department of Environmental Protection (NJDEP), has recently implemented a watershed permitting system, however, the focus of that program is to improve the regulation of discharges. For the purpose of this report, the proposed “Walkill River Watershed Management Plan” will serve as an ecosystem-type model.

1) Focus of Program

In 1990, the US Fish and Wildlife Service (U.S. FWS) established the Walkill River National Wildlife Refuge. The refuge designation allows for the NJDEP to reconsider the classification of the surface water in the river. The U.S. FWS recommended designating the river as an Outstanding National Resource Water to afford it protection under the federal anti-degradation policy (40 CFR 131). To date, New Jersey has decided not to make this designation of the river. The Sussex County Municipal Utilities Authority (SCMUA) has a treatment plant which, discharges treated effluent to the Walkill River a short distance upstream from the Walkill refuge. The state recommended a somewhat less restrictive classification which would protect the Walkill River from measurable changes in water quality characteristics through regulatory control of existing and future point source discharges into the river. The SCMUA opposed this classification and proposed to develop an alternative watershed management plan instead. The proposal was based upon the belief that appropriate water quality protection could be provided via an integrated management plan which considers both point and nonpoint controls.

2) Goals set

The goals of the Walkill Plan, as accepted by the NJDEP, are as follows:

- Assess the relative contributions of point and non-point sources to in-stream loads and water quality;
- Address the present and future land use patterns and anticipated effects on water quality;
- Monitor the biological ecosystem of the Walkill River to determine the impacts, if any, to the relative contributions of point and nonpoint source loading;
- Develop strategies related to nonpoint source control;
- Develop wasteload allocations for point source discharges, which will result in the continuous maintenance of water quality standards and designated and existing uses of the River;
- Maintain and restore, if necessary, the chemical, physical, and biological integrity of the Walkill River;
- Protect the Walkill River National Wildlife Refuge;
- Ensure long-term environmental protection while allowing for reasonable, and sustainable, economic growth.

3) Legal/Institutional Structures

Since the proposed designation of an upgraded water quality classification in 1993, for the waters within the Refuge, spawned discussion of a watershed management plan, the U.S. FWS, under the Department of the Interior, plays a key role in the development of the plan. However, it was the SCMUA which initiated the plan with a preliminary scope of work developed in early 1996.

No special water quality designation has been placed on the river, so the NJDEP and Federal agencies do not have extended enforcement authority, beyond that applied to most waterways.

The SCMUA received authority to be the lead agency in development of the plan by the Sussex County Board of Chosen Freeholders, in conjunction with the County Planning Department and other county and local agencies, thus acting as the coordinator of management efforts for the watershed.

4) Timing, Mode and Quality of Participation

A public hearing in 1994 provided input from citizens, environmental groups and other utility authorities. While many were opposed to the state's proposal to reduce restrictions on the Wallkill, others felt that the Outstanding Natural Resource Water designation proposed by the U.S. FWS, would preclude economic development in the county without any appreciable improvement in water quality.

Since that hearing, much of the development of the plan has taken place through correspondence among stakeholder agencies and elected officials. There have been no additional public hearings, or other non-governmental inputs. The preliminary scope of work includes directives to develop a public participation program.

5) Interagency Coordination

The SCMUA has worked with the NJDEP and the U.S. Geological Survey to develop the scope of work and perform the initial characterization studies of the watershed.

Funding for the project is to be provided by the Utilities Authority, NJDEP (through federal Clean Water Act grants) and from the U.S.G.S. matching grant program. Additional funds will be required for completion of a comprehensive watershed management plan. The SCMUA has formally requested procurement of these funds from a variety of sources including, federal appropriations.

The U.S.FWS is on record as indicating that a watershed plan is consistent with the Department of the Interior's ecosystem management approach, but they feel the plan is insufficient without the further designation of an Outstanding National Resource Water for the portion of the river which traverses the Refuge.

6) Environmental Indicators

The SCMUA, as a requirement for its NPDES permit, includes a biological monitoring program between the discharge area and the National Wildlife Refuge, to screen for habitat impacts related to the discharge.

Both benthic macroinvertebrate and fish surveys have been determined to be appropriate environmental indicators. A fish survey performed by the Bureau of Freshwater Fisheries of the NJDEP in 1993, indicated that the river did not support trout species, and was therefore ineligible for a classification upgrade. Initial studies performed by SCMUA, indicate that habitat quality, not water quality, was the principle limiting factor in the Wallkill River.

7) Program Strengths and Achievements

As the program is in its infancy, no program achievements have been reported.

8) Lessons for Delaware

The Wallkill River watershed management program is an interesting program to follow because it is led by a utility authority, a body likely to be more concerned with economic growth than environmental protection.

F. Massachusetts/New Hampshire: “Merrimack River Initiative”

1) Focus of Program

The Merrimack River Initiative (MRI) is a watershed management strategy designed to rehabilitate the river which flows through the states of Massachusetts and New Hampshire. Both states, along with local, regional, and federal authorities, have developed the MRI to educate the inhabitants of the watershed about the complex quandaries facing the region. It is hoped that through this enterprise, the quality of the Merrimack River will meet the stringent demands of the 1990 Clean Water Act.

2) Goals set

- Improved water quality, so that the Merrimack could eventually be considered as a source for drinking water
- Educate the public as to what actions need to be taken to restore the purity of the river
- Provide planners with the tools and information that would aid in their understanding of the ecology of the region

3) Legal/Institutional Structures

The main target of the MRI is to meet the demands of the 1990 Clean Water Act. The MRI is administered by a Management Committee made up of 25 members from various local, state, and government agencies, as well as business groups and non-profit organizations that have a stake in the watershed. This group oversees the use of federal funds, which included a \$500,000 grant by the EPA. Additionally, there are four subcommittees that tackle specific issues regarding water-quality, in-stream flow, information management (GIS), and resource utilization and values. Furthermore, the Citizen’s Watershed Advisory Group, a shadow cabinet made up of local citizens, helps the Management Committee set priorities for the watershed.

4) Interagency Coordination

The EPA, which first initiated the MRI, collaborates with numerous regional stakeholders to address the environmental dilemmas of the Merrimack. The New England Interstate Water Pollution Control Commission actually administers the funds provided by the EPA, that were subsequently supervised by the Management Committee. Other agencies working with the EPA in the MRI include the U.S. Forest Service, the U.S. Geological Survey, the Massachusetts Departments of Environmental Protection and Fish and Wildlife, the New Hampshire Departments of Natural Resources and Planning, and many local governments.

5) Timing, Mode, and Quality of Participation

The MRI has developed into a forum for state agencies and citizens' groups to meet with their counterparts regarding the state of the Merrimack River.

6) Environmental Indicators

None have yet been established.

7) Program Achievements

The most degraded river segments have been targeted for water quality remediation measures.

8) Lessons for Delaware

Currently the MRI promotes dialogue more than it implements policy. As such, the MRI is an example of how to facilitate public discourse on watershed policy. Environmental assessments of the watershed have been administered by various state and federal agencies, but that data is only beginning to be shared. The regional politics of the watershed have proven to be a difficult obstacle for the MRI. New England is very much a locally oriented region of the country. New Hampshire is notoriously so. In many instances, individual townships hold more sway than counties, and in some cases more than their respective states, when it comes to formulating policies for the benefit of the watershed. Unlike Delaware's WBM Plan, which designates the state as the chief actor in environmental planning and decision-making, the MRI is constricted by the unique local political culture and traditions of the region.

However, the MRI is slowly overcoming these cultural and political impediments, and may still become a mechanism for improving the condition of the watershed. MRI currently provides planning agencies the tools to better understand the function of each land type in the watershed. In this way, it can have a positive effect on land-use planning, and provides an example of how the watershed's planners and managers can work with each other.

G. Washington: “The Puget Sound Water Quality Management Plan”

1) Focus of Program

The Puget Sound Plan is a state and federal initiative to restore and protect the biological diversity and health of Puget Sound. The Puget Sound Estuary is a unique and vitally important basin which affects the health of the region and the state. Expanding population and environmentally risky policies in the past, have contributed to severe ecological stress throughout the Sound. Owing to the national importance of Puget Sound, the EPA designated it for inclusion in the National Estuary Program (NEP). However, this was not the impetus to coordinated watershed management in the Sound. The Puget Sound Water Quality Management Plan, which had been founded by the state of Washington, had already been underway when this EPA designation was made. Washington State’s plan became the foundation for the Puget Sound Estuary Program (PSEP). Under NEP, the Puget Sound Plan is unique because the state, not the federal government, oversees the restoration of the estuary. The state and federal governments coordinate their strategies with each other, as well as with local governments, and Indian tribes. Furthermore, cooperation with businesses, non-profit organizations, industry, and private citizens will become a key ingredient to the success of this plan if it is to meet the requirements of the Clean Water Act.

2) Goals set

- Ensure protection of wetlands and threatened aquatic habitats
- Control sources of toxic contamination into the Sound
- Cleanup of Superfund sites that abut the Sound
- Improve the control and cleanup of nonpoint source pollution in the Sound
- Prevent spills and enhance the capability to respond to spills when they occur
- Provide long-term support for research and education of Puget Sound
- Involve and educate regional stakeholders in the restoration of Puget Sound

Although improved water quality is not specifically addressed by the plan, higher water quality will be achieved once the set goals are met.

3) Legal/Institutional Structures

In 1985, Washington State created the Puget Sound Water Quality Authority expecting it to develop a management plan for Puget Sound. That plan would seek to achieve the goals of the state Puget Sound Water Quality Act (33 U.S.C.1330). The Authority did later create the Puget Sound Water Quality Management Plan. This plan assigned local governments major roles in protecting ecologically sensitive lands, preventing water pollution, and protecting indigenous biota. These assignments included planning, regulation, education, remediation, and enforcement activities.

The Puget Sound Plan has since been revised to be consistent with the state's Growth Management Act (GMA), a measure which strengthens the linkages between water quality and land use under provisions of the federal Coastal Zone Reauthorization Amendments. The Puget Sound Plan assigns the Authority, the Department of Ecology and the EPA the lead in managing the resources of the Sound. Other state agencies involved include the Departments of Fish and Wildlife, Natural Resources, and Health, as well as the state Forest Practices Board. The Department of Ecology is responsible for establishing intergovernmental teams in high need watersheds to develop appropriate plans and responses to address concerns in each watershed. The twelve counties in the basin have identified local watersheds to be ranked for protection under the Plan. Action plans in turn are designed by the localities, Indian tribes, business groups, private citizens groups, and other stakeholders. Such plans are then administered by the Department of Ecology, and overseen by the EPA, so as to ensure they correspond with PSEP guidelines.

4) Timing, Mode, and Quality of Participation

Public hearings are to be held by the Puget Sound Action Team, and subsequently local governments must implement local elements of the approved plan. The PSEP Management Committee provides a mechanism for communication among various state agencies, levels of government, and other stakeholders, and provides a formal system of communication for the implementors of the plan.

5) Interagency Coordination

The PSEP has assigned the EPA a permanent lead role in the Puget Sound Basin. Through the NEP, EPA provides much funding and technical assistance to Washington state towards which they then use to implement the Puget Sound Plan. As the lead state agency in this implementation effort, the Department of Ecology consults with local stakeholders of each watershed about pollution limits to be used. It coordinates the actions and strategies used to fulfill the objectives of the Puget Sound Plan. The Authority has now been divided into the Puget Sound Council, which oversees plan implementation activities, and the Puget Sound Action Team, which surveys other actions. Both these groups include representatives from EPA, involved state agencies, Indian tribes, and local governments. The Council is in charge of monitoring efforts throughout the Sound, and then recommending to the Action Team what strategies and actions need to be employed by various governmental and non-governmental agencies in the region.

6) Environmental Indicators

Measurements to gauge the success of the Puget Sound Plan:

- Concentrations of toxic chemical found in sediments in the basin
- Relative health of shellfish beds
- Tonnage of pollutants flowing into the Sound
- Number of spills or other shipping accidents that occur in the Sound
- Acreage of wetlands, salt marshes, and forests in the watershed
- Health of indigenous wildlife populations

7) Program Achievements

The Puget Sound Plan has enjoyed limited success in the restoration of Puget Sound. In general, water quality has improved, and many shellfish beds have been reopened. However, parts of the estuary have actually experienced declines in water quality. Nevertheless, it is postulated that without any plan the Sound would have continued on its downward spiral, so in that way it has been successful. In the long-term, many beneficial programs have been established that may result in the further improvement of Puget Sound. The region has taken a much more comprehensive approach towards controlling sewage overflow and stormwater pollution from entering the Sound. Local communities have developed innovative methods to better tackle sources of nonpoint pollution. Furthermore, education of the region's residents has brought the plight of the estuary to the forefront of public discourse.

8) Lessons for Delaware

The Puget Sound Plan is the framework for the promotion of progressive policies fulfill the PSEP. Furthermore, the Plan facilitates intergovernmental cooperation between the various levels of government and society, preventing ineffective piecemeal strategies. Consequently, the Puget Sound Plan has been heralded as a national model for ecosystem management.

H. Wisconsin: "Reorganization of the Wisconsin Department of Natural Resources on a

Natural Geographic Basis'

1) Focus of Program

The Wisconsin Department of Natural Resources (DNR) is in the process of reorganizing the operations of the agency on a natural geographic basis. The impetus for the reorganization comes from a 1995 report entitled "Wisconsin's Biodiversity as a Management Issue: A Report to the Department of Natural Resources Managers." The report proposed that the best way to address biodiversity as a management issue was to use the ecosystem approach in all the Department's planning and programs.

The new field organization will be done in 23 Geographic Management Units (GMU's) for the Departments Land and Water Divisions, but the agency will still be divided into five regions along county lines. The new management of the department will follow the philosophy of integrated ecosystem management, specifically using a model developed by the department in the 1995 report. The model aims to ensure sustainability of ecosystems across spatial and temporal scales. Furthermore, customer service is addressed in a way no other reviewed states do it. The reorganization will give rise to Service Centers. These centers increase staff presence around the state and foster partnerships and improve community relations. In 1996, the policymaking Natural Resources Board approved a "watershed approach" to managing the state's waters. The reorganization of the Department supports this approach.

2) Goals Set

The Integrated Ecosystem Management Approach will make use of natural watershed boundaries as a basis for the management units. Under this initiative, the goals of the reorganization are to:

- Improve customer service;
- Increase integration between the Department's resource and environmental programs;
- Improve agency efficiency and effectiveness by creating stronger internal management systems to assure consistent policy implementation, indicate and measure performance, and set and implement priorities;
- Organize employees into integrated teams;
- Build partnerships and involve citizens in making natural resource decisions.

3) Legal/Institutional Structures

The reorganization plan was developed in June 1995, and implementation planning began later that year. Early in 1996, the Department of Administration granted conditional approval to proceed with implementation on a Pilot project in one region (the Northeast Region). The pilot project ran for six months, and the entire Department switched to the new organization in early 1997. Currently, the reorganization and implementation of the ecosystem management approach is only a feature of DNR, not other state agencies.

4) Timing, Mode, and Quality of Participation

During the pilot period, there were training programs for the transition of employees into teams. From the outset, many comments have generated concern about poor communication within agency departments and a lack of models for increasing citizen participation in agency programs. A Senior Management Team will be developing criteria for stakeholder involvement. Some of the proposed criteria include: relative uniformity of stakeholder involvement statewide; avenue for public participation of those not well represented by stakeholder categories; mechanism for stakeholder 'sectors' to gather information from representatives and present that information to the DNR; and a network for public involvement across all media divisions of the Department. The project is in the early implementation phase so feedback is still incoming.

5) Interagency Coordination

The restructuring of field operations by GMU's is beginning in the Land and Water Divisions and communication and coordination problems have arisen because the Air and Waste Division is not currently organized in the same way. Also, many Service Center locations do not co-locate with the GMU's, but do in some cases. Reallocation of existing staff will be carried out through decentralization of staff and decision-making. The reorganization is a DNR internal process, and does not currently focus on interagency coordination.

6) Environmental Indicators

The ecosystem approach to environmental management calls for a set of specific environmental indicators by which to measure program success. The Wisconsin reorganization plan does not outline any steps the Department may have taken to develop an indicator system. However, there are reports of a system of performance measures is being developed.

7) Program Strengths and Achievements

The adaptability of the program, and focus on customer service and community relations are two of its strengths, but time will be required for evaluation of the achievements.

8) Lessons for Delaware

The 1995, "Wisconsin's Biodiversity as a Management Issue" report, outlines an "Ecosystem Management Decision Model." This is the model being used by the Department to guide the reorganization process. The model incorporates the ecological, socio-economic, and institutional contexts upon which management decisions are based, and aims for plans amenable to all three contexts. Each of the Land and Water Division's GMU Teams have developed an Integrated Ecosystem Management Project which will be implemented in 1997 and 1998.

The Service Center concept is unique to the Wisconsin approach. They are considered to be the backbone of the reorganization. These centers will provide a central location to the public for: permit application and processing; licensing, registration forms; customer assistance, enforcement, and information; technical assistance; a forum for public input into planning and regulation; distribution of department reports, plans and maps; current listings for names and phone numbers for zoning, flood insurance, real estate questions; and more. These centers may significantly improve public and interagency partnerships by increasing the accessibility of the Department, thus increasing public dialogue and community involvement in the development of programs.

The Great Lakes Initiative

Any analysis of the ecosystem approach to watershed management must consider the Great Lakes Initiative because it is the premier example of this approach. The Great Lakes Initiative has been exhaustively researched. Ideas about how to use the ecosystem approach were developed and tested there.

In 1909, the U.S. and Canada signed the Boundary Waters Treaty, a measure that established the International Joint Commission (IJC). The Commission was authorized to act in an integrative way so that policies regarding the Lakes could evolve with changing needs (Caldwell: 1988, 6). Gradually, the Commission has assumed greater responsibility for policy formation and implementation. This was considered preferable to uncoordinated, single nation, state, and province efforts.

The 1978 Great Lakes Water Quality Agreement was the first official expression of the need for an ecosystem approach to saving the lakes. The approach itself was to be anticipatory, rather than reactionary, to environmental problems. It required the integration of science (especially an understanding of ecosystem dynamics) into policy formulation. The ecosystem approach takes into account the interactions of air, land, water, living organisms and man within a defined drainage basin. The Agreement paid less attention to discrete, well-defined problems and more to complex, systemic problems. The approach had to be flexible and adaptive, not static. It had to evolve in response to increased understanding of forces that influence environmental quality (Caldwell: 1988).

However, by 1986, it became obvious that several barriers existed to the implementation of the approach. The IJC identified these barriers as (Caldwell: 1988, 2):

- a general lack of understanding of ecosystem concepts and the ecological perspective;
- the existence of material use values instead of an environmental ethic;
- prioritization of economic considerations (including free enterprise, as well as personal and property rights) over environmental considerations;
- localized, ego-centered, and short-term perceptions of responsibility;
- fragmentation of jurisdiction between levels of government, and a lack of coordination between science and governance.

The IJC determined that a coordinated operational policy was needed to address these barriers. This policy would provide a long-term perspective to the approach, and a basis for coordinated institutional action to support implementation. According to Caldwell, even rhetorical commitments are forms of action, as they generate expectations that become the focus for implementation of declared principles (1988, 16).

The Four Concurrent Phases Towards the Implementation of an Ecosystem Management Plan (Caldwell: 1988, 17):

- 1. Assessment of the environmental conditions of the system;*
- 2. Development of the scientific or technical means of solving the problems discovered in the assessment;*
- 3. Analysis of the legal and institutional impediments to implementation;*
- 4. Building of constituency, and popular support for the ecosystem approach.*

The Great Lakes Initiative is considered by DNREC as the model for Whole-Basin Management in Delaware. Therefore, it is important to review what that program has accomplished. Its experience illustrates why coordinated organizational structures are needed. The institutionalization of planning processes and public input are central to the success of an ecosystem plan. The use of scientific knowledge in policy formulation and implementation is also required. Cooperation between levels of government, between governmental and non-governmental agencies, and between governance and other fields of research, is essential. The approach often induces public leaders to act against the interests of many local and bureaucratic officials. However, if the ecosystem approach is ultimately not used those leaders will be held responsible for the resulting environmental decline. The choice is to safeguard the future rather than concede to short-term interests.

IV. State of the Environment in Delaware

A. Delaware Watershed Assessment

1. Surface Water Assessment

Delaware's Rivers and Streams: According to the Department of Natural Resources and Environmental Control (DNREC), 66% of the rivers and streams in Delaware do not support swimming use while 29% do not support fish and wildlife use. For ponds and lakes, accumulated pollutants and enriched nutrients are also major concerns since a variety of pollutants washed from the land and the air deposit in those areas.

Bacteria (Pathogen Indicators): High levels of bacteria pose an increased risk of illness to shellfish consumers, swimmers, and others who may come in contact with contaminated waters. Approximately 66% of Delaware's rivers and streams and 38% of ponds and lakes were found to have bacteria concentration above the acceptable levels for primary contact use (ie. swimming, bathing, water skiing) (DNREC; 1996).

Nutrient Enrichment: Characteristic symptoms of nutrient enriched water bodies are murky green waters or nuisance plant growth. Activities linked to soil erosion, domestic waste disposal, and run off can greatly increase the rate and the amount of nutrients reaching lakes and ponds and accelerate the nutrient enrichment process.

Toxic Substances: The contents of toxic substances accumulated in the flesh of fish have begun to restrict Delaware residents' consumption of fish. For this reason, DNREC has issued several advisories on fish consumption.

Physical Habitat Quality: About 87% of all non tidal perennial streams in Delaware were found to have degraded physical habitat (DNREC: 1996). The number of stream miles with impaired physical habitats would be larger if intermittent streams segments were included. In the Northern Piedmont Basin, the degradation appears to be caused by urbanization and stormwater runoff. In the coastal plain, the degradation appears to be caused by agricultural practices, stream channelization, and maintenance activities.

Overall, as a result of water quality protection reforms that are in place, Delaware's surface water quality has generally remained stable. But, with the state's increasing development and population growth, it still needs to step up its effort to control water pollution, especially nonpoint sources of pollution. Most of the water problems in Delaware can be attributed to nonpoint source pollution impacts.

2. General Watershed Assessment

Surface Water Quality: High nutrient loads, bacteria counts, degraded physical habitat conditions and occasional low dissolved oxygen levels are the main concerns in Delaware's watersheds. First, high nitrogen and phosphorous concentrations lead to the nutrient overload. Second, in some watersheds, high enterococcus bacteria levels did not support 100% of the primary contact use. Third, low dissolved oxygen levels, in some areas, such as in Little Creek, are only 3.0 mg/l did not support 100% of the Fish, Aquatic life and Wildlife use (DNREC: 1996).

Physical Habitat Quality: Physical habitats in Delaware's watersheds evidence impaired biological conditions. According to DNREC, the majority of the non-tidal streams miles in Delaware (about 80%) don't fully support the aquatic life they are supposed to. The probable source of this concern is urbanization, construction, land disposal and of wastes, and the effects these have on hydrology and water quality.

Nonpoint Source Activities: The susceptibilities of ground and surface waters to nonpoint source pollution vary according to land use types. In Delaware, generally speaking, activities related to agriculture, silviculture, construction, waste disposal and hydromodification are likely to contaminate ground and surface waters. Hence, these should be given high priority in nonpoint source pollution control.

3. Groundwater Assessment

In Delaware each year, more than 32 billion gallons of water are withdrawn from groundwater sources to meet about two thirds of the state's domestic water needs (DNREC, 1996). Even though most of its groundwater is of high quality, groundwater in Delaware is a relatively vulnerable resource due to the state's shallow water table and high soil permeability. Delaware soils are very permeable in many parts of the state and facilitate the movement of contaminants from the surface into the groundwater. Therefore, if groundwater resources are improperly managed or inadequately protected, the quality of groundwater will deteriorate. Realizing this, Delaware officials have begun to act on this issue.

Water supply system: The most common water supply problem is limited local groundwater availability. Since, groundwater use continues to increase statewide, safe limits have been reached in some specific areas; shortages during time of peak demand have been experienced by major groundwater users.

Septic system: If a septic system is designed properly, the soil medium can fully play its role as an effective agent in the removal of oxidizable nitrate compounds by filtering out pathogenic organisms from sewage effluent. Otherwise, septic systems will become a cause of nitrate and bacteriological contamination. For example, in areas of poor drainage and high seasonable water tables, septic system overflow or failure can lead to bacterial contamination of groundwater. Hence, further efforts on this issue will focus on its design and management of these systems.

Landfills: The types of landfills found in Delaware include sanitary, industrial, and dry-waste facilities. Most of these have confirmed groundwater contamination. Although some cleanups have taken place, further careful management and monitoring is required to prevent any further contamination. The level of this network and remediation should be based on the type and concentration of contaminant.

Salt water intrusion: Salt water intrusion in Delaware continues to be a problem along the Atlantic Coast, Delaware Bay and Estuary, and Inland Bay. As population increases and water use increases, the possibility for salt water intrusion escalates. This is one of the issues that has to be addressed. This problem is very localized and persists primarily in the Inland Bays areas and in some Coastal communities along the Delaware Bay. Therefore, this program has targeted these areas through a number of measures.

Land application and treatment: Land application in treatment of wastes includes spray irrigation, sludge application, and percolation basins. Land application of waste has been shown to be a viable and environmentally safe disposal method if properly managed. There are already some active or proposed wastewater spray irrigation and sludge application sites in the state. To ensure the effectiveness of this system, nearby groundwater monitoring network at each of these sites is required, or is highly recommended.

Agriculture activities: Agricultural activities that may contribute to groundwater contamination include fertilizer and pesticide application, animal feedlots and manure storage and disposal. These activities have been identified as the most common groundwater contaminants in the state because of their contribution to nutrient enrichment, especially to shallow unconfined aquifers. Best management practices (BMP) have been developed to reduce or prevent pollution from fertilizer application and animal waste. At present, monitoring networks and further studies are needed to insure that pesticides do not compromise Delaware's groundwater quality in the future.

Drinking water quality: Water from some public and private water wells has been determined to contain a nitrate-nitrogen concentration that nears or exceeds the EPA's drinking water standard of 10 mg/l (DNREC). This problem generally occurs in the southern half of the state where the major water source for many public wells is a superficial aquifer. Possible sources of nitrate which have been identified include agricultural activities, septic system effluents, and so on. In groundwater, the highest concentration of nitrate occurs in Kent and Sussex counties where the soils are excessively well drained.

B. History of Environmental and Watershed Management in Delaware

The Delaware Constitution provides the Governor with the ultimate responsibility for the protection of natural resources. Policy for the management of environmental resources is established at the state level. Population growth, an increase in tourism, and an increase in non-agricultural jobs are intensifying environmental stresses in the state. To manage Delaware's environmental resources and to alleviate these environmental burdens, many new actions have been taken.

In the past 10-15 years, many have come to recognize in Delaware environmental management must adopt an ecosystem perspective. Human activities, including environmental management activities, have measurable impacts within an ecosystem. Traditionally, environmental management has been compartmentalized into media-specific divisions and agencies. In order to re-focus these efforts in a coordinated fashion, it is important not only to identify environmental problems, but also to institute arrangements which try to correct those problems. In 1986, Governor Castle created "Delaware's Environmental Legacy" Program (DEL) which was to gather information on the public's opinion of the state's long-term environmental issues and create a broad understanding of the interrelationships between quality of life, economic development, and the management of natural resources. DEL was to develop an agenda for an action-oriented set of recommendations to resolve the issues and problems identified, and they were to submit an implementation plan to the governor. The "Delaware Environmental Legacy Report of 1988" recognized the need to "devise a system capable of formulating policy that will prevent environmental degradation rather than react to it." Specifically it called for a "Holistic Approach to environmental Management" (Delaware's Environmental Legacy: 1988, 158).

Institutional Structures for Watershed/Ecosystem Management:

The DEL report determined that one of the keys to managing Delaware's environment was to require greater coordination and cooperation among state, local, federal, and regional governments and the private sector. Specifically, it noted the importance of local governments' roles in controlling environmentally sensitive land uses. Historically, land use decisions have been made at the local level without regard to state or regional plans, so there has been little intergovernmental coordination on this issue. Water resource planning has traditionally been done at the state level, so coordination with counties and municipalities had been lacking in that area as well (Hoeh: 1966).

Before 1970, there were many agencies active in the regulation and conservation of natural resources. In 1970, the Department of Natural Resources and Environmental Control (DNREC), was created to unify these agencies and their efforts at environmental protection. Today, DNREC and the Department of Agriculture (which administers both farming and forestry practices) have virtually comprehensive jurisdiction over the state's environment.

Other agencies concerned with water resources and ecosystems include the Delaware Emergency Management Agency, the State Planning and Coordination Office, the Department of Health and Social

Services, the Information Services Office, the Public Service Commission, the National Estuarine Research Reserve (as part of the National Estuary Program), the Delaware River Basin Commission (DRBC), the Water Resources Agency for New Castle County and varied non-profit and community organizations.

Legislative History:

Several state laws enacted in the 1970's, have implications for watershed and ecosystem management: among them are the Coastal Zone Act (CZA) of 1971, the Wetlands Act of 1973 and the Delaware Environmental Protection Act of 1974. Subsequent laws, such as the Conservation and Preservation Easement Act, the Natural Areas Preservation System, the Land Protection Act and the Agricultural Lands Preservation Act, also have implications for watershed/ecosystem management.

The Environmental Protection Act greatly affects development activities throughout the state. The CZA and Wetlands Act laws apply restrictions on the development or conversion of those areas.

The Conservation Laws (including the Conservation and Preservation Easement Act, the Natural Areas Preservation System, the Land Protection Act and the Agricultural Lands Preservation Act) serve to increase efforts at coordinated conservation of natural resource areas. These laws generally restrict development activities while permitting farming, forestry and recreational uses. Their intent was to provide the people of the state, current and future, with an enduring resource. Under both the Natural Areas System and the Land Protection Act, councils have been set up to evaluate properties nominated for protection. Notably, the Land Protection Act has been responsible for the designation of "Greenways" or corridors connecting natural areas with each other. Greenways along riparian areas have also been established, especially along the Brandywine and Christina Rivers in New Castle County.

The City of Newark has floodplain regulations which prohibits construction in defined areas along the Christina River and the White Clay Creek. Also, water conservation districts are statutorily set forth in each of Delaware's three counties to further the conservation, protection, development and utilization of land and water resources. The counties work with DNREC and the Department of Agriculture in the establishment and monitoring of those areas.

In addition, a recent statute in New Castle County protects aquifer recharge areas and wellheads through zoning restrictions. There is no similar zoning law for environmentally sensitive areas.

C. Current Watershed/Ecosystem Programs in Delaware:

In addition to Whole Basin Management, several watershed projects are underway in the state:

(1) The Governor's Task Force on the Future of the Brandywine and Christina Rivers

This task force was convened by Governor Castle in 1992, and reconvened by Governor Carper in 1994, to create a vision and implementation plan for the rivers. Members included two state Senators, the New Castle County Executive, the Mayor of Wilmington, the President of the Christina River Conservancy, the President of the Wilmington City Council, the Secretary of DNREC, and provided for additional members from community organizations, environmental organizations, businesses and governments. The original objectives of the task force were to:

- improve water quality;
- preserve historical, cultural, and community attributes of the river corridors;
- protect and enhance wildlife habitat;
- increase recreational opportunities;
- encourage compatible economic uses.

The bulk of the report of 1994 focuses on environmental issues, however, the implementation plan of 1995 focuses on the economic development of the Wilmington waterfront and the establishment of the Delaware Riverfront Development Corporation. The plan seems to have lost most of its original environmental focus.

(2) The Christina River Basin Water Resource Management Committee

In 1994, The DRBC, concerned with the lack of coordination of water quality management policies between Delaware and Pennsylvania, established a voluntary, bi-state committee for water resource management on the Christina River basin. The Christina River and its major tributaries (the Brandywine river and the Red and White Clay creeks) provide over 75% of the drinking water supply to New Castle County.

Members of the committee include representatives of the Delaware River Basin Commission, the Water Resources Agency for New Castle County (DE), the Delaware Department of Natural Resource and Environmental Control, the New Castle Conservation District (DE), the Pennsylvania Department of Environmental Resources, the Chester County Conservation District (PA), the Chester County Water Resources Authority (PA), the U.S. Geological Survey and the U.S. Environmental Protection Agency.

The program has two phases underway. Phase I includes a monitoring program which will assist in the development of a Total Maximum Daily Load (TMDL) model for point source pollution discharges. This is the preferred model for pollution control outlined in the Clean Water Act. Phase II is addressing

nonpoint sources of pollution. These pollutants (especially stormwater, urban and agricultural runoff) will be quantified and incorporated into the TMDL model. The Phase I and II results will be used to identify sub-basins for pollution control efforts. The Water Resources Agency for New Castle County indicates that this program will be incorporated into DNREC's Whole Basin Management Plan.

(3) Delaware Estuary Program

At the request of the governors of Delaware, Pennsylvania, and New Jersey, the Delaware Estuary was admitted into the National Estuary Program in 1988. Its significance as a natural resource, and its location in the densely populated Northeast corridor, warranted the special designation. Like other estuaries in the region, such as the Chesapeake Bay, the Delaware Estuary is suffering the strains of its mammoth population. Its fisheries and recreational values are threatened by pollution from urban development, agricultural runoff, and industrial wastes. The Delaware Estuary Management Conference is charged with developing a course of action for the DRBC and for other involved agencies. Along with the DRBC, other agencies included are EPA, DNREC, N.J. DEP, and PaDEP.

The program provides a framework to achieve the goals established by the Management Conference:

- the restoration of the living resources of the estuary through the protection of sensitive habitats;
- the reduction of point and nonpoint sources of pollution, especially high nutrient and toxic loads in the estuary;
- the protection of water supplies within the watershed;
- management of economic growth and environmental protection;
- promoting a greater public understanding of the function and problems of the estuary.

(4) The Delaware Inland Bays National Estuary Program

The Inland Bays Estuary Program was established to address the dilemmas facing these interconnected estuaries. In 1994, Governor Carper and the U.S. EPA accepted the Inland Bays Program into the NEP.

Agricultural runoff and discharge from nearby sewage treatment plants have severely polluted the bays. The EPA, DNREC and the Center for the Inland Bays have been working closely to devise the best management plan for the estuaries. Current demonstration projects include reintroduction of submerged aquatic vegetation into the bays, increasing the acquisition of open space, and developing alternatives for excess poultry manure. Shoreline stabilization programs have increased wildlife habitat and reduced erosion.

V. Delaware's Whole Basin Management Program

Whole Basin Management Framework

Whole Basin Management is DNREC's new ecosystem management approach to tackling Delaware's complex environmental dilemmas. WBM involves assessing, measuring, planning, and managing all

aspects of the environment, in all five basins in the state. The watershed approach has been the standard design for well over three decades in the management of water resources, since it is recognized that watersheds are the foundation of every ecosystem. Delaware's WBM plan is generally modeled after the Great Lakes Basin Ecosystem Management Approach. The latter aspires to restore and secure the integrity of the Great Lakes Basin ecosystem as a multi-use resource with full commitment to renewable resource management principles. In the same way, WBM hopes to safely provide for the requirements of society such as:

- food and drinking water;
- human health;
- shelter and energy;
- industrial and commercial opportunity;
- culture and recreation.

These objectives necessarily entail addressing complex issues such as water quality, wastewater treatment, land use planning, transportation, permit coordination, etc.

Moreover, in Delaware basins and watersheds are common, natural geographic management units. The coordination and efficiency of management activities, among involved agencies in each watershed, will be greatly enhanced by basin ecosystem management. DNREC has to maximize the use of its finite resources:

- funds;
- information collection, access, and dissemination;
- physical resources;
- human and organizational capacities;
- relations formed through interactions by different divisions of the department with the public, local government, and other state agencies.

Through this holistic, multi-disciplinary strategy, DNREC can better utilize the resources of its five separate divisions (Air & Waste Management, Fish & Wildlife, Parks & Recreation, Soil & Water Conservation, & Water Resources) to avoid replicating accomplished tasks. Consequently, WBM allows concerned agencies to resolve Delaware's environmental problems by working together, instead of separately. As a consequence of this approach, DNREC expects to meet the needs and achieve the goals of the entire department, involve the public closely in its efforts to manage basin-wide ecosystems, and as a result, better manage Delaware's natural resources and environment.

The WBM strategy divides the state into five basins made up of the state's 41 watersheds. For each basin, staff members from each DNREC division form a team to assess, monitor, and develop a five year, eight phase implementation plan. Early phases involve basin planning, assessment, and monitoring. Subsequent phases focus on public participation, comprehensive analyses of issues, evaluation of management options, development of resource protection strategies, and implementation of the final plans. This process has already commenced in the Northern Piedmont Basin, which was designated the highest priority basin in the state, with the Chesapeake and subsequent basins to follow.

By eliminating redundancy, DNREC can achieve significant gains in dealing with Delaware's environmental dilemmas without requiring a vast influx of additional resources. In this way, Whole Basin Management is a step in the right direction. Furthermore, WBM could be implemented cooperatively with agencies inside and adjacent to the state's boundaries. DNREC officials see WBM as a useful tool for coordinating the efforts of the state, New Castle County, and the nearby Pennsylvania jurisdictions involved in the restoration of the Christina River Watershed Basin.

DNREC may also find its WBM Plan a worthwhile tool through which to consult with members of the DRBC in its watershed plans. They are also concerned about the Delaware Bay Drainage Basin and the Delaware Estuary. Likewise, WBM can help the state address its concerns in the Chesapeake and Inland Bays/Atlantic Ocean Basins. WBM may facilitate coordinating activities with the state of Maryland. Interstate coordination is vital in a small state like Delaware, a state greatly affected by what transpires in its larger neighboring states.

VI. Conclusion

Will WBM effectively address the issues it is designed to address? The draft plan suggests that WBM may be effective in coordinating the management activities and permitting processes of the Department's five divisions. Much of this effectiveness might stem from the efforts at improved information sharing among divisions. Management activities and permits may be tracked and monitored along watershed lines, and their effects may be measured in relation to one another. Integration of all management

activities continues to present a problem. Many environmental programs shared by DNREC's land and water divisions show reasonable potential for coordination. Coordination between air and water, and air and land, is more difficult. A further limitation of WBM lies in its definition of basin boundaries. Surface water, groundwater, land-based ecosystems, and airsheds rarely share coincident boundaries. This presents a problem for the holistic inclusion of all environmental management initiatives within a single natural boundary.

The WBM plan manifests an inability to address issues of policy fragmentation between levels of government. For example, leaving land use authority in the hands of county and municipal governments presents a conflict with state-level environmental protection initiatives. While New Castle County has begun managing its own water resource protection areas, it does not statutorily protect other environmentally sensitive areas like unique habitat or biodiversity, and that is its prerogative.

WBM seeks to reset funding priorities among DNREC's environmental programs. However, this could result in some popular programs, like trout stream maintenance, losing funds to priority programs, like Superfund. While this re-ranking may be laudable for its overall environmental effects, it raises the question as to whose priorities will receive funds. When funding is pooled for priority-ranked distribution, how will citizen interests be represented, and who will be accountable?

Finally, is WBM really an ecosystem approach to environmental management? The answer is inconclusive. While WBM must be praised for its initiatives, coordination and its recognition of a need to be flexible in response to changing environmental needs, it is only the first step toward an ecosystem approach. The most successful attempts at an ecosystem approach (notably the Great Lakes) have evolved over time, and they require many incremental changes. A true ecosystem approach requires an eco-centric perspective and the cultivation of an environmental ethic. Priorities must necessarily shift from economic development to ecological integrity. Social patterns and cultural behaviors must be recognized as capable of altering an ecosystem's capacity to sustain itself. These patterns and behaviors must be addressed. WBM is a step in the right direction, but must evolve to incorporate these vital issues. Due to Delaware's geographic conditions (a small, downstream, downwind state) WBM will be limited in its ability to holistically address all environmental concerns, unless it performs in conjunction with larger regional initiatives. However, if WBM is performed in concert with Delaware's other environmentally responsible programs, particularly Growth Management, its potential effect is greatly increased.

VII. Recommendations

Statement of Goals

In order to promote the environmental sustainability that supports the state's economy and quality of life, the General Assembly can support the goals of the ecosystem approach through expansion of the Department of Natural Resources and Environmental Control's Whole Basin Management initiative. Generally, the legislature can prepare a statement of goals for all government agencies and the public. These goals include:

- The efficient use of resources;
- Coordination of all government agency activities;
- Cooperation between governmental and nongovernmental entities;
- Enhanced citizen participation;
- Environmentally benign economic goals;
- Economically considerate environmental goals;
- Cultivation of an environmental ethic.

A statement of goals from the Legislature represents a commitment to the ecosystem approach and can provide the expectations upon which environmental initiatives are based.

Policies and Processes

New policies and processes may be needed to fully support the statement of goals.

1. Coordinate environmental management plans among all government agencies.

a. Establish interagency meetings with the intent to coordinate agency missions.

Often, incompatible missions cause programmatic overlap and inconsistency. A Memoranda of Agreement which develops common goals for environmentally sustainable management, could apply to all governmental agencies, especially those involved in land use, transportation, public health, energy, and recreation.

b. Establish data collection, sharing and management standards, and protocols between all agencies.

Information sharing helps to eliminate duplicate efforts and can increase the scope of any one program's potential. Some agencies collect scientific data while others collect social and economic data. All of this information needs to be available for consideration in program management decisions for environmentally, socially and economically sustainable programs.

c. Encourage flexibility in program management.

Project managers must have the authority to change management efforts rapidly, based on new information. Likewise, accountability at the project management level improves responsiveness to new information.

d. Expand Whole Basin Teams to include representatives of stakeholders in each basin.

- Other state departments (ie. Transportation, Public Health)

- County and Municipal agencies involved in the basin
 - Public Interest Groups
 - DNREC's counterparts in the border states (MD, NJ, PA), when dealing with interstate issues
 - Assign DNREC as the head department in each Basin Team
- e. Develop Geographic Information Systems (GIS) capabilities to assess land use, water-quality, habitat analyses, etc.*
- GIS can help to keep data current, and can be used to compare against satellite and aerial photographs for things like wetland delineation, protected open space, new construction etc. GIS can help locate illegal dumps or accidental spill sites, construction sites which might require immediate response or planned clean-up activities. GIS can also be used to prepare "Land Development Suitability" maps to guide growth while protecting water resources.
 - The development of GIS capabilities by DNREC will allow the department to incorporate geographical data from numerous sources, such as other state agencies, federal agencies, universities, etc. This can facilitate coordination among various watershed actors.
 - GIS can also be a valuable public education tool. GIS maps can provide the public with useful information on WBM plans in a visually pleasing manner.
- f. Create a forum for coordination, conflict resolution and consensus for each basin team.*

Models for coordination among many agencies already exist in the state. The Governor's Task Force for the Future of the Brandywine and Christina Rivers provides a model for an advisory commission which can define specific goals and implementation plans. The Water Resources Agency for New Castle County provides a substantive model, with its Christina River Basin Water Resource Management Committee, for coordination between states and leadership at a local level.

2. Develop a statewide environmental awareness program.

Citizen input is a central tenet to watershed management especially for nonpoint source control because it depends on people's voluntary action. Without environmental education, it is difficult to identify behavior damaging to the environment, thus difficult to make people stop their irresponsible behavior. Through educational programs the public has a chance to know what is going on in their watershed. They may then lend support to watershed management programs. Citizens who are knowledgeable about the management program may help keep interest high and hold appropriate parties accountable for implementation. A citizen-government partnership in water protection might be established which

would mobilize public support for watershed protection. Therefore, teacher education, media relations and general educational activities are needed to promote public awareness and responsible citizen action.

Some recommendations for this program include:

- Use of video and cable television, newspaper, radio and other media to convey information to the public and to generate their interest in watershed management;
- Establishing public participation workshops and scheduling seminars or workshops on new program;
- Funding and collaborating nonprofit organizations to enlarge their ability to educate public;
- Establishment of a series of educational programs which are geared to the needs of citizens;
- Develop brochures and fact sheets on the management program and place them in public libraries, schools and other public gatherings.

3. Develop environmental indicators to provide a basis for decision-making.

The transition to a sustainable path in managing the ecosystem requires that decision-makers evaluate their performance and take action based on measures that account for key factors of sustainability. Existing measurement practices are controversial and rarely point out linkages between socioeconomic and environmental factors. Thus, the indicators of sustainable development should take social, economic, and environmental factors into consideration.

- Under DNREC's leadership, develop guidance on baseline ecosystem and socioeconomic assessment techniques, interagency coordination, and other ways to further the ecosystem approach.
- Managers should understand that the ecosystem approach is a philosophy that drives all natural resources programs and activities. Agency budget priorities should be adjusted accordingly.
- Environmental problems are inter-media issues which require integrated approaches. Research and Development focuses on holistic considerations should be encouraged. For example, a common set of water quality indicators, TMDL (Totally Maximum Daily Load) should be developed and used to achieve watershed targets.
- Create an effective data and information management program to collect, translate, and integrate technical information for ecosystem managers, technical managers, and the public.
- More sophisticated water quality models are needed to address complicated water problems. With the help of this model to collect data and information about watershed condition, the accuracy of estimates about point/nonpoint source loading may be improved.

- Create and coordinate an aggressive statewide monitoring program to determine ecological health, status, and trends for all pertinent ecosystem components state-wide. This should be coupled with an inventory of biological, hydrologic, air, and anthropogenic resources.

4. Authorize legislation and resource allocation procedures which encourage coordination of environmental management.

Budgeting for long-term goals is necessary to comprehensive environmental management efforts, like WBM. Monitoring phases which produce valuable information are expensive and may take several years to show results. Public and interagency budget support must be solicited.

At the state level, steps should be taken to ensure that budget allocations better reflect priority needs under the ecosystem approach. Allocations in the Annual Budget might be aligned to favor coordinated, interagency efforts. Funds could be allocated for each agency's contribution to a cooperative plan. This will reduce program overlap between agencies and reduce managerial or implementation fragmentation.

Legislation may be necessary to establish lead agencies for various projects. For example, DNREC should be the authorized leader for the Whole Basin Management plan, with other agencies as participating members. Similarly, there is a need to select a single coordinator for interstate water pollution control efforts with border states.

With WBM, DNREC has established itself as the leader towards ecosystem management in Delaware. It should assert this leadership to promote WBM, and at the same time, cooperate with other agencies whose input is necessary for the success of the plan. Ecosystem management efforts in other states have illustrated the accomplishments and mistakes made in this strategy, and thus should be examined by DNREC when further developing WBM programs. Then, hopefully, Delaware can take a giant step towards responsible management of its environment.

References:

- Caldwell, Lynton K. 1988. Perspectives on Ecosystem Management for the Great Lakes: A Reader. State University of New York Press, Albany, N.Y.
- Delaware's Environmental Legacy. January 1988. Shaping Tomorrow's Environment Today: A Report to the Governor and the People of Delaware. Dover, DE
- Delaware Estuary Program. September, 1996. Discover its Secrets: A Management Plan for the Delaware Estuary Environmental Protection Agency.
- Environmental Protection Agency- Office of Research and Development. Delmarva's Coastal Bay Watersheds: Not Yet up to the Creek Conference on Ecology and Economy: Ocean City, MD; March 8-9, 1996.
- Environmental Protection Agency- Office of Water. The Watershed Protection Approach: An Overview December, 1991.
- Funderburk, Steve. "Chesapeake Bay- An Approach to Ecosystem Management." Coastal Zone '95 New York: American Society of Civil Engineers, pp. 120-121.
- Hoeh, Roger Smith. 1966. Water Resources Administration in Delaware. Division of Urban Affairs, University of Delaware: Newark, DE
- Ibid. June 1995. Implementing a Vision for the Rivers: Final Report.
- Kinerney, Butch. 1996. "Oh How They Can Harmonize." in: *Outdoor Delaware*. Fall 1996
- MacKenzie, Susan Hill. Integrated Resource Planning and Management.
- Rabe, Barry G. 1986. Fragmentation and Integration in State Environmental Management. The Conservation Foundation, Washington, DC.
- Smith, Robert Leo 1972. The Ecology of Man: An Ecosystem Approach Harper and Row, New York.
- Telsey, Albert I. 1994. Delaware Environmental Law Handbook. Government Institutes, Inc.: Rockville, MD
- The Governor's Task Force on the Future of the Brandywine and Christina Rivers. October 1994. A Vision for the Rivers. Department of Natural Resources and Environmental Control: Dover, DE

State of Delaware, 1996 Watershed Assessment Report (305(b)), 1996, Department of Natural Resources and Environmental Control, Dover, DE

Water Resource Agency for New Castle County. Annual Report for 1994.

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Florida Department of Environmental Protection, Ecosystem Management Implementation Strategy Committee. September 1995. Ecosystem Management Implementation Strategy. Vol. 1: Action Plan, Vol. 2: Appendices

Hillsborough River Greenways Task Force, et al. January 1996. Hillsborough River and Bay Ecosystem Demonstration Project: Interim Status Report.

Southwest Florida Water Management District. June 1996. "Hillsborough River Watershed: Draft Plan."

Trimble, David. 1996. "Why Ecosystem Management?" in "State Environmental Monitor" September 2, 1996.

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Merrimack River Watershed Council. "Merrimack River Initiative."
<http://www.merrimack.org/who.html#mri>; 12/5/96.

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Glendening, Parris N. "Maryland Tributary Strategies- Restoring the Chesapeake: Statewide Summary." Maryland Department of Natural Resources, August, 1995.

Glendening, Parris N. Trib Team Monitor Maryland Department of Natural Resources: Volume 1 Number 1; Spring 1996.

Marx, Wesley. "Great Water Bodies at a Watershed." EPA Journal Volume 18 Number 4; September/October, 1992, pp. 45-47.

Maryland Department of the Environment. Tributary Strategy- Developed Land Nonpoint Source Nutrient Reduction Options Chesapeake Bay & Watershed Management Administration; 10/95.

Maryland Departments of Environment, Natural Resources, Agriculture; Maryland Office of Planning; Maryland Governor's Office; University of Maryland. Maryland's Tributary Strategies for Nutrient Reduction: A Statewide Summary University of Maryland; March, 1995.

Maryland Department of Natural Resources. "About the Tributary Strategies."
http://www.gacc.com/dnr/Bay/about_tribstrat.html; 5/19/97

Tassone, Joseph F.; Hall, Richard E.; Edwards, Nevitt S.; Weller, Deborah M.G. "Integrated Watershed Planning and Management: Growth, Land Resources, and Nonpoint Source Pollution." Watershed '96 Maryland Office of Planning; May, 1997, pp. 271-274.

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Department of the Interior, US Fish and Wildlife Service. September 1993. "Wallkill River National Wildlife Refuge." Sussex, NJ

Sussex County Municipal Utilities Authority. June 1996. "Wallkill River Watershed Management Plan: Preliminary Scope of Work."

New Jersey Register. February 22, 1994. "Environmental Regulation: Surface Water Quality Standards" Comments on Water Quality classification on the Wallkill River. (26 NJR 1124-1132)

Correspondence:

Letter from SCMUA to US Representative Marge Roukema. May 31, 1996

Ibid. October 18, 1996

Letter from US FWS to Commissioner Robert Shinn, New Jersey Department of Environmental Protection. September 8, 1994

Letter from US FWS to US Representative Marge Roukema. September 27, 1996

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Creager, Clayton S. and Baker, Joan P. 1991. North Carolina's Basinwide Approach to Water Quality Management: Program Description. North Carolina Division of Environmental Management (Report No. 91-08).

Draft: White Oak River Basinwide Water Quality Management Plan, July 1996. North Carolina Division of Water Quality, Raleigh, NC

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Chester County (PA) Conservation District and The Water Resources Agency for New Castle County (DE). Phase I: Nonpoint Source Pollutant Strategy for the Christina River Basin. May 15, 1995.

Lathia, Durla. Pennsylvania Storm Water Management Program Pennsylvania Department of Environmental Protection; September, 1996.

Pennsylvania Department of Environmental Protection- Bureau of Land and Water Conservation. Pennsylvania Nonpoint Source Program: Christina Basin Watershed Initiative 1996.

The Water Resources Agency for New Castle County (DE). (interview. March 1997)

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Department of Natural Resources- Forest Practices Division. Washington Forest Practices
Washington Forest Practices Board; July, 1995.

Puget Sound Water Quality Action Team. Puget Sound Local Watershed Action Program
August, 1996.

Puget Sound Water Quality Authority. Amendments to the 1994 Puget Sound Water Quality
Management Plan May 15, 1996.

Puget Sound Water Quality Authority. 1994 Puget Sound Water Quality Management Plan
Adopted 5/18/94.

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Wisconsin Department of Natural Resources. September 1996. Progress Report on Reorganization of
the Wisconsin Department of Natural Resources. Madison, WI

Wisconsin Department of Natural Resources. May 1995. Wisconsin's Biodiversity as a Management
Issue: A Report to the Department of Natural Resources Managers. Madison, WI