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Setting Priorities:

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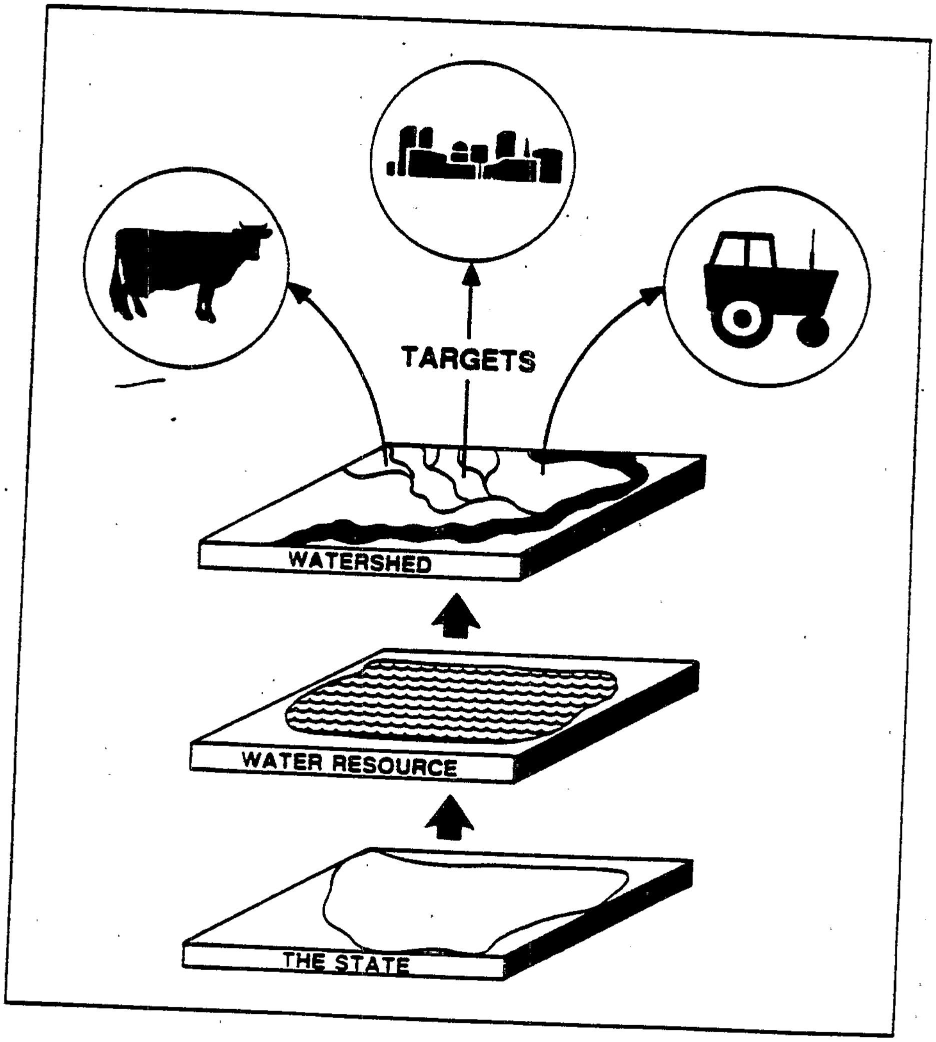

SETTING PRIORITIES: The Key to Nonpoint Source Control

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Final Report for the Project:
"Guidance Document on Targeting of NPS Implementation Programs to Achieve Water Quality Goals"

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PREFACE

In 1983, 6 of the 10 EPA regions identified nonpoint source (NPS) pollution as their primary obstacle to realizing the objectives of the Clean Water Act. They attributed this, in part, to progress in point source control during the previous 10 years, but also to a lack of progress in NPS pollution control. While point source control has matured, NPS control has been neglected, with very limited funding, relatively little research attention, and no federal regulatory authority. Although the 1972 Clean Water Act provided states with money to develop plans for both point and NPS pollution control (under section 208), until passage of the Water Quality Act of 1987 there was no provision to implement the NPS components of these plans.

The targeted approach, recommended here, focuses NPS implementation efforts to limited areas with the objective of obtaining visible achievements. This recommendation differs drastically from the more traditional approach in which program resources are made available to qualifying participants on an equal basis throughout the state. Although the latter approach is politically expedient and may achieve a great deal of NPS pollution control, its potential for producing any detectable change in a water resource within a 25-year period is quite low. The targeted approach, on the other hand, by concentrating pollution control efforts and applying all project resources to clearly specified goals and objectives can produce results in a reasonably short period, such as 5 to 10 years.

As of 1987, most states have recognized the need to treat NPS pollution to protect their high priority water resources, and many states are initiating programs to treat NPS pollution from agricultural, urban, and suburban areas. This document attempts to aid these developing NPS control programs by drawing from about 15 years experience in water quality projects including the Rural Clean Water Program, the Model Implementation Program, and water quality demonstration projects funded in the Great Lakes Basin. While the concept of targeting applies to all types of nonpoint sources, the emphasis in this document is primarily on agricultural nonpoint source control.

This document was written prior to passage of the Water Quality Act of 1987, and therefore, does not specifically address the NPS provisions of this Act. The Water Quality Act of 1987, in section 319, requires states to develop programs to manage nonpoint sources of pollution. Section 319 specifically requires states to prepare, within 18 months of enactment, an assessment report of their NPS problems and a management program for addressing NPS problems in the next 4 fiscal years. The Act authorizes $400 million over 4 years for grants to states for implementation of approved management programs. Thus, given this new mandate in the Water Quality Act of 1987, states have a new impetus to assess and prioritize their NPS problems and to develop new NPS programs and/or refine existing programs. This document should be helpful to states in developing their NPS assessment and management programs required by section 319. In addition, states should refer to EPA's guidance on implementation of section 319 for specific guidance on the requirements of this section.

EPA's Office of Water is encouraging states to develop comprehensive State Clean Water Strategies (SCWS) to help coordinate implementation of the NPS provisions and other provisions of the Water Quality Act of 1987. Central to the SCWS is the concept of targeting geographical areas for control action. The NPS targeting strategy, as presented in this document, is intended to complement the SCWS targeting concept, more specifically it is intended to present successful state approaches to targeting NPS water pollution problems.

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Targeting is a straightforward concept--identify priority water resources and treat the major sources of pollutants that impair those resources first. However, variability in hydrological systems can complicate the targeting procedure. This document is a working outline of the procedure and can provide insight for state and local decision-makers involved in developing, administering and implementing NPS control programs.

Many specific recommendations are listed but the need for states and localities to be flexible in their NPS control efforts is recognized, too. No two water resource problems, state agency infrastructures or watershed landowners will be exactly alike. Thus, program flexibility to address a wide range of environmental and socio-economic factors must be anticipated. Specific goals and objectives, however, remain the focal point of NPS control programs to achieve water quality improvements.

The nation is at a critical juncture in NPS control. With several years of project experience and research now complete, the ongoing process of expanding NPS control efforts nationwide lies ahead. Under the 1987 Clean Water Act, states must now begin the formal process to bring state water resource quality closer to the goals stated in the Water Pollution Control Act of 1972. This is an immense task which requires a sound perspective on how to proceed. Targeting provides this perspective.

SUMMARY OF RECOMMENDATIONS

Setting Priorities At The State Level

1. Establish water quality authorities of different agencies. Define roles and responsibilities of each participating agency. Appoint one agency to coordinate the NPS control program.

2. Set realistic program goals that will result in visible improvements in water quality for priority water resources. Goals should be attainable with the available financial and staff resources and within a reasonable timeframe.

3. Assess the institutional resources and capabilities of all agencies that will be involved in the program. Focus agency resources and expertise on NPS control efforts that will be most effective in achieving the stated program goals.

4. Establish a statewide water resource prioritization procedure to rank resources in priority for NPS control projects. Prioritization of water resources should be based on these criteria: identifiable water

resource problem that is controllable with treatment practices; high probability of successful treatment with the available funding and staff resources; and a high public use value.

Setting Priorities At The Watershed Level

1. Define the institutional responsibilities and roles of all participating agencies and establish one agency as the lead agency responsible for administering the project. Identify communication channels through which the project will operate. Appoint one project coordinator to manage the project.

2. Refine the nature of the water resource impairment identified during the statewide water resource prioritization process. Determine how much and what type of NPS reduction will be necessary to restore designated uses of the resource.

3. Develop a watershed profile that will serve as a project data base, including an inventory of nonpoint sources and point sources.

4. Establish water quality goals and objectives for each phase of the project. Establish goals that are quantitative and measurable with flexibility to accommodate appropriate modifications. Determine pollutant reduction needed to achieve water quality goals. Determine control options including land treatment, incentives for landowner participation and regulatory ordinances.

5. Assess methods for obtaining landowner participation and implement those which are appropriate for the project area.

6. The selection process should be based on the following five criteria:

    1) type and severity of water resource impairment;
    2) type of pollutant;
    3) source magnitude considerations;
    4) transport considerations; and
    5) project specific criteria.

    The procedure for selecting critical areas should follow farm level ranking of nonpoint sources. Two figures are provided on pages 39 and 40 as examples of farm level ranking for phosphorus and pesticide use to identify sources of priority resource impairment.

7. Carry out the BMP implementation and water quality monitoring program in such a way that impacts of treatment on water quality are documented from the start.

8. Maintain clear and accurate records of reporting, accounting and evaluation procedures throughout the project's life. A sample project report outline is listed in Appendix A.

Chapter One

SETTING PRIORITIES

This document presents guidelines and suggestions for designing and implementing a targeted nonpoint source (NPS) pollution control program to achieve improvements in water quality. Our theme is that a state's NPS control effort should be coordinated and directed to focus resources on clearly specified, realistic goals and objectives. Focusing program resources, or "targeting," is recommended as a means of optimizing the visible water quality improvement, thereby generating public support and participation for water quality protection programs.

Targeting should occur at all levels of a state program. The state program should select and target priority areas in coordination with national and regional goals. Within priority areas, the program should target water bodies that are likely to improve in quality as a result of NPS control treatment. Finally, within the targeted watershed, individual farms and fields should be targeted to optimize pollution reduction.

INTRODUCTION

Why Prioritize

Although high quality water resources are important to the economic welfare of a state and are valued by the public, there are not enough public funds to address all the significant water pollution sources that presently exist. Nor is this situation likely to change. Analysis of one of the earliest water quality demonstration projects, the Black Creek project in Indiana (35), showed that nearly $1 million in cost share funding was not sufficient to address all the pollution problems in a 10,000 acre agricultural watershed. The answer, suggested by the Black Creek project and reaffirmed in the Rural Clean Water Program (RCWP), is targeting.

The concept of targeting assumes that focusing state resources to a limited geographic region improves the chance of achieving visible water quality improvement. Further, it assumes that as a result of demonstrating water quality benefits the public will become more supportive of NPS control programs and more closely attuned to overall water quality goals. Such a change of attitudes with a corresponding increase in pollution control knowledge and skill is the primary ingredient of lasting water resource protection.

National and State Water Resource Priorities

Before a state begins to target its nonpoint source problems, it should consider any recognized national, regional, or interstate priorities. For instance, restoration of the Chesapeake Bay, international treaties concerning the Great Lakes, and the quality of the Ohio River are clearly stated high priority water resource concerns shared by several government entities. Coordination among these entities is essential to achieve water quality improvements in shared water resources. Thus, for example, states in the drainage of the Chesapeake Bay are working under a cooperative agreement to reduce NPS loading to the Bay.

A state should consider the impact of treating one resource and affecting another. For example, there should be an initial decision between targeting surface water versus groundwater, streams versus downstream lakes or reservoirs, or upstream lakes or reservoirs versus estuaries.

State and Watershed Level Targeting

State level targeting refers to prioritization of water resources for treatment. This process is a ranking of resources according to specific criteria which are indicators of a high probability of NPS project success. Success is important for building public support and individual responsibility for pollution control.

Once the priority water bodies have been identified, the project can determine whether or not available resources are sufficient to implement enough pollution control to achieve the water quality objectives. If resources are not sufficient, the prioritizing procedure can be repeated to target subwatersheds with definable water quality problems that can be solved.

Targeting at the watershed level involves identifying the predominant pollutant sources, prioritizing these sources and treating first those critical areas that contribute the most to the designated water resource impairment. A targeting program designed to treat the major sources first can substantially expedite the achievement of water quality goals.

OVERVIEW OF A NONPOINT SOURCE IMPLEMENTATION PROGRAM

Three major steps are involved in determining how to control nonpoint sources of pollution. First, a careful analysis of institutional resources and capabilities should ensure that program goals are achievable. Next, priority areas must be chosen where implementation efforts will be focused. Finally, an implementation strategy which considers site-specific factors should be designed for each priority area.

Nonpoint source pollution control requires the expertise and cooperation of diverse agencies and organizations. National agencies can bring external funding, related experience from similar projects, and other benefits to state NPS projects. Where possible, appropriate regional agencies should be involved because the water resources of a state are seldom independent of those in neighboring states, and interstate cooperation can benefit all participants. Local agencies and organizations are essential because they provide the commitment and implementation effort that determines ultimate success or failure.

Water quality agencies, primarily at the state level are recommended as the most appropriate coordinators because their mission generally overlaps most environmental interests and is usually closest to the water quality objectives of the project. Assistance and input from other environmental agencies or organizations, too, is valuable. Agencies or organizations representing agriculture, forestry, mining, urban and suburban sediment control, stormwater management, and water resource planning should participate. Agencies or organizations involved in planning or management of recreation can play an important part in planning, justifying, and evaluating the success of a pollution control project.

Once institutional capabilities have been determined, a select number of areas should be targeted and site-specific NPS implementation strategies developed. The selection of NPS priority watersheds should be part of a Continuous Planning Process as mandated in section 303 of the Clean Water Act. This is described in detail in 40 CFR 130 - the Water Quality Planning and Management Regulations.

States may also choose to select areas with groundwater problems for development of site-specific NPS implementation strategies. EPA is currently developing guidance for classifying groundwater. This guidance will assist states in determining which groundwater areas should be targeted for further NPS control.

Chapter Two

SETTING PRIORITIES AT THE STATE LEVEL

Priority areas designated for treatment to improve water quality may be selected for different geographic scales: regional (e.g., Chesapeake Bay and the Great Lakes area), watershed (e.g., James River), subwatershed (e.g., Appomattox River), and farm levels. The area covered in each of these levels may vary considerably from a small section of a watershed to basins of several million acres.

At the state level, water resources should be prioritized to achieve an optimal distribution of efforts and funds. The development of a procedure to prioritize state water resources should consider several factors, including: 1) concerns and interests of participating agencies, 2) establishment of realistic goals, 3) resources and capabilities of institutions; and 4) criteria such as water quality problems, economic factors, political considerations, and cooperation. This chapter describes methods for establishing a statewide water resource prioritization (WRP) program based on these factors.

ESTABLISH AGENCY AUTHORITIES

It is critical when establishing a state WRP program to determine clearly which agencies have the authority to perform certain tasks. Without definition of authority, replication of efforts, conflicts between agencies and/or omission of tasks could occur, thereby reducing the effectiveness of the program.

All appropriate agencies should be encouraged to contribute to a WRP program. The state should draw on federal, regional, state, county, and local agencies to the extent possible. Because the causes and impacts of water quality problems are diverse, a wide selection of agencies should be involved. Appropriate state agencies may include those with interests in 1) water resource planning, 2) natural resource protection, 3) land use planning, 4) point source regulation, 5) agriculture, mining, construction, 6) economic evaluation, and 7) health and welfare.

Interagency Commitments

Multiple levels of commitment from some agencies may be necessary. Participating state and federal agencies should pass authority to complete project tasks to their local counterparts once a watershed is selected. For example, the state office of the Soil Conservation Service may be involved in selecting priority areas; and county personnel should be given authority to conduct the implementation of treatment within the selected priority areas. Multiple levels of commitment by different agencies allow efficient collection of data, formulation of plans and utilization of limited staff resources. Involving different agencies will generate broad support in the selected priority areas.

Coordination Among Agencies

Because several agencies will be involved, coordination among the agencies is essential. Together, agencies should determine the role each will fulfill such as data collection, technical assistance, financial management, educational assistance, enforcement of regulations, program development and implementation. It is recommended that one state agency be accountable for all aspects of the WRP program. This does not mean that only one agency participates in the program activities; rather, one agency is responsible for coordinating the activities of the many agencies that have WRP program responsibilities. Appropriate and clearly stated authorities should give a firm foundation to a WRP program.

SET REALISTIC PROGRAM GOALS

Once a network of agencies has been established and agency commitments have been specified, program goals should be developed. Goals should be clearly stated to the extent possible in quantitative, measurable terms so that progress and accomplishments can be assessed. Flexibility should be allowed so that individual projects within the program can modify their goals as knowledge of the dynamics of their water resource problem is obtained.

Quantitative and Measurable

Quantitative goals may be based on water pollution standards, pollutant concentrations and/or loadings, restoring biological resources, or the amount of land or sources treated. For example, a quantitative goal would be to meet state standards for a designated use, such as the maximum fecal coliform concentrations and frequency of exceedance allowed for shellfishing waters. On the other hand, a goal for a specific project could be to achieve a stated average condition, such as concentration of nitrate nitrogen (N), or to achieve a loading reduction, such as for sediment or phosphorus. Many nutrient and sediment control projects focus on achieving a certain percent reduction in concentrations and/or loadings. Such goals should be based on the estimated magnitude of reduction necessary to achieve a perceptible change in water quality. Progress toward these quantifiable goals can be measured through achievement of operational goals expressed in conventional land treatment terms. For example, operational goals may be to treat a specified percentage of targeted cropland with conservation tillage or number of identified animal operations with barnyard runoff controls. Operational goals provide a framework for accounting on-the-ground project implementation. These goals should be very specific, distinguishing treatment of critical areas from general conservation needs.

Interim goals can be developed for phases of the project. These project goals should correspond with the time required to complete various activities and should anticipate the response time of the water resource.

Timeframe

In establishing program or project goals, the timeframe for implementation and water resource response should be considered. Some water resource problems respond quickly to intensive treatment, whereas others require extensive treatment and involve long response times. Likewise, certain types of water resources respond rapidly to treatment. For example, a first order stream would respond more quickly than a lake (2).

There are two timeframes to consider in establishing realistic goals: 1) the time in which water resources can actually improve to the desired level in a physical, chemical, biological, or aesthetic sense, and 2) the time required to document the water resource improvement through monitoring. The latter consideration achieves accountability but places more constraints on the project, because it requires a monitoring timeframe that includes a pre-treatment period, an implementation period, and a post-treatment period. As illustrated by the Model Implementation Program, too often in NPS projects the time allowed for observing water resource benefits does not realistically consider start-up periods, pre-implementation water quality data needs, Best Management Practice (BMP) implementation stages, and the responsiveness of the water resource (3).

ASSESS INSTITUTIONAL RESOURCES AND CAPABILITIES

Focus Resources

A key to developing a successful NPS implementation program is to focus efforts on only as many water resources as can be adequately treated with the financial and technical support available. Spreading implementation funds too thinly reduces the chance of obtaining any observable impact on water resource quality. First, the treated water resources will not respond sufficiently to restore impaired uses, and, second, public and legislative enthusiasm for NPS implementation will decline before the goals are achieved. Demonstration of successful NPS control in a few intensive projects can be more effective than treating a large area where water quality effects may take much longer to observe.

It is important that water resource problems be assessed and prioritized before state level funding requests for implementation are made. Ideally, funding decisions should be based on information from assessment of economic use impairments and the anticipated cost to alleviate the problems. In many cases, doing nothing about an NPS impairment incurs tremendous cost to the economy of a state. For example, closure of Oregon's Tillamook Bay to commercial and recreational shellfishing by the Federal Food and Drug Administration would have cost the public more than $30 million in benefits over a ten year period. The cost of the Rural Clean Water Program (RCWP) project to clean up dairy wastes was $6 million, considerably less than the benefits (4).

Additional Resources

Intensified NPS control efforts within a particular watershed require appropriate fiscal authorizations and experienced technical assistance staffing. Funds are needed for information and education programs such as field days, meetings, and one-to-one contact and service programs, such as BMP demonstrations, pest scouting and soil sampling services. Such programs have been helpful in obtaining participation in NPS programs and have aided in reinforcing the proper use of implemented practices (5,6). To conduct these information and education or technical assistance programs, projects require funds and personnel in proportion to the size of watershed and the intensity of the programs.

Expansion of NPS control efforts to include additional watersheds, too, requires additional fiscal authorizations to cover the expanded work load. Without additional funds and staff, newly designated projects will drain these resources from established projects and diminish the potential for all projects to achieve their goals.

RANK NONPOINT SOURCE PRIORITY AREAS

Criteria for Statewide Prioritization

Prioritization of state water resources affected by NPSs should be based on the following three criteria:

1) the water resource problem should be identifiable and controllable with treatment practices;

2) treatment should have a high probability of producing visible water quality improvements with the level of funding available; and

3) the water resource should have a high public use value.

Priority for treatment should be given to those water resources which meet the above criteria.

Probability of success is vital to the state's ongoing NPS control efforts. In order to achieve water quality goals, NPS control must become a public concern with heightened individual awareness of responsibility for resource stewardship. Such concern and awareness will develop more easily when a state program can demonstrate the value of NPS control with examples of successful projects which yield public benefits.

Development of operational guidelines for identifying and selecting priority areas is the next step in the prioritization process. There are five general categories of factors which need to be considered when developing these guidelines.

1) degree and type of water resource problem
2) economics
3) politics
4) willingness and capability of participants
5) institutional constraints

Degree and Type of Water Resource Problem. Several factors should be considered when evaluating a water resource problem, including the degree and sources of impairment, the type of water resource, and the type of pollutant. The severity of existing problems, potential for resource degradation, and the estimated magnitude and distribution of pollutant sources should also be examined. Water quality degradation could have many causes, and it is often not only a result of NPSs but other pollution sources as well. Water quality problems attributable to specific point sources often have an NPS component that must be treated. Therefore, some water resources require treatment of both point and nonpoint sources to meet the desired level of water quality improvements.

Once the severity and sources of the problem have been assessed, treatment feasibility should be evaluated. The biological and physical complexity of water resources may complicate treatment selection. For example, areas with surface and groundwater problems may require specifically tailored approaches. The type of pollutant may also dictate the type of treatment needed to alleviate a particular water quality problem.

Economics. The two main economic factors are costs incurred due to use impairment and restoration of the impaired uses. Benefits from agricultural NPS treatment may be designated as on- or off-site as well as short- or long-term. Recipients of these benefits may be landowners (e.g., farmers or property owners near water bodies), communities (e.g., consumers of public drinking water supplies and recreational opportunities), or commercial enterprises (e.g., fisheries or recreation-based enterprises). Part of the prioritizing process should include an assessment of the water resource use by the public and the economic value of this use. The estimated amount of funds required to implement a project should be compared to the estimated benefits. Attention should also be given to the distribution of these benefits among all participants, including private citizens, local entrepreneurs, and the local, state or regional community.

Politics. Political factors always influence the selection of priority water resources, and these factors must be incorporated in the process in a way that strengthens the program. Politically favored projects are projects which have outstanding interest group support. These projects may be used to showcase the entire program. Care must be taken, however, to assure that such projects meet the program's technical selection criteria. These projects should not utilize funds and personnel in excess of the shares committed to their level of priority within the entire program.

__Willingness and Capability of Participants.__ Landowner participation is essential for a successful agricultural NPS control program. Most NPS control projects have relied on a voluntary approach, usually through cost sharing incentives. Voluntary participation implies landowner acceptance of water quality goals and a commitment to project objectives. The voluntary approach, however, has not always been successful. Economic stress, in particular, has been an obstacle. An important step in program development is to examine the willingness and capability, and economic condition of landowners and local agencies within project areas.

__Regulatory Authority.__ The use of regulation could change the perspective of landowner participation. Two project areas within the RCWP have regulatory authorities and have had extremely high landowner participation (FL-RCWP, OR-RCWP). For example, the existence of regulatory authority, although not used at the present, has greatly encouraged the voluntary participation in the Florida RCWP project. Thus, regulatory authority, if available, is likely to increase the voluntary cooperation of landowners.

__Institutional Constraints.__ Some final considerations are the constraints on agencies which may be involved in the NPS control program. Though water quality related, the mandate of some agencies may be quite rigid, restricting the ways in which these agencies can participate in the state program. Constraints on time commitments and staff availability will also affect the roles of different agencies participating in the project.

Examples of Statewide Water Resource Prioritization

Various strategies have been utilized by states in the prioritization of water resources. Several states use screening models to prioritize their water resources, whereas at least one state, Illinois, has more of a local grassroots approach. Five such selection processes are discussed here to represent different approaches used by Maryland, Pennsylvania, Illinois, Ohio, and Wisconsin.

__Maryland.__ A rating system where watersheds are ranked and selected by state agencies was developed for prioritizing Maryland's watersheds based on agricultural nonpoint sources of pollution (7). This procedure was developed by a technical team established by the Maryland State Soil Conservation Committee. This committee, in cooperation with the Maryland Department of Natural Resources and Office of Environmental Programs of the Department of Health and Mental Hygiene, used this procedure to prioritize the state's watersheds.

Separate rankings for potential, not measured, loadings of P and N were developed for two levels: 1) the potential loadings that occur at the base of each of the 124 watersheds; and 2) the potential loadings of each watershed into Chesapeake Bay.

A relatively straightforward set of criteria was used in the ranking process, including the amount of agricultural land, percentage of such land on steep or permeable soils, use of conventional versus conservation tillage, and potential P delivery estimated on the basis of fertilizer and manure application rates and calculated delivery rates. The use of other soil conservation BMPs in addition to conservation tillage is not considered by this classification scheme.

One advantage of this ranking system is that it does not require extensive data collection. In fact, most of the necessary information could probably be obtained from existing resource surveys. Second, the system allows screening of all watersheds within the state with respect to their potential effects on a regional water resource, Chesapeake Bay. The disadvantages are that it does not include a factor for the sensitivity to impairment or quality condition of the water resources within each watershed.

Pennsylvania. Pennsylvania's system for prioritizing water resources is similar to Maryland's in that the system is initiated at the state level by the Department of Environmental Resources. A departmental task group of experts in soils, water quality, and agriculture has developed and implemented a priority ranking procedure using uniform criteria to assess each watershed within the state. In contrast to the Maryland system, Pennsylvania's criteria consider the use of cropping practices, site-specific factors (e.g., soil erodibility and rainfall intensity), and an index representing the sensitivity of lakes and impoundments within the watersheds (8). Pennsylvania's system also includes a factor representing the effects of acid mine drainage as well as agricultural nonpoint sources. These factors were placed into a formula to rank all 104 watersheds in the state.

Pennsylvania's prioritization scheme was taken from their section 208 plan. The use of section 208 plans by other states in the development of water resource prioritization programs may be beneficial. However, since the initial section 208 plans were developed some time ago, these plans should be reevaluated and updated. Some section 208 plans may not be adequate due to the lack of knowledge or emphasis placed on nonpoint sources when the plans were developed. Pennsylvania has a mechanism to update previously ranked watersheds using new information on stream P-levels. Such watersheds may advance in treatment priority.

Advantages of Pennsylvania's approach are that it considers more specific information about the cropping practices and also allows for consideration of the quality conditions of the lakes and impoundments. For this very reason, however, it requires more data and effort to compile information and calculate the ratings.

Illinois. Unlike the two approaches described above, Illinois uses a grassroots approach initiated at the local level for prioritizing watersheds in need of agricultural NPS treatment. Watershed projects are identified at the county level, and reviewed, screened, and prioritized at county, regional, and two state levels (9). Emphasis is placed on soil erosion because it has been identified as the most severe NPS related problem.

The primary level of authority for NPS control involves county personnel, including the soil and water conservation districts (SWCDs). Potential projects based on an inventory of critical areas are being developed by the SWCDs along with other local agencies. If a county submits more than one potential project, then it must prioritize them. The first review of submitted proposals must be done by a committee representing a region of the state. The regional committee reviews potential projects submitted from the counties in its area, then prioritizes the proposed projects and passes them with rankings and comments to the State Watershed Priority Committee. The state committee may seek additional information from individual potential projects by direct request to the counties. It submits complete plans to the State Soil Erosion and Water Quality Advisory Committee, the fourth level of governmental review, for final approval of the resource prioritization and recommendations.

This grassroots approach gives strength to the program by utilizing the people who are most familiar with local water resources. On the other hand, only those projects submitted by the counties are considered. If a particular county did not have personnel who were ambitious enough to submit plans, critical areas in that county would be overlooked. In addition, counties that can make themselves heard might be given preference, even if these counties did not actually have water resources that merited priority program funds.

<u>Ohio</u>. Ohio utilizes a much more data intensive approach to water resource prioritization. In addition to agricultural NPSs, the strategy considers other sources of pollution (e.g., wastewater treatment, waste disposal, and other NPSs) and different uses of water resources (e.g., public water supplies, groundwater supplies, and recreational resources). The strategy uses a computerized information system with nine maps or layers of information. Information from these nine maps is used by individuals or small groups of individuals within various state agencies to select independently watersheds for treatment. Emphasis is placed on restoration of water bodies with the most severe degradation and the <u>need</u> for protecting the most valuable resources. Watersheds that are selected by more than one group are reviewed by a policy team which formulates the final prioritization.

This method employs a sophisticated data analysis system interpreted through professional judgment. It emphasizes multiple sources of water pollution and considers the uses of these water resources. The disadvantage of such a system is that it is expensive to develop the data base. However, once the data base has been developed, it can easily be updated and maintained and has numerous other uses for resource assessment and planning.

<u>Wisconsin</u>. The State of Wisconsin has designated its Department of Natural Resources (DNR) as its lead NPS agency, and the DNR has developed a process for ranking state priority areas. The DNR has ranked each of the state's 330 watersheds according to severity of land management and water quality problems. Watersheds generally overlap two to three counties, including about 100,000 acres. Priority watersheds are those where NPS problems occur over extended areas and where major portions of the watersheds require intensive NPS controls. Watershed projects address agricultural as well as urban problems.

The selection process for priority watershed projects is designed to involve local and regional interests while meeting statewide water quality goals and objectives. Accordingly, it is designed to incorporate quantifiable and nonquantifiable criteria.

The primary selection criteria are: <u>1</u>) the severity of water quality use impairments; <u>2</u>) the practicability of alleviating the impairments; and <u>3</u>) the threat to high quality, recreationally valuable waters. Secondary criteria include: 1) the potential to achieve a significant reduction in the amount of pollutants from the nonpoint sources in the watershed; <u>2</u>) willingness and capability of counties, cities, and villages in the watershed to initiate the project within a 2 or 3 year period; <u>3</u>) likelihood of owners or operators of critical nonpoint sources to participate in the project; and <u>4</u>) public use of the lakes, streams, and groundwater (10).

The Wisconsin DNR uses a four step process to select priority watershed projects. The first step is a technical screening to identify the top 25% of the watersheds with the most severe land management and water quality problems. The screening is based on weighted land management and water quality characteristics. Land management characteristics include the extent of severe soil erosion, the extent of urban land in the watershed, and the concentration of animals in the watershed. Water quality characteristics include the extent of acreage in lakes and streams.

The second step involves regional review of the top priority watersheds. Regional committees review the watersheds in their areas and each nominates three watersheds for further consideration. This process narrows the list to about 30 eligible watersheds. Regional committees may nominate one or more "wild card" watersheds not on DNR's initial screening. The "wild card" concept assures that watersheds which have significant local merit (e.g., high public use) or unique problems (e.g., groundwater protection needs) are considered. The review is based on the criteria listed above.

The third step is review by a state level committee consisting of various agency and interest groups. This state committee narrows the list to 15 to 20 watersheds for inclusion in a selection pool.

The final step is DNR's selection of priority watershed projects from the selection pool. Projects are selected annually by DNR in accordance with available funds. The first three steps in the process are repeated every 2 or 3 years.

Groundwater in Statewide Prioritization

Another factor affecting statewide prioritization of NPS problems is the identification of groundwater recharge areas needing a high level of protection from nonpoint and other pollutant sources. According to a recent EPA report, nearly half of the states have developed or proposed groundwater classification systems (11). These systems are being used by states to set priorities for groundwater protection since such systems typically identify a range of groundwater uses and the value attached to each use. Different uses merit different levels of protection. Certain decisions regarding facility siting, acceptable land management practices, and contamination cleanups will be based on these state classification systems. State NPS programs should integrate groundwater protection needs in any scheme for prioritizing state NPS problems. A state's highest NPS control priority may be to protect one of its sole source aquifers for public drinking water supplies.

The 1986 Amendments to the Safe Drinking Water Act (SDWA) established two new programs which will affect state efforts to protect groundwater from nonpoint and other sources of pollutants. Specifically, the Amendments created the Sole Source Aquifer Demonstration Program to protect critical portions of designated aquifers and the Wellhead Protection Program to protect areas around wells supplying public drinking water systems. These two new programs will provide resources for planning and implementation, and therefore, will affect state NPS control activities. Presumably, some NPS implementation activities will be conducted in states in conjunction with these two new programs.

• The Sole Source Aquifer Demonstration Program, SDWA section 1427, requires EPA to establish demonstration programs to protect critical aquifer areas, that is, to protect all or part of a designated sole source aquifer from degradation. EPA is to establish, by June 1987, criteria for selecting critical aquifer areas. States and local authorities then are to map these areas and provide a comprehensive protection plan to EPA for such areas. Once a plan is approved, EPA may enter a cooperative agreement to implement a project on a 50/50 funding basis. The maximum grant to a state for any one aquifer is $4 million per year.

• The Wellhead Protection Program, SDWA section 1428, requires states to develop programs for protecting areas around wells supplying public drinking water systems from contamination that could harm public health. EPA is to provide criteria to states for defining wellhead protection areas by June 1987 and states have three years to submit plans to EPA. State wellhead protection programs must identify the responsibilities of state and local governments among other requirements. Upon EPA approval, states are eligible for EPA grants for 50 percent of costs of plan development and implementation.

Chapter Three

SETTING PRIORITIES AT THE WATERSHED LEVEL

Once statewide NPS-affected water resources have been prioritized and decisions have been made concerning how far down the priority list the state program can spread its efforts, problem definition and implementation strategies within selected watersheds must be further refined.

DEFINE INSTITUTIONAL RESPONSIBILITIES AND COMMUNICATION CHANNELS

The Lead Agency

Table 1 (page 15) provides an outline of the primary steps for assessing institutional arrangements. Once the lead agency has been designated, it has the responsibility to identify other potential cooperating agencies such as: USDA Agricultural Stabilization and Conservation Service (ASCS), USDA Soil Conservation Service (SCS), state Cooperative Extension Service, US Geological Survey (USGS), state agricultural agencies, regional agencies and planning commissions, and conservation districts and Agricultural Stabilization and Conservation committees. Public land managers such as Bureau of Land Management and Forest Service personnel should be included. Experience has shown that including all affected or related parties at the planning stage is critical in getting a NPS control project off on the right foot.

The Project Coordinator

Some important lessons learned in program management have come from the Model Implementation Program (MIP) (3). Perhaps foremost among these is the strong MIP recommendation that individual NPS control projects designate a coordinator. Ideally, the coordinator should be a person with both water quality and project management experience. Those MIP projects which had no project coordinator experienced problems such as lack of interagency communication and confusion over responsibilities. The coordinator should be involved from the outset of project planning on a full-time basis.

The MIP experience also indicates that a lead agency should be designated to coordinate project activities. Preferably, the lead agency should be locally based and have water quality concerns as a primary mandate. Although MIPs focused only on agricultural NPS control, these recommendations should apply to other types of NPS control projects as well.

TABLE 1. STEPS IN INSTITUTIONAL ASSESSMENT

1. Identify Cooperating Agencies:

--Federal, state, and local government
--Planning districts
--Private groups/organizations

2. Assign Lead Agency With:

--water quality as a primary mandate
--state accountability

3. Evaluate Cooperating Agency Roles:

--data gathering
--delivery service
--technical assistance
--monitoring and evaluation
--financial services

4. Delegate Authority According To:

--agency mandates
--financial resources
--agency management commitments
--legal authority
--ability to obtain project funding independent of the other cooperators
--the agency's local commitment to the project

5. Produce Summary Document Outlining:

--rolesandresponsibilities
--coordinating mechanisms

Establish Agency Roles

The cooperating agencies should meet and determine the role each will fulfill in carrying out the project: data collection, service delivery, technical assistance, program development and implementation, public relations, etc. An evaluation should also be made of each agency's potentially available NPS resources: money, grant funding, loans, cost sharing programs, legal authority, and personnel.

We recommend that a written summary be developed to define the roles and responsibilities of each agency and the mechanisms to ensure effective coordination. This explanation of designated responsibilities of each agency, signed by all participants, will serve to clarify each agency's role and prevent future misunderstandings. Although in many states this was done in a general way as part of the section 208 planning process, NPS implementation plans at the project watershed level need to be much more specific in terms of tasks and responsibilities.

Institutional capabilities must be evaluated before, during, and after specific implementation sites are chosen to ensure that adequate resources are available and responsibilities are clearly delegated. A basic recommendation from the MIP experience is that agency responsibilities and tasks be defined clearly, agreed upon, and recorded in written contracts and memoranda of understanding (3). Table 2 provides an overview of agency capabilities and possible roles in NPS projects.

TABLE 2. INSTITUTIONAL ASSESSMENT, CAPABILITIES AND POTENTIAL ROLES FOR COOPERATING AGENCIES AND ORGANIZATIONS.

Agency/Organization	Capability/Expertise	Possible Role
USDA Soil Conservation Service	Technical guidance on soil conservation, animal waste, and water quality management systems	Assessment of soil and water resources; incorporate water quality goals in farm plans; assure proper BMP implementation; data source for project planning
Cooperative State Extension Service	Education of farm and nonfarm audiences; technical advice; fertilizer and pesticide management programs; manure and soil testing	Informational and educational support; identifying agricultural community leaders; motivational support; 4H youth projects
USDA Agricultural Stabilization and Conservation Service	Cost sharing for approved soil conservation or water quality management practices; agricultural data and crop statistics	Financial incentives for participation; provide records of present conservation status
US Environmental Protection Agency	Water quality monitoring; evaluation of resource impairment; control of point sources	Water quality technical assistance; clarifying regulatory options; guidance for project management and reporting; data source for project planning
US Forest Service	Technical assistance in forest management; assistance for tree planting and harvesting	Technical assistance to landowner; assessment of forest-related NPSs
US Geological Survey	Watershed monitoring; hydrologic information	Data source for project planning; assistance in developing a monitoring plan
US Fish and Wildlife Service	Information on impairment, value, and recreational use of water resource	Planning and justifying NPS control project
State Department of Agriculture	Crop statistics, cost sharing programs; liaison to farm community	Project planning

(Continued)

Table 2 (Continued)

State Water Quality or Environmental agency	Water quality monitoring; water quality assessments; establishing quality standards; regulatory authority	Coordination of NPS project; monitoring water resource impairment
Regional/local planning agencies	Planning capabilities; resource assessments; coordination of local efforts; identification of funding options	Coordination of local agencies; reporting on progress and objectives
Soil and Water Conservation Districts	Administration of local agencies reporting on progress	Leadership in local initiatives; technical assistance with soil conservation or water quality management; targeting farms; education
Landowner associations, environmental groups, commodity groups, farm groups	Contacts with individuals affected by project; support for project objectives; education and information	Information and awareness efforts; promote local support and participation

DEFINE NATURE OF WATER RESOURCE IMPAIRMENT

Once project areas have been chosen from the prioritized list and the institutional/organizational framework and responsibilities have been mapped out generally, the next step is to refine further the nature of the water resource problem. This will facilitate more accurate critical area identification and BMP selection.

Pollutant Loads Versus Concentrations

Many previous agricultural NPS control projects (e.g., LA-RCWP, IL-RCWP) have stated water quality goals in terms of pollutant loading reduction without due consideration of the actual use impairment. For example, if a river is impaired by pesticide inputs (e.g., fish kills, loss of submerged macrophytes, high residue levels in fish tissue, violations of drinking water standards), reducing pollutant loads is often not an appropriate goal. These impairments are usually caused by high ambient or peak pesticide concentrations as opposed to loads. Thus, in this case, pesticide BMP options should be selected for their effect on concentrations rather than loads. It is possible that peak concentrations exist when loads are low if the amount of pesticide in runoff is high and volume of runoff is low.

This concept has important implications for groundwater protection. For instance, practices which increase infiltration of water through the soil profile, such as no-till or terraces on cropland, may significantly reduce pesticide loads to surface waters. However, research shows that when runoff volume decreases by a greater amount than pesticide loads decrease, pesticide concentration in runoff actually increases (23). Conversely, although more pesticide might be leached to the groundwater, the resulting concentration of pesticide in the aquifer might, in fact, be reduced through dilution by the increased infiltration.

With such considerations in mind, a project might opt to cost share management practices which reduce pesticide use rather than ones which affect runoff and infiltration. For NPS control projects addressing lake eutrophication, setting project water quality goals in terms of nutrient load reductions will often be very appropriate. It should be noted, however, that changes in pollutant concentrations in response to NPS control measures are often much easier to document through monitoring.

If the impairment is related to the sediment filling of a water supply reservoir, then it would not be appropriate to state the project's water quality goal as a reduction in mean annual sediment concentrations. Since the majority of sediment is usually transported by a very few major runoff events, mean annual sediment concentrations could decrease while total sediment loads actually increase. This again has important implications for BMP and critical area selection. Some BMPs (e.g., contouring) control erosion very well and are most cost-effective for small to moderate rainfall events but have almost no effect in major storms. In terms of critical area selection, if the impairment is related to turbidity, then areas of the watershed with fine erosive soils might be much more critical than those with the highest gross erosion rates (e.g., IL-RCWP).

Dynamics of the Impairment

Determining other dynamics of the impairment such as whether it is continuous, periodic, or seasonal can provide insights for critical area and BMP selection. A closer examination of the hydrology of the impaired water resource also helps to delineate critical areas. For example, the impairment (e.g., fish kills, algal blooms) may occur only in the upper portion of the reservoir, in which case tributaries which drain only into the lower part of the reservoir probably would not need to receive treatment to alleviate the impairment.

Examination of historical water quality data is an obvious but often overlooked means of obtaining additional insight into the dynamics and causes of the water quality problem. For example, in the PA-RCWP, determination of the correlation between groundwater nitrate levels and major recharge events enabled the project to estimate the timeframe within which land treatment and nutrient management might affect changes in the aquifer nitrate concentrations.

Attainability of Use

A central activity of a targeted NPS project is to determine how much and what type of NPS reduction will be necessary to restore designated uses of the water resources. A reduction estimate should be made for each water resource as part of the state-level targeting process. However, further refinement at the individual project level is necessary to make good decisions concerning which NPS treatment options to use and how much of the watershed area is critical. Another important factor in the use attainability analysis is public perception of the use impairment. We have found, particularly in projects with fishing and other recreational impairments, that as the public becomes aware of the NPS control project activities, perceptions that the water resource is becoming acceptable for previously impaired uses increases overall public use. In such situations (e.g., IA-RCWP, SD-RCWP, AL-RCWP, OR-RCWP), money and effort spent on information/education and public relations might be at least as effective in attaining designated uses as expenditures for land treatment.

DEVELOP WATERSHED PROFILES

A watershed profile document should be developed to support land use maps. This type of document can serve both as a data base and a baseline of resource information. The profile should include an inventory of potential pollutant sources which is more thorough than the general inventory used to prioritize watersheds at the state level. The inventory should be conducted early in the project as it is vital in developing a realistic implementation strategy. A data gathering planning session held before data is collected will help ensure all the necessary information is obtained as easily as possible and a data management plan is considered.

Point Sources

Discharge monitoring or NPDES permit data should be used to develop estimates of the pollutant inputs of each point source. Such estimates need only be determined for the pollutants known or suspected to cause the identified water quality problems.

Nonpoint Sources

The watershed inventory should consider all potential nonpoint sources. Some of the sources that should be considered are listed in Table 3 on page 22. Based on the information contained in the watershed profile, major sources of loadings can be identified, BMP options developed, and implementation goals established. Data may be limited, especially on sources of groundwater contamination. However, an adequate data base is vital if the program is to set and achieve water quality goals.

Sources of Information

The watershed inventory should be tailored to address the identified water resource impairment. Detailed information on use of fertilizers, manure, pesticides or other toxics may be required depending on the specified use impairment. Information is available from a variety of sources. One valuable source of information is fish and wildlife departments, both state and federal. Most fish and wildlife departments have an individual who is very knowledgeable about a particular stream or water body and its problems. SCS and Extension programs, too, have a large reservoir of information concerning agricultural areas. The county ASCS office has a list of agricultural operators with detailed accounting of participation in federal conservation or commodity programs. The ASCS office also will usually have estimates of crop types and acreages, other land uses and aerial photos. Local planning departments and USGS monitoring stations can also provide useful information. Wasteload allocation calculations and watershed loadings models can be helpful as well.

An inventory of permitted point source discharges can be obtained from the state water quality agency or directly from EPA's STORET program. Other useful sources include municipal governments, state highway departments, and chambers of commerce.

TABLE 3. POLLUTANTS AND MOST LIKELY SOURCES TO CONSIDER IN A WATERSHED INVENTORY

Pollutant	Possible Sources
Sediment	cropland forestry activities pasture streambanks construction activities roads mining operations existence of gullies livestock operations (streambanks) other land disturbing activities
Nutrients	erosion from fertilized areas urban runoff wastewater treatment plants industrial discharges septic systems animal production operations cropland or pastures where manure is spread
Bacteria	animal operations cropland or pastures where manure is spread wastewater treatment plants septic systems urban runoff wildlife
Pesticides	all land where pesticides are used (cropland, forest, pastures, urban/suburban, golf courses, waste disposal sites) sites of historical usage (organochlorines) urban runoff irrigation return flows

ESTABLISH WATER QUALITY GOALS AND OBJECTIVES

Quantitative, Measurable and Flexible

Quantitative and measurable goals provide reference points toward which all other project activities can be directed. Individual project goals should be more specific but still compatible with overall state program goals.

Experiences from the MIP and RCWP programs demonstrate the importance of quantitative and measurable goals. MIP projects which developed vague goals such as: "to improve the water quality within the project area" or vague objectives such as "to obtain an adequate level of land treatment" could not use these same statements to guide project activities or assess project performance. Generally, the statements of goals and objectives were more specific and water quality-oriented in the RCWP programs. Statements of goals and objectives in terms of changes in water quality, reductions of pollutant concentrations or loads, changes in water resource use, achievement of state water quality standards, and number of acres to be treated or contracts to be signed were used in the more successful MIP and RCWP programs.

Although projects benefit from stating quantitative water quality goals and land treatment objectives, sufficient flexibility should be retained so that goals and objectives may be modified as new information is gained from project activities. The goal-setting process should be flexible and interactive, with its primary purpose to optimize the efficiency of project activities; only secondarily should it serve as an accountability mechanism for agency participants. If accountability is too strongly stressed in this process, agency participants will be reluctant to state quantitative and/or measurable goals for fear that if the project falls short, it would reflect badly on them or their agency.

Timeframe. The timeframe in which water quality changes occur is an important consideration at the project level. Expectations for achieving project water quality goals should consider that project implementation takes varying amounts of time. Experience from the Nationwide Urban Runoff Program (NURP) indicates that when control practices are being placed on public land using only designated program monies, implementation can be completed relatively quickly (1-2 years), and is limited only by the time required to identify sites and complete construction. Conversely, experience from large-scale agricultural cost share programs such as RCWP and MIP indicate that up to ten years may be required to progress from planning to complete implementation in a voluntary program with private landowners. Generally, time must be allowed for developing public awareness, identifying critical areas, arranging contracts with landowners, and installing BMPs. Farmers are often reluctant to sign a cost share contract unless it provides flexibility on when their share of the implementation cost must be paid out. This is particularly true of large structural practices such as animal waste storage facilities (AL-RCWP, WA-MIP, OR-RCWP).

Examples of Project Level Goals and Objectives

Some examples of appropriate project level water quality goals and implementation objectives are provided below.

Water Quality Goals

- --Reduce maximum summer fecal coliform concentrations in Lake Tholocco below 200/100 ml so that beaches can remain open at all times through the swimming season (AL-RCWP).
- --Reduce the fecal coliform concentrations in Tillamook Bay to FDA standards for commercial shellfishing waters (OR-RCWP).
- --Extend the usable life of Broadway Lake by reducing mean annual sediment loads by 40% (SC-MIP).
- --Reduce maximum groundwater nitrate/nitrogen concentrations below 10ppm so that project area groundwater will meet domestic supply standards (PA-RCWP).

Implementation Objectives

- --Install animal waste management practices on at least 75% of the identified critical dairies in the project area (VT-RCWP).
- --Install runoff control practices which will intercept the first 1/2 inch of runoff from all areas within 1/4 mile of the lake and its major tributaries (NC-Nutrient-Sensitive Watershed).

In many situations, water quality goals may be more appropriately stated in probabilistic terms such as reducing the frequency of exceedance for concentration of a pollutant. For example, an urban NPS project could state its primary water quality goals to reduce the frequency of BOD concentrations exceeding 400 mg/l by 50%.

DETERMINE POLLUTANT REDUCTION NEEDED TO ACHIEVE WATER QUALITY GOALS

General Considerations

Determining the amount of pollutant reduction needed to achieve water quality goals is an essential part of the targeting and implementation effort. The required pollutant reduction affects both the selection of NPS control measures and the extent of areas or number of sources that must be treated. In general, the larger the pollutant reduction needed, the larger the critical area or greater the number of sources which must be targeted. Within the critical area, the largest and/or most intense sources should be given first priority. An important part of this project component involves determining the relative importance of pollutant contributions from point and nonpoint sources.

Reliability of Estimation Techniques

It is important to note here that the following discussion of statistical estimations of point and nonpoint source contributions addresses present conditions only, not projected estimates.

Point Sources. The accuracy of point source loading and concentration estimates depends on the frequency of effluent sampling and the variability of the point source. For domestic wastewater treatment plants which record outflow continuously and sample nutrients daily, estimates of nutrient loads and mean annual concentrations are generally accurate to within 10%. For other point sources whose effluent quality is determined by variable or intermittent industrial processes, errors in calculated loads or mean concentrations can be considerably higher (up to 50%) especially if effluent sampling is infrequent relative to process variability.

Nonpoint Sources. Statistical confidence in estimation techniques for determining nonpoint source pollutant contributions varies greatly between NPS categories. Agricultural NPS areal estimates have proven to be particularly difficult. The Universal Soil Loss Equation deals only with erosion rates and has limited usefulness because sediment delivery is not considered. Models such as CREAMS (12), ANSWERS (13), and AGNPS (14) attempt to combine land management, meteorologic, topographic and transport factors to predict areal pollutant loadings and how they may be affected by NPS controls (15). Proper use of these models should generally improve areal loading estimates. Use of state-of-the-art estimation techniques such as computer models should control the error to be within a margin of plus or minus a factor of two.

Areal pollutant loadings from urban areas are somewhat better defined than those from rural areas. This could be attributed to the more definable relationship between impervious surface area and runoff rates for urban areas. A wealth of areal storm loading data is available from the NURP (16) and several other recent studies (17, 18). While areal loading from urban areas can be estimated with approximately ± 50% accuracy, it should be noted that instantaneous runoff pollutant concentrations are extremely variable because they are highly dependent on storm hydrograph position and time interval since the last runoff event.

Point Versus Nonpoint Sources. Water resource impairments are almost always caused by a mixture of point and nonpoint source pollution. Estimates of relative point and nonpoint contributions can help target NPS treatment more effectively. Such estimates are useful in gaining an idea of the magnitude of the NPS problems and the amount of resources it will take to address these problems. Although the error margin associated with areal loading estimation models may be large, proper use of models, or other acceptable procedures, can generate good estimates of NPS contributions. As can be seen in Table 4, a simple estimate of NPS contribution can be bounded by a relatively narrow confidence interval even when NPS loading has as much as a factor of two error (factor of two error represented as the range from one-half the estimate to two times the estimate). In the example shown, a maximum error of 34% occurred when point and nonpoint loadings were approximately equal. Thus, in most cases, targeting NPS control resources need not be unduly constrained by limitations in point/nonpoint source definition.

TABLE 4. AN EXAMPLE OF CONFIDENCE INTERVAL ASSOCIATED WITH ESTIMATING RELATIVE POLLUTANT CONTRIBUTIONS OF POINT AND NONPOINT SOURCES

Actual Pollutant Load Units* Point	Nonpoint	Actual NPS %	Minimum Estimate of NPS %	Maximum Estimate of NPS %
1	9	90	82	95
2	8	80	67	89
3	7	70	46	82
4	6	60	43	75
5	5	50	33	67
6	4	40	25	57
7	3	30	18	46
8	2	20	11	33
9	1	10	5	18

*Assumes absolute point source loadings are known within ± 10%

DETERMINE NONPOINT SOURCE CONTROL OPTIONS

NPS Control Effectiveness

Construction. Effectiveness of BMPs for sediment control at construction sites is relatively well known. Sediment fences, retention basins, and traps are effective for retaining large sediment particles on site. A series of studies on sediment retention basins shows that they are 56-95% efficient in removing gross sediment loads depending on retention time, basin geometry, and incoming sediment size distributions (19). Sediment control practices are generally only about one-half as efficient for total phosphorus removal than for sediment removal because a disproportionate amount of the total phosphorus is attached to the finer, less easily captured sediment particles.

Urban. NPS control measures include sediment basins whose effectiveness is noted above. Urban catch basins designed to retain the first one-half inch of runoff have been shown to remove most incoming heavy metals (17) and to be effective for control of P. Other control measures include street sweeping, grassy swales and devices to retard storm drain flow. The effectiveness of these practices was studied intensively under field conditions in the NURP (16). Street sweeping, in particular, was not found to reduce urban NPS loads significantly.

Agricultural. A large amount of plot and field studies have been conducted on the effects of BMPs on edge of site pollutant losses. Most agricultural BMPs are summarized in the Best Management Practice reviews prepared by the NWQEP (20, 21, 22, 23). Common BMPs are discussed below.

• Conservation tillage has been found to reduce edge of field soil loss between 60 and 98% depending on tillage method, soil type, slope and crop. No-till studies have generally been found to reduce soil loss by 80-98%. Conservation tillage systems yield smaller surface losses of P and N than surface loss of sediment, and these systems often increase the amount of N loss to subsurface waters. The effect of conservation tillage on pesticide losses is not clear. For herbicides such as atrazine and alachlor, total annual losses to surface waters are reduced 80-90% (no-till versus conventional tillage) when the first rainfall after application is of low or moderate intensity. However, if the first post-application rainfall is of high intensity more herbicide may be lost from no-till than conventional till. There are very few studies on the effect of tillage systems on groundwater pesticide losses.

• Terraces used with conventional tillage have been shown to reduce soil loss by 50-98% compared with conventional tillage without terracing. Again, reduction of the loss of nutrients in surface runoff is not as great and subsurface N losses may increase.

• Improvements to furrow irrigation systems, such as furrow and drain modifications, subsurface drainage and sediment catch basins, reduce sediment export by about 80%. Surface P export is reduced by only about 40%, however, and these systems have had no observed effect on N export (5).

• Nutrient management systems, which include soil testing for available N, split N applications, elimination of fall applications, winter storage of animal waste, and designated animal waste application rates based on plant requirements for N, appear to be the most effective and cost-effective means of reducing N export to both surface and groundwater.

• Pesticide management systems. A linear relationship between pesticide application rates and surface runoff losses is suggested by numerous studies (23). The implication is that improved spraying and integrated pest management techniques will reduce pesticide inputs to aquatic systems to the extent that these techniques reduce the quantities applied.

• Animal waste management systems in humid regions include diverting runoff to by-pass barnyard areas, restricting the access of animals to streams, manure storage, elimination of winter manure spreading, applying manure at plant P requirement rates, and not applying manure to poorly drained areas. These practices can reduce P and bacteria losses to surface waters by 80% and 90%, respectively, compared to farming systems that are not managed for pollution control.

• Contour farming alone has produced 15-55% reductions in sediment export in several different studies using different crops, slopes and soils (22). The practice rapidly loses effectiveness on slopes greater than about 8%, however, and nutrient reductions are always less than sediment reductions.

• Cover crops reduce erosion on agricultural land depending on when the cover crop is planted and the growth stage of the cover crop during the nongrowing season. Erosion rates on land in continuous conventional till corn have been reduced by as much as 95% when a dense rye cover is present until the time of planting. Cover crops are often not good options if they are planted late, however, because there is little establishment in the fall, and the cover delays soil warming in the spring. There is recent evidence that non-legume cover crops may reduce N leaching to groundwater as a result of plant uptake.

• Diversions and grassed waterways are widely recognized as effective sediment-control measures for agricultural, urban, and construction nonpoint sources, although there is very little quantitative data on their effects. Grassed waterways, in particular, are rendered ineffective by excessive sediment loading and are generally used in conjunction with other erosion control practices such as strip cropping or conservation tillage.

• Filter strips have become recognized as effective BMPs for control of silvicultural, urban, construction and agricultural nonpoint sources of sediment, P, bacteria and some pesticides. Parameters which determine their effectiveness include: filter width, slope, type of vegetation, sediment size distribution, degree of filter submergence, runoff application rate, initial pollutant concentration, uniformity of runoff along the length of the filter, and proper maintenance.

Landowner Acceptance

In the case of voluntary agricultural programs, the practices chosen for emphasis in the project must integrate with the farmer's production considerations. Otherwise, landowners will choose not to participate, or they may not maintain implemented practices properly. A number of projects (IA-RCWP, WA-MIP, LA-RCWP, ID-RCWP, DE-RCWP) have obtained high participation rates by cost-sharing a mix of practices that are highly acceptable to the farmer.

For addressing urban and construction nonpoint sources, where often a key control measure is limiting the percentage of impervious surface area, local ordinance provisions which include such limitations can circumvent the difficult issue of individual landowner acceptance.

Financial Incentives

The basic issue which has emerged related to the control of nonpoint sources from private land is that much of the benefit from control (e.g., improved water quality) does not accrue to the landowner but rather to water users downstream or groundwater users. This has been the rationale for assisting private landowners with NPS control using public funds. In some cases BMPs have sufficient on-site benefits that landowners will choose to adopt them without financial incentives if technical assistance is provided. An example is conservation tillage systems which have been widely adopted without cost sharing.

Other practices such as animal waste storage and manure spreading may have on-site cost-effectiveness over the long-term but require large up-front capital investment. Practices such as improved fertilizer management have been shown to be the most effective NPS nutrient control practice and theoretically have agronomic benefits (fertilizer savings) which would encourage their adoption (21). However, there is a perceived yield risk factor which is difficult to quantify in dollars. Projects which have provided extensive soil testing services to the farmer have been the most successful in obtaining adoption of this BMP.

Ordinances for Sediment Control

The existence of regulatory authority over nonpoint sources such as sediment from construction activities creates a different type of incentive. Localities and states which have successfully addressed construction nonpoint sources have ordinances with inspection provisions and financial penalties (e.g., VA, NC).

METHODS FOR OBTAINING PARTICIPATION

Cost Sharing

The importance of cost sharing for agricultural BMPs has been discussed above. Experience indicates that cost share rates should be set for each specific BMP based on the relative on-site/off-site benefits and the capital investment involved. Assistance with long-term maintenance costs should also be considered. Some projects have had success offering a high cost share rate initially to gain project momentum and reducing the rate when the BMP gains widespread acceptance. While cost sharing has been used most extensively for agricultural nonpoint sources, the cost of runoff control practices can be cost shared with municipalities by the state (e.g., Wisconsin).

Information and Education Programs

While financial incentives are generally needed to obtain private landowner participation in voluntary NPS control projects, such assistance is usually not sufficient. In both MIP and RCWP, a vigorous information and education program has proven essential to obtaining adequate farmer participation. Successful program efforts have emphasized radio, newspaper and TV media, landowner meetings, field days, demonstration farms and youth activities. One-on-one contact with landowners, although time-consuming, appears to be the most effective method for gaining participation. Several projects have provided services such as soil testing or pest scouting as inducements for participation.

The watershed inventory should be used as a starting point for identifying critical area landowners who should be contacted first. Targeting recruitment efforts to key landowners who are community leaders is also often an effective strategy. Local Extension or Soil Conservation Service agents can identify these individuals.

Regulatory Options

As of July 1, 1985, approximately 26 states had sediment or erosion control regulations which apply primarily to construction activities. The number of states considering or developing such regulations is increasing, and there is a trend towards stronger enforcement provisions.

At this time, there are only a few states with regulations that apply to urban or agricultural NPSs. Oregon and Minnesota have state regulations which can force small dairy operations to clean up observed manure management problems, and regulations of dairies is expected in the Lake Okeechobee basin of Florida. Regulation is generally enforced on a complaint basis, and, therefore, is seldom invoked.

The North Carolina "nutrient sensitive watershed" designation regulates the percentage of impervious surface area in suburban areas near certain lakes and requires that new developments include measures to capture the first one-half inch of surface runoff.

Examples of Other Incentives/Inducements

- The creamery which buys essentially all the milk produced in the Tillamook Bay, Oregon RCWP project area is very concerned about the image of Tillamook cheese. The creamery managers score each dairy on various sanitary factors. Dairies which fall below the minimum acceptable score are penalized in the price paid for their milk. This appears to have greatly enhanced participation in the RCWP project.

- The State of Oregon allows a 50% tax credit for pollution control expenditures spread over 10 years. North Carolina allows a 25% tax credit for purchase of conservation tillage equipment. The Wisconsin state program also provides tax incentives for installing agricultural BMPs.

CRITERIA FOR SELECTING CRITICAL AREAS AND SOURCES

Once the previous steps of designating responsibilities, such as selecting BMPs and setting water quality goals, are well underway, a watershed project should begin the process of prioritizing source areas and sources within the watershed. The first step is to identify and weigh critical area selection criteria which are relevant to the water quality problem and watershed characteristics.

Water quality critical area selection criteria can be grouped into the following five broad categories:

1) type and severity of water resource impairment;
2) type of pollutant;
3) source magnitude considerations;
4) transport considerations; and
5) other project specific criteria.

These criteria vary somewhat by pollutants as discussed below.

Type and Severity of Water Resource Impairment

The type of impairment is the primary consideration for selecting water quality critical areas. The impairment may be caused by excessive pollutant loading, high average or maximum concentrations, or perhaps high frequency of violating a given standard. Impairments such as loss of reservoir or stream storage capacity, destruction of benthic habitat, and eutrophication are generally related to excess pollutant loading. In contrast, drinking water and swimming impairments are often caused by peak pollutant concentrations. Frequency of standard violation is generally the concern for impairment of shellfish harvesting.

The spatial orientation of BMPs and the hydrology of the watershed can interact to affect the dynamics of the water use impairment. For instance, in the case of impairments related to peak concentrations, it may be found that pollutants from the upper watershed are not delivered to the site until well after the peak concentrations have occurred. Thus, from the water use impairment standpoint, a strong case could be made for eliminating the upper watershed from the critical area even though the overall pollutant loading from this area may be high. Another example related to peak concentration impairments is the case where a wastewater treatment plant is a major contributor to pollutant concentrations during low flows, but is a minor contributor after storm events when the peak concentrations occur.

The severity of the impairment, too, is a major factor in critical area selection, because the greater the pollution reduction goal, the greater the extent of treatment needed. The extent of treatment can refer to more thorough treatment of intense sources such as dairies and feedlots or wider treatment of general sources such as cropland.

Type of Pollutant

Sediment. The designation of critical sediment contributing areas varies depending on whether the impairment is due to sedimentation or turbidity. Sedimentation may cause loss of reservoir storage capacity or degradation of fish habitat, whereas turbidity may impair recreational uses or provide a vector for transport of pesticides or other toxics. In the first case, critical areas would be selected primarily on the basis of sediment delivery, selecting the largest per-acre sources. The turbidity problem, on the other hand, might be addressed best by controlling runoff from areas where fine soil particles originate.

Nitrogen. Possible surface water resource impairments from N include eutrophication and toxicity from nitrites, nitrates, and ammonia. Groundwater impairments generally include toxicity from nitrites or nitrates. The definition of critical areas varies depending on whether the problem involves surface or groundwater. Nitrate problems frequently occur in areas with excessive use of N fertilizer or manure disposal. Groundwater problems are most pronounced in areas where soil characteristics facilitate transport to groundwater (e.g., sandy soils, fractured limestone). In addition, there is evidence that some soil conservation practices promote downward transport of nitrates. Practices such as conservation tillage or tile outlet terracing, in particular, may be associated with groundwater contamination if fertilizer or manure application rates are high.

Phosphorus. Phosphorus (P) is almost always associated with surface water rather than groundwater use impairments. Most P-related water resource problems result from excessive annual loading. However, if the water resource flushes seasonally, only the P loading immediately preceding algal bloom periods may be of concern. For instance, runoff from row cropland or suburban developments may be the major P loading source on an annual basis, but these may be less important than wastewater treatment plant contributions to algal bloom conditions during summer and early fall. From a water quality perspective, only available P (P forms which enter the food web) is of concern; however, there is wide disagreement over which chemical forms are available and how large a fraction they constitute.

Microbial Pathogens. In general, the magnitude of the water resource impairment and the degree of control required determine the extent of the critical area for microbial contamination. Reversing the impairment of a shellfish harvesting area with a fecal coliform standard of 14 mpn/100 ml generally calls for a more inclusive critical area than that required to treat an impaired contact recreational area keeping coliform densities below 200 mpn/100 ml.

Pesticides. Nearly all documented water resource impairments from pesticides involve either damage to aquatic fauna (fishery impairment) or concerns for human health (contamination of domestic water supply or fishery). Other impairments caused by more subtle ecological effects have been suspected but are largely unverified. All of these impairments are the direct result of pesticide concentrations rather than total loadings. Thus, critical areas for pesticide contamination should be chosen to reduce concentration. This may mean that some upper portion of the watershed, from which runoff reaches the impaired areas only after peak concentrations have occurred, may not be critical. The critical area, therefore, depends on the hydraulic retention time of the water resource such that an impaired stream segment would have a smaller critical area than a lake.

If the impairment is in a lake or impoundment with sufficient retention time, all runoff within the watershed may affect the concentration in the lake. Note, however, that local toxicity problems may result from BMPs which reduce surface runoff volume but cause an increase in the runoff concentration of pesticides.

Special considerations may be necessary for certain pesticide problems.

- Organochlorine insecticides concentrate with trophic level (biomagnification), resulting in sport and commercial fish species which contain concentrations that may pose human health problems. Concentrations in the water column, however, are seldom measurable.

- Most organophosphorus insecticides are highly toxic to both aquatic fauna and humans, but have low persistence in surface water and are not biomagnified. Most documented impairments have been associated with accidental spills or over-applications. Impairments result from intermittent high water concentrations. Only surface water impairments have been documented.

• Most carbamate insecticides are moderately toxic to fauna and humans, have low persistence and are not biomagnified. An important exception is aldicarb, which is highly toxic and has shown persistence of several years in groundwater. Incidents of both ground and surface water contamination are well documented.

• Triazine herbicides exhibit chronic effects on aquatic ecosystems at low ppb concentrations. Algal communities are most sensitive, exhibiting changes in community structure which, in turn, affect trophic status and parameters such as dissolved oxygen. Aquatic macrophytic communities also are affected adversely at these concentrations. Triazines may be a problem in drinking water because they are not removed by conventional treatment processes.

• The anilides, like the triazines, are hi ·'y toxic to algae and aquatic macrophytes, and only moderately toxic : fish and humans. Effects of long-term, low-level exposures are largely unknown, although recent studies implicate alachlor as a moderately strong animal carcinogen. Anilides are frequently detected in the 1-40 ug/l range in surface and groundwaters, and, as with the triazines, little removal occurs through water treatment processes.

Source Magnitude

Erosion Rate

Sediment. Erosion rate has served as the primary criterion in traditional soil conservation programs. As a practical matter erosion rate is generally not measured directly, but rather is estimated from the Universal Soil Loss Equation in which erosion rate is a function of slope (length and steepness), soil erodibility, and the density of vegetative cover.

Phosphorus. Many studies show P losses are closely correlated with erosion rates. However, erosion reducing practices do not reduce P losses as efficiently as they do sediment because the finer fraction of sediment is typically most enriched in P; and the fine sediment fraction is not reduced effectively by on-field erosion control practices. A major study found that in a 12,000 acre watershed P reductions were only one-half of sediment reductions from erosion control practices (26).

Other Pollutants. For N and microbial pathogen-related water quality impairments, erosion rate is generally not an appropriate critical area selection criterion. Conversely, nearly all presently and historically used organochlorines have been shown to adsorb strongly to soil particles. For this reason, they are lost in surface runoff almost entirely in the sediment-adsorbed phase. Hence, erosion rate should be considered an appropriate criterion for selecting critical areas for control of organochlorine aquatic inputs. As in the case of other sediment-adsorbed agricultural pollutant such as phosphorus, the reduction in pesticide losses will be less than the erosion reduction because of enrichment on the fine soil fraction.

There is evidence that the organophosphorus insecticide, fonofos, is lost in surface runoff primarily in the sediment-adsorbed phase (23), suggesting that the inclusion of erosion rate as a selection criterion may be appropriate. On the other hand, modeling efforts indicate that methylparathion runoff losses, are 90% dissolved, implying that erosion rate should not be used as a selection criterion for this pesticide.

Extensive research has shown that the carbamates, triazines, and anilides are lost predominantly in the dissolved phase of surface runoff, and thus, erosion rate has limited applicability to critical area selection. Chemicals in all three of these classes have been identified as soil leachers, and thus the presence of sandy soils or Karst areas should be used as a primary criterion for groundwater protection.

Manure Sources

Barnyards, feedlots, milk houses, or fields where high rates of animal manure are spread should be considered as sources of N, P, and pathogens. These may represent extremely critical areas if the impairment involves bacterial contamination.

On a weight basis the nutrient availability from various livestock manures is as follows:

Poultry > Horses > Cattle = Dairy > Hogs

A selection process for identifying animal confinement areas which are critical sources of P has been proposed by Motschall et.al. (28). The method involves comparison of soil P levels in the confinement area drainageways with the P levels of adjacent soils. Drainageway soils with relatively high available P levels indicate that the barnyard is a critical source of P. Minnesota and Wisconsin use the Minnesota Feedlot Model (14) to prioritize barnyards and feedlots. This model is available from USDA's Agricultural Research Service for use on a programmable hand calculator.

Fertilization Rate and Timing

Fertilization rate and timing is not an appropriate selection criterion for sediment-related impairments. It has been known for some time that surface and subsurface losses of N are a function of how well application is matched to crop needs. Critical cropland sources of N include those fields where excessive N rates are applied or N is applied to the surface in fall. Areas where N is applied at recommended rates and timed to meet the needs of growing crops may be designated noncritical.

Fertilization rate is also an important criterion for selecting critical areas for P control. Areas with high rates of manure applied to P-rich soils are a particular problem to be recognized in designation of critical areas for P. The timing of application is less important than for N because P is much less mobile either in surface runoff or through the soil.

Microbial Pathogen Sources

High intensity sources of fecal coliform bacteria usually include feedlots, manure storage piles, cropland where manure is spread, stream access areas for livestock, municipal wastewater treatment plant effluent, leaking sewage connector lines, and failing residential septic tanks. Runoff from urban areas also may contain high fecal coliform densities, often attributed to leaky sanitary sewer systems, combined sanitary and storm sewer systems, or domestic animal wastes washed from impervious surfaces.

Pesticide Usage Patterns

In general, this is the most important criterion for selecting critical areas for pesticide control. Since pesticides do not occur naturally, only use or disposal areas are sources. Thus, the selection process of critical areas for pesticide control should identify the usage patterns by cropland in the watershed.

With few exceptions (e.g., toxaphene), organochlorines were phased out of agricultural use in the U.S. from 1972 to 1976. Heptachlor is still used to some extent for fire ant control, chlordane for termite control, and lindane for certain forestry uses. In terms of water use impairments, however, banned organochlorines are still of concern. They continue to persist in historically treated agricultural soils and are, thus, available for transport and uptake into the aquatic food web. Cotton acreage received the most organochlorine applications during the latter 1960's and 1970's making it the most likely candidate to have banned organochlorine residue problems.

Usage information by crop can provide an important first cut for identifying initial areas associated with particular pesticides. The usage pattern within a given region may differ considerably from the aggregate usage statistics.

Transport Considerations

Distance to Nearest Watercourse

Sediment. For sediment, distance to nearest watercourse is a major factor in selecting critical areas because extensive research has shown that not all eroded soil reaches watercourses. The sediment delivery ratio, defined as the ratio of sediment delivered to the estimated gross soil erosion, is inversely related to DISWC.

Nitrogen. For nitrogen (N) contamination of groundwater, the distance downward from the soil surface to the saturated zone is the distance of interest. A short distance from the soil surface to groundwater can mean rapid transport of N. This criterion should be considered in conjunction with the soil permeability and organic matter content, however, because poorly drained soils do not transmit N rapidly to groundwater, and denitrification may reduce the N available. Nitrogen delivery to surface waters, too, decreases with increasing distance. Unlike sediment, however, there is relatively little deposition. Stabilization occurs primarily by plant uptake and denitrification.

Transport mechanics for N compounds are diverse because N can be transformed among a variety of chemical species (e.g., NO-3, NH-3, NH-4, N-2, NO-2, organic-N) which have vastly different transport characteristics. Water mobile forms such as NO-3 can move readily in surface and subsurface flow. One recent study showed that 60% of the NO-3 loading to a stream involved a subsurface route (29). While the partitioning of N is complex, it appears that most of the N that leaches through the plant root zone eventually reappears in either ground or surface waters. This reduces the utility of the distance to nearest watercourse as a critical area selection criterion for N.

Phosphorus. Critical area considerations for P are similar to those for sediment. The delivery efficiency of P is greater than for sediment, however, because the fine sediment fraction that does not settle readily in the field is enriched in P. In addition, between 5-30% of P may be lost in the dissolved phase depending on soil type and cropping practices employed.

Pathogens. As with previously described pollutants, distance from a potential pathogen source to a watercourse is an important consideration when identifying critical areas for pathogens. Wastewater treatment plants that discharge to streams are considered to have 100% delivery efficiency.

Pesticides. The distance criterion is applicable to all pesticide classes, although the dominant transport mechanism varies greatly with pesticide class. Criteria for selection of critical areas for strongly absorbed pesticides are similar to those for sediment and P. Delivery efficiency decreases with watershed size such that areas with short distance to nearest watercourse may be critical. The potential for drifting pesticides to reach a watercourse should be considered in the selection process. Pesticides, such as toxaphene, which are often applied aerially are highly susceptible drift losses.

- Distance is important for organophosphorus pesticides because of the large drift losses often associated with their application, and because their relatively low persistence (1-8 weeks) in the environment means that longer transport reduces the probability that active chemicals will reach the water resource. Because organophosphorus pesticides are lost primarily in the dissolved phase of runoff, delivery efficiency may be higher than sediment.

- Carbamates, like organophosphorus pesticides, have a short root-zone half-life and are lost primarily in the dissolved phase of surface activity. For proven soil leachers such as carbofuran or aldicarb, it may be the depth to the water table and soil permeability which are the concern.

- The triazines are relatively mobile as a pesticide class. Studies have shown that 0.2-16% of applied amounts are lost in surface runoff (30), the majority being in the dissolved phase. The time interval between application and the first runoff event is a major factor influencing runoff losses. Soil column leaching experiments show that triazines move fairly readily through soils, particularly if the clay content is low (31). Numerous field studies have found triazines in groundwater (32). In summary, it appears that triazine transport efficiency decreases only moderately with increasing distance.

- The anilides are lost almost entirely in the dissolved phase. Edge-of-field studies show that alachlor is lost in surface runoff even more readily than atrazine (33). A recent watershed study, however, showed that alachlor had considerably lower delivery efficiency to streams than atrazine (14). This implies that, although anilides are very mobile initially, their surface transport susceptibility decreases rapidly with increasing distance. Because the mobility of alachlor through the soil is a concern, distance to the water table and soil permeability are key critical area criteria for groundwater protection.

Distance To The Impaired Water Resource

Distance to the impaired water resource is another potentially important criterion for selecting water quality critical areas because not all material that reaches a watercourse is delivered directly downstream. Losses take place by deposition particularly where stream gradients decline. Nitrogen flux also may decrease within a watercourse due to biological uptake or denitrification, and a significant fraction of the biologically available P may be lost from solution due to adsorption to sediment or biological processing.

Most pathogenic bacteria die off rapidly at ambient temperature, and so distance is a very important consideration. Because watercourse transport distance and time are closely related, it is actually the time interval between excretion and delivery to the site of the water resource impairment which determines the amount of die-off which occurs. However, die-off is generally more rapid in the watercourse than in fields, barnyards, or street surfaces (34).

The importance of distance to the impaired water resource as a critical area selection criterion for various pesticide classes derives from the transport considerations presented above. Dissipation of sediment-bound pesticides between the nearest watercourse and the impaired water resource results from deposition and subsequent stabilization.

Dissipation of triazine and anilide herbicides between an upstream watercourse and the site of impairment occurs primarily by adsorption to particulates and by plant uptake. Their persistence is on the order of several months so degradation within the watercourse is generally small. Therefore, this concept should not be a major selection criterion for these herbicides in surface water unless the watershed is very large. In the case of groundwater impairments, on the other hand, distance to groundwater may be important since concentration decreases with depth in the soil profiles.

Other Selection Criteria

Present Conservation Status. Cropping or animal production operations which already have effective soil conservation or manure management systems should not be considered as critical sources or areas. A major problem that arises from using this as a targeting criterion is that in voluntary NPS projects, landowners who previously installed some conservation practices at their own expense fail to qualify for cost sharing funds.

As with other agricultural water pollutants, present conservation status should be carefully considered in designating criti[illegible] areas for pesticide control. The most important parameter is generally [illegible] amount of pesticide being applied. Numerous studies show that for a [illegible]n set of management practices, the amount of pesticide lost by each transport route is roughly proportional to application rate. If information on the method and rate of application is not available, surrogate measures such as the level of integrated pest management practiced can give an indication of how current application rates compare with what can be feasibly achieved.

Another important consideration is the method and timing of pesticide application. Optimal methods control drop sizes and spraying with ground-based equipment to reduce drift and use formulations which minimize volitization, runoff, and drift losses. Timing options include relying on pest scouting and avoiding application on windy days or when heavy precipitation is forecast.

Planning Timeframe. There may be areas that are adequately protected from a 1 or 2 year recurrence runoff event but are susceptible to massive pollutant transport from a 50 year recurrence event. Since most detached soil will eventually reach waterways, critical areas will generally increase in size with longer planning timeframes.

Designated High or Low Priority Subbasin. In many cases, monitoring or hydrological data indicate that certain subbasins have a disproportional effect on the water quality of the impaired water resource. Hence, a decision to assign the entire subbasin a higher priority may be appropriate for addressing the water resource impairment. Conversely, it may also be found that some subbasins with relatively high unit area loading may not have a significant impact on the water resource because of isolating factors. For example, in an impoundment that is impaired by high pathogen levels, the tributary with the highest fecal coliform levels may not be a critical subbasin if its point of entry to the water resource is downstream from the impaired area.

On-site Evaluation. Although the selection criteria described above provide some useful guidelines, and the information may be available without visiting the site, on-site evaluation of the individual farm or field often provides additional information on pollutant input potential. The on-site evaluation often reveals that areas which were initially designated critical on the basis of distance or source magnitude, for example, are not contributing to the water quality problem for one reason or another.

PROCEDURES FOR SELECTING CRITICAL AREAS AND SOURCES

Develop Farm Level Ranking Procedure

Once the relevance and the importance of each critical area selection criterion has been considered, these decisions must be translated into a form that can be used to prioritize specific sources within the watershed.

We have developed several one page forms for translating the selection criteria into a practical tool that can be used at an on-site inspection. Examples for P and pesticide-related water resource impairments are included below. The point scale is presented as arbitrary values that should be adapted to meet local conditions. In Figure 1, fertilizer and manure management practices are by far the most important rating criteria. With Figure 2, use and disposal of pesticides are the primary factors that will determine farm ratings.

FIGURE 1. FARMLANDS CRITICAL AREA RATING FORM FOR PHOSPHORUS CONTROL

Criterion	Score
Type of Crop	
Tobacco, peanuts	20
Corn, soybeans, cotton	15
Wheat	5
Hay and pasture land	0
Distance to Nearest Watercourse	
Greater than 1/4 mile	-10
1/8 to 1/4 mile	10
Less than 1/8 mile	20
Distance to Impaired Water Resource	
Greater than 5 miles	0
1 to 5 miles	10
Less than 1 mile	20
Gross Erosion Rate	
Less than 5 tons/acre/year	0
5 to 10 tons/acre/year	10
Greater than 10 tons/acre/year	20
Present Fertilizer Practices	
Soil test recommendations with banded or split application (nitrogen)	-10
Soil test recommendation	0
Exceedance of soil test recommendations (Add 1/2 point for each pound of applied P in excess.)	0-100
Magnitude of Manure Source (A.U. = animal unit)	
Less than 0.2 A.U./acre	0
0.2 to 1.0 A.U./acre	15
Greater than 1.0 A.U./acre	30
Present Manure Management Practices	
Manure nutrients measured; applied at recommended rate from soil test; no winter spreading	-10
Manure applied at soil test recommendations	0
Excess manure applied (Add 1/2 point for each excess pound of manure P applied)	0-100
Observed barnyard, feedlot, or milkhouse runoff problem	0- 30

FIGURE 2. FARM LEVEL RATING FORM FOR SELECTING CRITICAL FARMS IN WATERSHEDS WITH PESTICIDE-RELATED WATER RESOURCE IMPAIRMENT

Factor	Range of Factor	Points
Use of Suspected Pesticide	At Label Recommended Rate Excess of Recommended Rate Not Used	100 100 + Excess % 0
Distance to Nearest Watercourse	Short Distance (e.g., ≤ 0.5 km) Long Distance (e.g., ≥ 0.5 km)	15 0
Distance to Impaired Water	Short Distance (e.g., ≤ 5 km) Long Distance (e.g., ≥ 5 km)	10 0
Application Method	Low Drift (e.g., ground-based with shields, recirculators, etc.) Ave. Drift (e.g., ground-based with no shields) High Drift (e.g., aerial)	0 5 15
Level of IPM Practiced	High Average Low	-10 0 10
Pesticide Disposal Practice	Excellent Average Poor (e.g., dumping containers into stream)	0 15 30
Erosion Rate (use only for sediment-adsorbed pesticides)	High Average Low	20 10 0
Runoff Rate (use only for dissolved pesticides affecting surface water)	High Average Low	20 10 0
Infiltration Capacity (use only for dissolved pesticides affecting groundwater	High Average Low	20 10 0

Modify Implementation Plan on The Basis of Water Quality Monitoring

As the project proceeds, water quality monitoring or other observations may indicate that certain subbasins are unlikely to respond to further treatment, while others are larger contributors of pollutants than originally estimated on the basis of land management selection criteria. Targeting should be redirected as appropriate. It is important, however, to maintain a clean record to document the reasons for modifying the plan.

CARRY OUT BMP IMPLEMENTATION AND MONITORING PROGRAM

Develop Contracts

Ideally, water quality contracts should address all of the potential nonpoint sources at a site if this can be done without cost constraints and with landowner acceptance. However, it should be remembered that a basic concept of the targeting approach is to treat efficiently the identified water resource impairment. Thus, in many cases, it may be appropriate to develop water quality contracts with landowners that address only those on-site problems directly related to the water resource impairment, targeting the most important water quality concerns at the farm level.

It is also important that contracts be explicit in terms of the time allowed for completion and the consequences of nonfulfillment. For agricultural projects where water quality goals involve nutrient control, the importance of tying fertilizer management (soil testing and N applications) to all land treated with other BMPs cannot be over-emphasized.

Monitor Land Treatment

At a minimum, all NPS implementation projects should monitor the location and areal coverage of each type of control practice applied, particularly those which are assisted by public funds. A land treatment program with water quality objectives should include the following:

a. location of practices, including distance to watercourse and distance to the impaired water resource, and a detailed project map;

b. the area covered, protected, or otherwise benefited by each practice (or system of practices);

c. aggregate coverage by all implemented practices (area treated);

d. accounting of practice implementation by subbasins associated with individual water quality monitoring sites;

e. the dates on which individual control measures were contracted and installed; and

f. records on site visits to evaluate location, assess progress, or assure maintenance.

Water Quality Monitoring

The project should decide from the outset whether or not to monitor water quality effects. A strong case can be made that if the water resource is valuable enough to be targeted for intensive NPS control, then verifying the project's impact on the water resource is worth tracking. In the overall state NPS control program, at least a subset of projects should include water quality monitoring. Because monitoring is expensive, the monitoring program should be designed carefully to answer clearly defined questions using an efficient experimental design (27). It may be advantageous to monitor only certain representative or more intensively treated subbasins rather than the impaired resource itself, particularly if the project area is large or there are parts of the watershed influenced predominantly by point sources.

The decision of whether to monitor changes of water resource quality, physical, chemical, or biological attributes should be based partially on whether the implementation program can be expected to reduce these parameters sufficiently for detection through monitoring. Recent work indicates that about 40% reduction in annual mean pollutant concentrations may be required to be statistically significant in a five-year monthly grab sample program (1, 2, 5, 6). Even this sensitivity requires that the program include corresponding hydrologic and meteorologic-related measurements with each sample.

Socio-economic Impacts

Accelerated NPS implementation projects often have major, albeit localized, social and economic effects. Production practices may change to increase or decrease their labor requirements, machinery usage, energy consumption, fertilizer and pesticide usage, and equipment needs may change.

Urban or construction NPS control regulations may influence development patterns. Restoring impaired uses of the water resource may stimulate local economies, particularly where high-demand recreational uses are possible.

Finally, there may be multiple effects from the increased attention and dollars. For example, the Tillamook Bay, Oregon, RCWP project revitalized the local construction industry with numerous spinoff effects. Unless an attempt to measure such socio-economic impacts is made, many of the benefits of BMP implementation programs will be unrecognized.

REPORTING, ACCOUNTABILITY AND EVALUATION PROCEDURES

Analysis of Water Quality Trends

A description of appropriate water quality analysis methods is beyond the scope of this document. However, some general concepts are applicable when designing NPS water quality monitoring systems and conducting subsequent analysis.

NPS monitoring systems should have a clearly stated design that specifies both the sampling protocol and the data analysis. Several approaches have been presented for such application. These include:

a. before versus after (time trends)
b. above versus below (spatial trends, upstream-downstream)
c. paired watershed (treatment versus control)

Information on the data requirements, assumptions, advantages, disadvantages and corresponding analysis methods for each experimental design are available in NWQEP documents (27).

The 'before vs. after' design generally requires the largest time to document changes. It is for this design that corresponding measurements of meteorologic variability are essential. Otherwise, data variability is generally so large that only very dramatic changes can be observed, and it is impossible to attribute observed water quality changes to the implementation activities. The 'above vs. below' design is applicable only where NPS contributing areas are isolated in one segment of the drainage. This design is frequently used for point source monitoring or to document the existence of NPS problems.

A paired watershed design builds in adjustment for meteorologic and other sources of variability. Thus, it can provide the most sensitive and rapid documentation of water quality improvements. This design should be used whenever possible. The limitation is in finding appropriate subbasin pairs and excluding implementation from the control watershed.

Format and Content of Project Reports

Efficient and accurate reporting of NPS implementation activities assist program managers and decision-makers in evaluation and project coordination. It provides a useful process by which project agency personnel can see how their efforts are being coordinated with those of other agencies, and it shows where progress has occurred or where problems have arisen. A prototype NPS project outline designed for the RCWP program is shown in Appendix A.

APPENDIX A

SUGGESTIONS AND GUIDELINES FOR PREPARATION OF THE FIRST YEAR GENERAL MONITORING AND EVALUATION GROUNDWATER REPORT

I. Problem Definition

A. Water Quality Problems (Surface and Ground Waters)

B. Major Pollutants

C. Project Goals and Objectives

D. Land Use and Potential Pollutant Sources Descriptions

1. Non-Agricultural

   a. Municipal waste
   b. Industrial waste
   c. Construction
   d. Mining
   e. Landfills
   f. Septic tanks
   g. Silvicultural
   h. Other

2. Agricultural--Emphasize those elements which contribute to the primary water-quality problems.

   a. Cropland
   b. Animal production
   c. Examples of data are:
      1) topography
      2) climatic description including amount and seasonality of precipitation
      3) major crops and acreages
      4) average yields of major crops
      5) animal waste production
      6) average soil loss per acre, by land use
      7) level of irrigation and general irrigation methods

   (For more complete listing see: "Conceptual Framework for Assessing Agricultural Nonpoint Source Project" prepared by the National Water Quality Evaluation Project staff.)

E. Most Probable Pollutant Sources

1. Justification for omission of certain land use areas as pollutant sources
2. Justification for inclusion of certain land use areas as pollutant sources

F. Critical Areas

1. Map with critical areas delineated
2. Rationale for selection of critical areas
   a. Background data (e.g., relative pollutant loads)
   b. Surrogate measures

II. Water Quality Monitoring

A. Objectives

B. Strategy

1. Site locations - map
   a. Description
   b. Rationale for selection
2. Parameters
   a. Listed by site
   b. Rationale for selection
3. Data collection schedule

C. Methods

1. Sampling
2. Analytical

D. Quality Control

1. Precision
   a. Replicate samples
   b. Replicate instrumental analysis
2. Accuracy
   a. Intralab verification
   b. Interlab verification

III. Land Treatment Strategy

A. Objectives

B. Goals

C. Methods

1. BMP list
2. Other practices or activities

IV. Results and Discussion

A. Land Treatment

In this section, the goals and accomplishments for program implementation should be described.

Program implementation could be defined in several different ways: contracts approved, BMPs put into place, acreage served, program expenditures and farmer participation. Activities under other programs (Agricultural Conservation Program (ACP), Great Plains Conservation Program (GPCP), PL 566, etc.) and private individual efforts (your best estimate) should be included and separately identified from those under RCWP. Further, a separate accounting should be made for activity within critical areas as well as outside the critical areas.

Highlight water quality or conservation activities that have occurred in the project area prior to project approval.

1. Number of SCS farm plans in project area
2. Land adequately protected (SCS definition)
3. Earlier special practice or project emphasis or accomplishments, including private accomplishments within the project area

B. Summary of First Year Water Quality Data (Baseline)

1. By monitoring site
2. Emphasis on charts, figures and tables

C. Data Analysis

The requirement for this section is to present sufficient data to determine changes in water quality <u>trends</u>. It is not necessary to present all the water quality data collected for every parameter considered (although such data can be included in an appendix). Present changes or summaries of changes in those parameters that best represent trends in water quality for your particular project, emphasizing the major water quality impairments in the project area. It is acceptable to exclude those parameters which do not relate directly to problems specific to the project.

It is difficult to select a single or even several measures in combination which will perfectly characterize changes in water quality. Because of variations in water impairments and surrounding conditions, no specific set of measures can be required for every project area. It is, however, important that statistical analyses (such as correlations, trend analyses, regression analyses, etc.) be incorporated wherever possible in data summaries and interpretations. Water quality trend reporting should be presented on an individual sampling station basis. This is necessary to account for the variation within each project area in the source and extent of the impairment as well as the type and extent of program treatment.

D. Water Quality Progress

This section is to explain changes in water quality and their relationship to changes in: BMP implementation, agricultural factors and nonagricultural factors. Attributing changes in water quality to these three separate sources will help isolate program effects from other effects and thereby assist in the evaluation of RCWP.

Water quality changes related to the type of practice, the extent of the practice installed and the location of the practice application should be evaluated. It is here that the station-by-station information will be most useful. Water quality trends at each station can be linked to changes in all conservation practice applications occurring above that location. Practices applied under RCWP, other programs, and on private initiative should be considered.

In addition to effects from conservation application, changes in other factors may also be responsible for water quality changes. Use the background information presented in Section I as a checklist when considering the possible contribution of other agricultural and nonagricultural factors influencing water quality trends. After identifying the changes in water quality related to RCWP, it may be possible to make inferences concerning the role of practices applied under RCWP.

E. General Assessment

The purpose of this section is to give an assessment of the project in achieving its water quality objectives. This assessment should be organized as an appraisal of the strengths and weaknesses of each project in four program areas: funding, participation, practice application and water quality monitoring. Assessment should include the success or failure in achieving program goals. Examples could include the following:

1. Cost share levels offered
2. Contracts signed in the critical areas
3. Water quality practice implementation
4. Water quality monitoring
5. Informational and educational assistance

F. Recommendations

This section should present recommendations of changes that you plan to make in the operation of your project as a result of your evaluation. List and justify any recommendations for changes which should occur in the RCWP program.

G. References

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