INCENTIVE ANALYSIS FOR CLEAN WATER ACT REAUTHORIZATION:

POINT SOURCE/NONPOINT SOURCE TRADING FOR NUTRIENT DISCHARGE REDUCTIONS

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Office of Water

and

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U.S. Environmental Protection Agency
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EXECUTIVE SUMMARY

Since 1972, the nation has made much progress in surface water quality using technology-based effluent limits to control municipal and industrial point sources. As EPA and the states tightened the regulation of point sources (industrial facilities and wastewater treatment plants), the relative importance of nonpoint source pollution has increased. Recent evidence indicates that nonpoint source pollution -- from both urban and rural sources -- is now the dominant source of water quality impairment. The problem is large: EPA and the states recently identified over 18,000 specific waterbodies that will not attain water quality standards even if point sources fully implement controls to meet technology-based discharge requirements. For such waterbodies, solving the remaining water quality problems may require either or both (1) point source controls that go well beyond technology-based discharge requirements, or (2) nonpoint source reductions.

This report examines effluent trading as one option to achieve water quality objectives at least cost. Although it can take many different forms, effluent trading in principle allocates reductions in pollutant loadings across point and nonpoint sources using least cost as the criterion. While several options are discussed, this paper focuses principally on trading schemes in which regulated point sources are allowed to avoid upgrading their pollution control technology to meet water quality-based effluent limits if they pay for equivalent (or greater) reductions in nonpoint source pollution within their watersheds. This report focuses on nutrient trading because trading programs to date have dealt with pollutants of this type and because of the large number of difficult issues specific to trades involving toxic pollutants.

Conditions for Efficient and E

Several conditions appear necessary for an efficient and effective point/nonpoint source trading program. A program is considered efficient and effective if it achieves ambient water quality objectives at the lowest aggregate cost, including point source controls, nonpoint source controls, and administrative costs. Key elements of such programs include:

- The waterbody must be identifiable as a watershed or segment;
- There must be a combination of point sources and controllable nonpoint sources that each contributes a significant portion of the total pollutant load;
- There must be a water quality goal for the waterbody that forces action;
- There must be accurate and sufficient data with which to establish targets and measure reductions;
- Point sources, at minimum, must meet the technology-based discharge requirements of the Clean Water Act;

- There must be significant load reductions for which the marginal cost (per pound reduced) of nonpoint source controls are lower than for upgrading point source controls;

- Point sources must be facing requirements to either upgrade facility treatment capabilities or trade for nonpoint reductions in order to meet water quality goals;

- There must be an institutional structure to facilitate trading and monitor results; and

- Sufficient and effective implementation mechanisms (including appropriate enforcement measures) must be a component of the trading system.

Lessons Learned from Case Studies

Case studies of three trading experiences to date -- Cherry Creek and Dillon Reservoirs in Colorado; and Tar-Pamlico River Basin, North Carolina -- indicate that the absence of one or more necessary conditions will result in the delay of trading or will necessitate a shift in focus of the trading program to facilitate continued pollutant (i.e., nutrient) load reductions. These experiences also illustrate the importance of other necessary conditions to program planning, design, administration, and enforcement. These lessons include:

- The absence of one or more necessary conditions results in delay of trading. Specifically, in two programs, the marginal cost of point source reductions has not yet exceeded that of nonpoint source reductions, and point source loads are not yet limiting, i.e., actual load is less than allowed load. As a result there is neither economic incentive nor need to trade.

- Where point source loads do not reach levels anticipated, nonpoint source controls will have to be more heavily relied upon for nutrient reductions.

- The presence of necessary conditions supports watershed-based water quality management and provides an administrative framework for future trading.

- Total maximum daily or annual pollutant loads provide a practical base against which to require and measure load reductions.

- There must be enough data and information about pollutant loading and water quality effects available to develop water quality targets and translate the targets into nutrient reduction goals and allowable loads.

- It is necessary to have detailed information about point source facilities in order to determine the relationship between the marginal costs of point and nonpoint source controls.

- A comprehensive basinwide management approach, rather than a focus on point sources in isolation, provides opportunities to achieve least-cost pollutant reductions.

- A comprehensive approach also provides opportunities for targeting reductions to areas where they will be most effective and are most needed.

- The administrative framework for the trading program is not only important for the development of the basinwide approach, but may be critical to achieving desired pollutant reductions through trading.

- Implementation mechanisms (including appropriate enforcement measures) are important in creating compliance incentives where economic incentives are absent or fail.

- The local community, including environmental organizations, must support a trading program as a method to achieve water quality objectives. Broad-based support is helpful, especially among community leaders, environmental organizations, the farm community, and industry.

- If the program involves agricultural BMPs and will be implemented through a cost-share program, there must be sufficient farmer demand for funding in excess of the ongoing cost-share program to support point/nonpoint source trades in order to supplement, not supplant, ongoing nonpoint source control efforts.

- Regulatory requirements that increase the transaction costs associated with trading but that fail to provide an offsetting value in terms of compliance and enforcement may cause a trading program to fail.

- Trading ratios that account for uncertainty can be established without eliminating economic incentives to trade.

- It may be important to build flexibility into the trading program design, as conditions may change over the course of the program.

Benefits and Costs of Trading Programs

The dollar values of costs and benefits of point/nonpoint source trading programs will vary according to waterbody size, number and type of affected dischargers, and program design. The cost of project development and administration can be significant, especially for large or otherwise complex waterbodies. As an example of partial program costs, point sources at Tar-Pamlico have thus far contributed $400,000 to the development of an estuarine computer model of the basin, and will contribute $150,000 for two additional staff positions at the agency implementing nonpoint source reductions, and a minimum of $500,000 for nonpoint source reductions even if they do not require point source load reduction credits through 1994. EPA also contributed approximately $453,000 to the Tar-Pamlico program: $400,000 for the development of the basin nutrient model, and $53,000 for the monitoring and tracking of nonpoint source pollutants.

A comparison of marginal costs for point source load reductions and nonpoint sources gives some indication of the potential for cost-savings. At Dillon, it was estimated that further point source reductions would cost between $860 and $7,861 per pound reduced, while nonpoint source load reductions would cost between $67 and $119 per pound. At Tar-Pamlico, extensive point source upgrades were estimated to cost between $250 and $500/kg reduced, while nonpoint source reductions were priced at $56 per kilogram point source credit for Association members and $62 for non-members.

The following principal classes of costs and benefits are common among most trading programs:

Costs	Benefits
• Monitoring and modeling beyond those needed under current policy	• Direct cost savings to point source dischargers
• Permitting costs to establish discharge levels for the "with trading" case	• Improved water quality for people, commerce, and the environment
• Government transaction costs associated with review and approval of individual trades	

Nationwide Potential for Trading

Estimates developed from EPA's Water Body System (WBS), which is designed to track state assessments of water quality for surface water using information prepared for 305(b) reports, indicate that for the near term, the best opportunities are for trading nutrient allocations. Longer term opportunities may exist for trading pathogen or chloride allocations. Trading for toxic pollutants appears to be inconsistent with the goals of the Clean Water Act. The estimates were retrieved from the WBS using selection criteria that closely match those conditions identified as necessary for a successful trading program, including the presence of both point and nonpoint sources.

The number of waterbodies that could potentially benefit from point/nonpoint source nutrient trading fall into two general groups: (1) those that currently are water quality limited (i.e, identified by the states as "not supporting" or "partially supporting" their designated uses); and (2) those that are not currently water quality limited. An estimated 943 water quality-limited waterbodies could potentially benefit from trading under current conditions. Most of these immediate nutrient trading opportunities are in the east, in the mid-Atlantic region, and also in the Mississippi and Missouri River Valley states. The five states with the most opportunities are: Illinois, 221; Florida, 129; West Virginia, 78; Iowa, 56; and Mississippi, 50. Another 17 waterbodies are not currently water quality-limited but have met all the other necessary conditions. At current growth rates, it appears that these waterbodies could benefit from nutrient trading at some time in the future. These waterbodies are distributed as follows: Vermont, 5; Tennessee, 4; Washington, 3; Mississippi, 2; and Minnesota, West Virginia, and Wyoming, 1 each.

Clean Water Act Implications

The Clean Water Act does not currently address effluent trading as a means of attaining water quality standards. The act does provide a mechanism to facilitate the development and operation of trading programs: states <u>are</u> required to establish total maximum daily loads of pollutants from point and nonpoint sources in water quality-limited watersheds. In order to increase the visibility of trading as a programmatic option for states and local governments, the Clean Water Act could be amended to specifically sanction (or even promote) effluent trading. In addition, EPA could broaden the options available to states and local governments for meeting water quality objectives by clarifying the acceptability of trading, identifying the potential benefits that can result from trading, and providing assistance to help these jurisdictions establish workable, successful trading programs.

I. INTRODUCTION

The purpose of this report is to provide information and analysis pertaining to one of the key market incentives -- i.e., pollution credit trading between point and nonpoint sources -- being considered during the Clean Water Act (CWA or the Act) reauthorization process. Several bills that would amend the CWA have been introduced in Congress, either in the House of Representatives or the Senate. Most of these bills are relatively narrow, focusing on one or a few aspects of surface water quality. However, some bills (especially S. 1081) cover multiple issues. Some of the bills propose relatively minor changes to the Act, while others represent significant departures from the existing statute. While point/nonpoint source trading is not specifically addressed in amendments introduced to date (nor is it mentioned in the Act), language in both S. 1081 and H.R. 2029 would require EPA to strengthen existing state nonpoint source management programs. Point/nonpoint source trading is a potential tool for this program area.

Current Approach to Attain Water Quality Goals

The Clean Water Act currently provides a two-tiered approach to water quality protection. At a minimum, technology-based requirements limiting pollutant concentrations in effluents must be attained by all point source dischargers. These requirements take the form of nationally uniform standards for classes and categories of industries, and a parallel approach for publicly owned treatment works (POTWs) and their indirect dischargers. Dischargers are required to comply with these effluent limits, but there is no direct incentive for them to take additional steps to further reduce their discharges or otherwise improve water quality.

The Act also requires that point sources meet more stringent effluent limitations in certain circumstances. States establish ambient water quality standards that specify goals for specific waterbodies. If technology-based controls are insufficient to protect water quality, water quality standards serve as the regulatory basis for developing more stringent effluent limitations to be applied to specific point sources.

Analysis to Support CWA Reauthorization

In consultation with numerous other agencies, the U.S. Environmental Protection Agency (EPA) is preparing analyses of the costs, benefits, and other impacts of selected provisions of the various amendments now being considered. EPA is also assessing the extent to which certain water quality problems can be addressed through the application of market-based approaches that supplement regulatory approaches. If the analyses show that market-based approaches are useful, the approaches may be incorporated in the CWA during this reauthorization.

There are two major categories of reauthorization analyses. *Impact Analyses* are prepared for proposed CWA amendments that represent new or expanded surface water programs that may be costly to implement and/or for which the water quality benefits are unknown or suspected to be small. *Incentives Analyses* are prepared to help determine whether application of a market-based approach to surface water problems can efficiently and effectively supplement a statutory/regulatory approach.

Purpose of this Analysis

This incentive analysis is restricted primarily to evaluating the potential for point/nonpoint source nutrient trading to supplement existing point source regulation in order to achieve reductions in nonpoint source discharges and to meet water quality objectives for nutrients. To the extent that they offer useful lessons for point/nonpoint source arrangements, experiences with point/point and nonpoint/nonpoint source trading also are presented. As part of an evaluation of the potential for nutrient trading, this report analyzes current programs that incorporate nutrient trading between point sources and nonpoint sources. It then presents statutory, regulatory and administrative options that could change the extent to which this practice is used in the United States to deal with water quality problems.

This analysis focuses on trading to achieve water quality standards for nutrients for several reasons. Nearly all of the trading experiences to date have been with trading for only one type of pollutant -- nutrients. Further, nutrients constitute the largest pollutant common to both point and nonpoint sources. For the near term, nutrient trading presents the best opportunities for taking advantage of the benefits that a successful trading program can provide. Analysis of state data (described at length in Chapter IV) indicates that a significant number of waterbodies may meet the necessary requirements for nutrient trading and experience to date suggests that successful programs can be crafted.

Preliminary research suggests that there may be future potential for trading to supplement existing point source regulation of such pollutants as pathogens or chlorides. In fact, areas that undertake nutrient trading may also realize reductions in pathogens from nonpoint sources where nutrient trades result in additional and/or improved animal waste management practices.

At the moment there appears to be little potential for trading to supplement regulation of toxic pollutants. EPA is particularly concerned that many toxic pollutants are persistent and/or bioaccumulative in nature. The Agency has long pursued elimination of such discharges. To the extent trading facilitates reductions of toxics, it might be a valuable strategy. However, the Agency is not currently investigating applying trading to toxics.

This report will be considered by the Agency, the Administration, Congress, and other parties interested in the application of market-based approaches to environmental problems in general, and in solutions to nonpoint source pollution in particular. The information in this report will be used to help formulate decisions concerning the potential inclusion of point/nonpoint trading principles and/or requirements in the reauthorized CWA.

The remainder of this introduction summarizes surface water quality problems and identifies options available to address them.

A. SUMMARY OF THE SURFACE WATER PROBLEM

Since 1972, the nation has made much progress in surface water quality through a program of technology-based effluent limits for industrial and municipal point sources. As EPA and the states tightened the regulation of point sources (industrial facilities and wastewater treatment plants), the relative importance of nonpoint source pollution to water quality has increased. Recent evidence indicates that nonpoint source pollution -- from both urban and rural sources -- is now the dominant cause of remaining water quality impairment. Urban nonpoint sources include runoff from industrial sites, commercial development, and urban streets. Principal rural nonpoint sources include agricultural nutrients, pesticides, and soils; forestry operations; and mining.[1]

Current federal law encourages nonpoint source controls in the Clean Water Act, but these controls are voluntary, not regulatory in nature. Local nonpoint source regulation varies across jurisdictions in scope, type of controls required, and strictness of the runoff loading limits of toxics, sediments, and nutrients. In the absence of local regulation, compliance generally remains voluntary. Nationally, nonpoint sources typically face significantly less stringent controls than do point sources, except within the coastal zone where states have greater authority to regulate all activities affecting water quality. Under the Coastal Zone Management Act, states must review any kind of development within the coastal zone to ensure its consistency with the state's coastal zone management plan (CZMP). To the extent that runoff resulting from development fails to meet state CZMP requirements, the state may impose a variety of requirements including stricter performance standards and or may deny permits if conditions are not met.

Table 1 below presents data from the most recent national survey of surface water quality and indicates the scope of the nonpoint source pollution problem.[2]

TABLE 1

Percent of Impaired River Miles, Lake Acres, & Estuary Square Miles Affected by Nonpoint Source Pollutants

Pollutant Sources	River Miles	Lake Acres	Estuary Square Miles
Agricultural	61%	57%	18%
Hydrologic/habitat Modification	15%	41%	5%
Storm Sewers/Runoff	12%	27%	31%
Land Disposal	na	24%	19%
Silviculture	9%	na	na
Construction	5%	na	11%

[1] U.S. EPA, *National Water Quality Inventory -- 1990 Report to Congress*, Washington, D.C. (March 1992).

[2] U.S. EPA, *National Water Quality Inventory -- 1990 Report to Congress*, Washington, D.C. (March 1992) Tables 1-3, 2-3, and 4-3 on pages 10, 23, and 53, respectively.

Excessive nutrient (nitrogen or phosphorus) loading is a serious pollution problem attributed to urban and rural runoff.[3] High levels of these nutrients accelerate algal growth and lead to eutrophication and its water quality effects -- low dissolved oxygen, fish kills, reduction in biodiversity, odor, etc. Where municipal point sources have reduced their nutrient loads through pretreatment and secondary treatment, and in some cases advanced treatment, agricultural activities often account for the bulk of the remaining nutrient load. Urban nonpoint sources of nutrients, such as lawn fertilizers, septic systems, or stormwater runoff, can also contribute significant proportions of the nutrient load. While the runoff from rural areas contains natural levels of nitrogen and phosphorus loads, nutrients in fertilizers, crops, and livestock residuals greatly increase rural loading. Farming and other land-disturbing activities also release nutrients in the soil and free sediment, further contributing to water quality problems.

B. OPTIONS AVAILABLE TO ADDRESS REMAINING WATER QUALITY PROBLEMS

EPA and the states recently identified over 18,000 specific waterbodies that will not attain water quality standards even if point sources fully implement controls to meet technology-based discharge requirements (secondary treatment for sewage treatment plants or best available treatment technology for industrial dischargers) because nonpoint source pollution is such a significant part of the problem there. For such waterbodies, solving the remaining water quality problems may require the implementation of alternative water quality improvement strategies. Options to resolve remaining water quality problems include:

- Stricter point source controls beyond technology-based discharge requirements;
- Significantly reducing nonpoint source contributions; and/or
- A combination of controls on both point and nonpoint sources.

In general, stricter point source controls will be expensive and will not reduce the large pollution loads associated with nonpoint sources. The relative cost of point versus nonpoint source control measures is an important consideration in choosing among alternative water quality improvement strategies. Given the increasing costs of environmental protection and competing needs for limited financial resources, future water quality improvement efforts must consider the efficiency of alternative approaches and use the most cost-effective control methods to achieve the nation's water quality goals. To the extent that market incentives drive decisions about *how* to achieve specified improvements in water quality, these improvements will be made in the most economically efficient manner possible. Therefore, strategies combining point source and nonpoint source controls with market-based approaches -- rather than strictly regulatory approaches -- may offer the best opportunities to achieve significant reductions at the lowest cost.

One non-regulatory, market-based method for achieving environmental quality objectives is the general concept of "effluent trading." Although it can take many different forms, effluent trading in principle allows dischargers to allocate discharge reductions (beyond those required by technology-based standards) according to relative economic efficiency. This allocation can take many forms, including the buying and selling of marketable discharge permits, or one entity "buying" required discharge reductions by funding (or otherwise arranging for) controls to reduce another discharger's effluent.

When considered in the broadest possible sense, effluent trading does not necessarily have to be limited to one type of discharger or even to one type of pollutant. As a result, there are numerous potential models for a trading program, including trading between point sources only, between nonpoint sources only, and between point sources and nonpoint sources. An additional delineation can be made between new sources and old sources, where new sources may be required to trade for reductions from old sources equal to (or even greater than) the amount they are anticipated to discharge. Finally, it is conceivable that trading could be used across pollutant types, such that a source discharging one type of pollutant that requires control may trade for a reduction in another type of pollutant that also requires control. In this case, trades among different types of dischargers would be structured to ensure that water quality objectives for all the types of pollutants involved were being met through the trading program.

II. PRINCIPLES OF POINT/NONPOINT SOURCE TRADING: THE ROLE OF POINT/NONPOINT SOURCE TRADING IN MEETING WATER QUALITY OBJECTIVES

In point/nonpoint source trading program, point sources arrange for nonpoint source controls in lieu of more expensive plant upgrades that would otherwise be necessary to attain ambient water quality targets. Because point source/nonpoint source trading provides a means of controlling both point and nonpoint source discharges into a waterbody, usually through an allocation of permissible pollutant loadings to the waterbody across all dischargers and discharges, it generally represents a basinwide approach to controlling total pollution loading. In contrast, controlling discharges from point sources only is representative of traditional regulatory approaches. Trading is a way to supplement the technology-based requirements of the Clean Water Act by providing greater flexibility to the manner in which water quality goals are achieved. It is not a way for dischargers to avoid compliance with their minimum treatment requirements.

Currently, nonpoint sources are unregulated under the Clean Water Act. Trading programs can help attain water quality objectives by reducing nonpoint source discharges. Point-source discharges are regulated through National Pollutant Discharge Elimination System (NPDES) permits. By authorizing credits in NPDES permits in return for specified nonpoint source control efforts, trading programs can create economically attractive incentives for point sources to help reduce nonpoint source discharges.

A. THEORETICAL CONSTRUCT

The theory underlying point source/nonpoint source trading is based on marginal cost analysis.[4] For each of the variety of methods available to reduce pollutant loading, there is a specific cost associated with every increment of pollutant reduction (and accompanying increment of water quality improvement). The most efficient and effective approach to reducing pollutant loading requires implementing the least-cost method available for each additional increment of pollutant reduction. In a trading program, the lowest marginal cost of controlling both point and nonpoint sources can only be achieved by providing opportunities for point sources that would otherwise have to install high-cost technologies to pay for generally less expensive nonpoint source controls.

Nonpoint source controls will be economically attractive alternatives to point source controls where the marginal cost of the amount of nonpoint source controls that can be exchanged for one unit of point source reduction is less than the marginal cost of one unit of point source pollutant reduction. As the less expensive pollutant control choice, nonpoint source

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[4] There may be some circumstances where the result of marginal cost comparison is not the sole factor in the decision to trade. See the discussion of Nonpoint/Nonpoint Source Trading and Offsets later in this section.

reductions traded for point source reductions are the most cost-effective control option. Whether or not the marginal costs for point and nonpoint sources are ever equal depends on technology costs (both point and nonpoint), local land use, the number of each type of source, and the level of loading from each, as well as on the trading ratio established for the program.

The rate at which nonpoint source load reductions may be traded for point source load reductions -- the trading ratio -- is part of the marginal cost analysis. Ratios are determined at the outset of a trading program and reflect the volume of nonpoint source load reduction equivalent to one unit of point source reduction. Under a trading ratio of 1:1, a credit for one unit of point source load reduction is obtained by paying for or installing that level of nonpoint source control which will produce one unit of nonpoint source reduction. Under a ratio of greater than 1:1, more than one unit of nonpoint source reduction is necessary to obtain credit for one unit of point source load reduction.

The trading ratio may be established at greater than 1:1 for a variety of reasons, including the uncertainty in measuring nonpoint source reductions, both in terms of the amount of loading reduced for any given control and the permanency of the control once installed. Ratios are also set at greater than 1:1 to offset point source and nonpoint source impacts from new growth.[5]

Despite the potential benefits of trading, point and nonpoint source loadings are imperfect substitutes for several reasons. Point source loadings are relatively constant, with the exception of combined sewer systems where loadings may increase significantly during storm events. Nonpoint sources are typically spread out within a watershed and loadings are more diffuse and random than point sources, and are generally more dependent on the weather and topographic conditions. Further, there is a greater degree of uncertainty about the effectiveness of nonpoint source control, especially about the actual reductions achieved and the permanency of those reductions. Point source loadings, while more costly to reduce (in most circumstances), are more easily monitored and regulated, whereas nonpoint sources are far more difficult to monitor and are largely unregulated. Under the Clean Water Act, pollutant abatement responsibility lies with point sources, despite the fact that nonpoint sources contribute the greater share of nutrient loadings in many waterbodies.

[5] High ratios will decrease the cost-effectiveness of nonpoint source controls from the perspective of the point source (each "credit" becomes more expensive as the ratio increases). Furthermore, nonpoint source reductions are more difficult to measure than point sources and the dependence of the program on nonpoint source reductions may complicate or hamper enforcement of water quality standards. Technological changes or shifting growth patterns may also make it difficult to structure load allocations and limits in a manner that will continue to facilitate trading as conditions change.

B. NECESSARY CONDITIONS

EPA has identified several conditions necessary for a successful point/nonpoint source trading program.[6] This report's updated evaluation of existing programs suggests additional requirements. In the absence of implementation costs (sometimes referred to as "transaction costs"), *any* voluntary reduction in loadings through trading can be considered to be an improvement over the regulatory status quo because presumably a point source discharger would only fund nonpoint source controls if the necessary amount was less costly than point source controls that would reduce the required amount of pollutants. In practice, however, transaction costs, including those incurred by government to administer the program, may make trading inefficient. The following list of elements for a successful program is predicated on the assumption that the objective of trading is to meet water quality objectives through the loading reductions brought about by the program. In other words, a sufficient volume of reductions should be achievable through trading to make an impact on water quality *and* obviate the need for more stringent point source controls. Key elements of successful programs are listed below:

a. **The waterbody must be identifiable as a watershed or segment;**

b. **There must be a combination of point sources and controllable nonpoint sources that each type of source must contribute a significant portion of the total pollutant load;**

c. **There must be a water quality goal for the watershed that necessitates action;**

d. **There must be accurate and sufficient data with which to establish targets and measure reductions;**

e. **Point sources, at minimum, must meet technology-based discharge requirements as required by the Clean Water Act**

f. **There must be significant load reductions for which the marginal cost of each pound reduced of nonpoint source controls (multiplied by the trading rate) is lower than for upgrading point source controls;**

g. **Point sources must be facing requirements to either upgrade facility treatment capabilities or trade for nonpoint reductions in order to meet water quality goals;**

h. **There must be an institutional structure to facilitate trading and monitor results; and**

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[6] Kashmanian, Jaksch, Niedzialkowski, and Podar, "Beyond Categorical Limits: The Case for Pollution Reduction Through Trading," paper presented at the 59th Annual Water Pollution Control Federation Conference/Exposition, Los Angeles, California, October 6-9, 1986.

i. Sufficient and effective implementation mechanisms must be in place or enacted as part of the trading system (including appropriate enforcement mechanisms).

Many economic, technical, and institutional factors must be considered when designing a point/nonpoint source trading program. The necessary conditions indicate that trading will not be uniformly applicable in all watersheds. Where it is applicable, however, trading offers local jurisdictions the potential to reduce their cost of meeting water quality objectives. These identified necessary conditions are described in more detail below.

a. Identifiable Watershed. Confining trading to an identifiable watershed or segment facilitates the management of the trading program by establishing the boundaries in which trading is allowed and delineating the area that will be monitored for water quality improvement as a result of trading.

b. Sufficient Point and Nonpoint Sources. The water quality problem must result from both point and nonpoint source pollutant loadings in order for trades to be possible between point sources and nonpoint sources. A trading system for nutrients is likely to meet these conditions because nutrients are frequently a large part of the water quality problem for individual watersheds, and they are a common constituent of both point sources and nonpoint sources.[7] In a given watershed, for example, if controllable nonpoint sources contribute small loadings, point sources may not be able to "buy" enough nonpoint source control meet water quality standards. Alternatively, if point sources contribute very small loads, then even under trading ratios of greater than 1:1 there is little potential for significant increases in nonpoint source controls as a result of trading. Where point sources account for 20 percent of the load and nonpoint sources 80 percent, trading under a ratio of 2:1 could effect a significant impact on water quality.

c. Water quality goal. The water quality objective, frequently expressed as an ambient water quality standard, pollutant loading reduction target, or total maximum annual load allowed, provides the basis for determining the alternative loading allowances for point source dischargers under a trading program. The objective and the resulting alternative loading allowances then serve as part of the basis for point source dischargers to evaluate the cost-effectiveness of additional controls to meet these limits. It also serves as the base against which reductions are measured and the effectiveness of the trading approach can be determined.

d. Accurate and sufficient data. Sufficient and reliable water quality data, pollutant loading data, and an understanding of pollutant effects on water quality are necessary to determine maximum loadings allowable to achieve water quality standards, and to evaluate alternative point and nonpoint source control strategies. Modelling may be required to accurately establish the relationship between loadings and water quality, to allocate loadings

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[7] U.S. EPA, *National Water Quality Inventory -- 1990 Report to Congress*, Washington, D.C. (March 1992).

across different types of sources, and to help determine appropriate trading ratios and pricing of reduction credits.

Nutrient pollution is suitable for control through a trading program because it is the total concentration of nutrients (usually phosphorus or nitrogen, but not often both) in a waterbody that determines whether there is a risk of eutrophication, and the discharges from both point sources and nonpoint sources contribute similarly to the pollution problem. Total watersheds may be the most appropriate spatial scale to support nutrient trading because adverse effects from nutrient loadings may not be felt in the immediate receiving stream, but downstream in a lake or estuary where nutrient loadings can collect.

The trading system must be able to track total discharge levels, point/nonpoint source trades, and total nonpoint source controls implemented. A significant amount of planning and analysis may be necessary if the relevant regulatory agency does not already have sufficient water quality and nutrient loading information to establish appropriate water quality goals and calculate allowable nutrient loads that will achieve desired water quality improvements or maintain a given water quality level. Where such information is not already available, it may be necessary to develop a water quality model of the proposed trading area to determine the maximum allowable nutrient loads necessary to meet certain water quality goals.

When the necessary information is at hand, the relevant regulatory agency establishes a total maximum daily nutrient load (TMDL) designed to achieve a specified water quality goal. The TMDL may reflect a reduction over current point source loadings, and may decrease over time, in order to compel water quality improvements. The TMDL is allocated among point sources discharging in the waterbody identified for trading, sometimes being expressed in terms of annual maximum allowed pounds or kilograms of nutrient load.

e. Technology-based discharge requirements met. All point sources must meet and continue to meet, at a minimum, the technology-based discharge requirements of the Clean Water Act (i.e., secondary treatment or equivalent for POTWs; BAT for industrial sources). Trading may not result in increased loading for any individual point source above that allowed by technology-based controls.

f. Nonpoint source marginal costs less than point source marginal costs (accounting for trading ratio). Nonpoint source controls must be more cost-effective than point source controls necessary to achieve water quality goals. Otherwise, point source dischargers have no incentive to trade to achieve loading reductions. Additionally, because nonpoint source control effectiveness and costs are site-specific, it is important for both regulators and potential traders to have knowledge of the effectiveness of nonpoint source controls in reducing pollutant loadings, in part to establish a correct basis for marginal cost and cost-effectiveness comparisons, and in part to establish an appropriate trading ratio.

To facilitate the development of the trading program and trading itself, point sources need information on the marginal cost per pound or kilogram to reduce pollutants, and some entity (Soil Conservation Service, Department of the Environment, local planning agency, or developers' association) must be able to provide comparative marginal cost information on best management practices (BMPs), for urban, rural and farm nutrient reduction. Additionally, wastewater treatment facilities and other point sources may have to conduct engineering studies to determine the marginal cost of additional reductions. Nonpoint source reduction demonstration projects on farms and in urban areas may be necessary to determine the average marginal costs of nonpoint source reduction controls.

g. Point source allocations are limiting. Point source facilities must be under pressure to further reduce their discharge loads, otherwise there will be no reason to trade. Further, trading needs to result in significant reductions in nonpoint source loadings in order for a trading program to have a significant impact on water quality, and thus reduce the likelihood that point sources will be required to meet more stringent discharge limits.

h. Institutional structure. While trading programs are based on market incentives, they cannot rely entirely on market forces to result in attainment of water quality standards. An organization must take the lead in designing, administering, and monitoring program results -- to make the market, in effect. If one does not exist, or if a division within the institutional structure cannot appropriately assume this role, an organization or division must be created that can. Because trades affect the permit requirements of point source dischargers, there needs to be feedback to the agency responsible for permit issuance, review, and enforcement. Additionally, if water quality standards are not being met under a trading program, the implementing agency needs to be able to revise permit levels, program implementation rules, and possibly program design.[8] To ensure the trading program's success, the implementing organization requires cooperation and coordination from the state, affected local jurisdictions, other organizations that may facilitate trading (such as a local conservation district, State soil and water conservation agency, or the USDA Soil Conservation Service), and the landowners in the area where nonpoint source controls will be implemented.

i. Compliance incentives and enforcement mechanisms. Effective implementation mechanisms must be in place to ensure that the gain in cost-effectiveness of pollution reduction obtained through trading is not eroded by lack of clarity in the regulations or the inability or failure of point source dischargers to comply with other program or permit requirements. The strength of the NPDES system is the enforcement potential created by specified permit levels, monitoring, and fines. A program that departs from traditional point source permit requirements raises compliance concerns if there is the potential for lax enforcement or a weaker compliance incentive system. One party (the point source discharger) is subject to enforcement measures, yet it may be dependent on the actions of another party (the nonpoint source discharger) to bring about required reductions. This arrangement can create compliance issues under trading programs that are more complex than under traditional regulatory approaches. Careful

[8] Water quality standards may not be met for a variety of reasons, including: the load allowances do not result in the anticipated water quality improvement, or the necessary nonpoint source controls are insufficient and do not result in the same per pound improvement as would point source reductions.

consideration needs to be given to the delineation of authority over trading and the authority over nonpoint source control implementation.[9]

C. HOW POINT/NONPOINT SOURCE TRADES ARE IMPLEMENTED

When a point source discharger exceeds its allotted nutrient load, it must arrange to fund one or more nonpoint source control measures that will provide the level of reduction required to meet its allowance. In some cases the trading program may require point sources to fund more than one unit of nutrient reduction from nonpoint sources for every unit of reduction for point sources. Point sources may fund controls implemented by nonpoint source dischargers (either directly funding specific projects, or indirectly through funding provided to a nonpoint source control program), or may implement nonpoint source control measures themselves.[10]

There are primarily three options available to provide the opportunity for point sources to trade nonpoint source load reductions for point source load reductions:

1. A point source contributes a specified amount (based on the trading ratio) per unit of reduction needed into a fund that supports best management practices for nonpoint sources;

2. Alternatively, a point source contracts with a third party (e.g., Nonpoint Source Controls, Inc.) to install and maintain the level of nonpoint source control which will provide the necessary amount of nutrient load reduction to be credited to the point source; or

3. Point sources contract directly with a nonpoint source owner (e.g., developer, farmer, government agency) to install and maintain the level of nonpoint source control which will provide the necessary amount of nutrient load reduction to be credited to the point source.

It would be administratively difficult for a trading program to offer more than one option; it is therefore likely that a trading program would provide only one option. Under options 2 and 3 above where the point source contracts with another party, it may be necessary for the point source to include monitoring and maintenance provisions in the contract, as well as require the contractor to post a performance bond against the controls.

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[9] As discussed later in Section III and in the Tar-Pamlico case study, in the Tar-Pamlico trading program the North Carolina Division of Environmental Management, in the Department of Environment, Health, and Natural Resources (DEHNR) has final decision- making authority with regard to the adequacy of nutrient trades and allocations. The Soil and Water Conservation Commission has final authority with regard to agricultural best management practice (BMP) implementation. In this program point sources trade BMPs for point source loading reductions.

[10] Nonpoint source control obligations may have to be indexed to an established baseline because its nutrient removals at nonpoint sources are related to the amount of rainfall and topographic conditions.

The first alternative represents the most institutionalized option. The fund into which contributions are made could be an existing fund that supports nonpoint source controls, or a fund could be created specifically for the trading program. The reduction credits would typically be expressed in dollars per pound, where the price of the credit would be determined by multiplying the average marginal cost for nonpoint source load reduction by the trading rate. The other two alternatives represent less structured options, the third being somewhat ad-hoc in nature. Under these options, the reduction credit might typically be expressed in pounds necessary for one pound of nutrient load reduction, and the price per pound might vary across contractors.

Depending on the distribution of nonpoint sources in the trading area and their relative contribution to the water quality problems, a program may focus on urban nonpoint source load reduction at new development sites and existing urban areas, or on rural nonpoint source load reduction on farms, or even on both.

The regulatory form for a trade is a dual set of discharge limits in the point source discharger's permit: a stringent water quality-based limit which is applied (in addition to technology-based requirements) if point source reductions are the only means available for meeting water quality standards; and a less stringent requirement, typically expressed in terms of pollutant loading allowances, which is applied when trading is undertaken. The less stringent requirements are, at a minimum, equivalent to technology-based standards. Re-opener clauses should be included in permits because wasteload allocations may need to be altered in the event that water quality standards are not met. They provide the opportunity to revise total loading limits or set trading ratios at higher levels.

D. OPTIONAL PROGRAM SCENARIOS

To date, three distinct water pollution trading scenarios have emerged (see Section III): (1) those that permit trades only among point sources (not the primary focus of this paper); (2) those that permit trades between point sources and nonpoint sources; and (3) those that permit trades between nonpoint sources. All are similar in that they allow one source to trade some level of pollutant loadings with another source in order to receive reduction credits. Under each type of trading, point sources must continue to meet technology-based requirements and nonpoint sources must meet any applicable local or state minimum performance standards.

The three scenarios may be tailored to regulate existing sources only (with more strict or alternative standards applied to new sources), or they may be modified to target new sources. A fourth scenario, offsets, is a form of trading tailored to new sources that can enable a waterbody to accommodate growth without exceeding an established loading allowance. The scenarios may be used alone, or in combination with one or more of the other scenarios. They are described below.

1. Point/Point Source Trading

Under point/point source trading, designated point sources trade permitted discharge allowances only among themselves. In this approach, a point source may negotiate with another point source in the trading area to buy a portion of the other's loading allocation. When point sources agree to trade, the administrating agency modifies their discharge permits to reflect the traded allowances.[11]

The marginal costs of technological control measures differ among point sources. Point/point source trades would therefore be economically attractive if the cost to achieve reductions through in-plant modifications or facility upgrades was below that required to receive equivalent reduction credits through funding nonpoint source reductions. In point/point source trades, one or more plants would pay another to reduce its loading, thereby reducing the total loading of the group. Presumably, the plants might pay for reductions at the plant that could achieve the lowest pound-for-pound reduction costs until the reduction targets are met or until the marginal cost of treatment are equalized among the point sources.

This scenario offers several advantages. First, it may be relatively simple to calculate new permits or loading allowances under point/point trading because there are existing permits to work from. Second, the actual results of point source trades should be relatively certain simply because it is easier to monitor point sources than nonpoint sources. A disadvantage of this scenario (when it is not used in conjunction with point/nonpoint source trading) is that reductions may not be achieved at least cost due to the exclusion of nonpoint sources as trading participants. Among the four scenarios, this one is the most limiting in its scope because point sources cannot take advantage of cheaper, and often more abundant, nonpoint source nutrient reduction opportunities. This scenario thus fails to deal with a large source of waterbody impairment -- i.e., nonpoint sources. It does not present a truly comprehensive solution to water quality problems.

2. Point/Nonpoint Source Trading

Under point/nonpoint source trading, point sources pay for nonpoint source reductions (through contributions to a fund that supports nonpoint source control installation and management) and in exchange receive credits against their load allocations or reduction targets. Best management practices (BMPs) reduce pollutant loading from urban and rural nonpoint sources. Trades are cost-effective where the level of nonpoint source pollution control required to obtain credit for one pound of nutrient reduction is than the cost per pound reduced of facility modifications or upgrades at POTWs and other point sources.

Through the TMDL process, a regulatory agency allocates the total load allowance (water quality-based) among the point source dischargers in the trading area. Each point source's nutrient discharge must be less than or equal to its allotment. Under trading, in the event that a point source's actual load exceeds its allowed load, it can offset the difference with nonpoint source nutrient reduction credits rather than install additional treatment. POTWs and other point sources receive reduction credits by funding or otherwise arranging for a specified level or dollar amount of nonpoint source controls. Trading ratios may be set at greater than one to one to

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[11] The program is similar to the bubble concept in the air pollution control programs where a firm may trade emissions reductions among stationary sources within its facility, or with another facility, to achieve a given level of emission reductions at least cost.

ensure adequate reductions. For example, in areas with significant new growth, the resulting increases in nonpoint source runoff and point source loadings may warrant setting trading ratios at greater than 1:1, not only to account for uncertainty about the equivalency of reductions, but to offset associated increases in new nonpoint sources.

In point/nonpoint source trading programs, the group of dischargers may be considered a single trading-unit for the purposes of trading administration. A total aggregate allowable load is established for the group of dischargers and they decide among themselves how to allocate shares of the total load. The point sources jointly have to meet the aggregate total discharge level. In this type of program, individual plants will have two sets of permit requirements -- a "with trading" requirement and a "without trading" requirement, where the "with trading" allowance is usually determined by the group of point source dischargers through its allocation process. Individually, point sources are still subject to technology-based requirements and can face enforcement penalties in the event that its discharged load exceeds allowed levels and/or the less stringent requirements result in local water quality problems. This continuing responsibility provides incentive for the point source to insure that the other "traders" fulfill their agreements to use effective BMPs.

Point/nonpoint source trading offers several advantages. Increasing the classes and numbers of trading partners increases the potential for cost-effective reduction in pollutant loading. This is particularly true where the marginal costs of further point source reductions are relatively high and where population growth and development have increased the relative contribution of nonpoint sources of pollution. Including both point and nonpoint sources also tends to force the development of a watershed-wide or basin-wide approach to pollution reduction. This component provides the opportunity to target reductions to protect and maintain localized areas of high water quality and improve localized areas of low water quality. Treating the discharge community as a single unit can facilitate pollution reduction accounting and permitting. Where point sources are treated as one unit, public costs may be reduced because some of the administrative costs associated with allocating the total allowable load is shifted to the point sources.

Despite its advantages, point/nonpoint trading poses several obstacles that must be overcome in order to have a successful program. Trading places special responsibilities on authorizing agencies, program administrators, the participating dischargers, and those implementing the nonpoint source controls. Taking advantage of the opportunity to target nutrient reductions throughout the trading area may necessitate cooperation and information sharing between agencies without previous cooperative experiences (e.g., regulatory agencies with water quality authority and farmers' assistance programs).

There may be some difficulty in establishing effective enforcement. Point sources may face the risk of being subject to more stringent effluent limits if nonpoint source reductions fail to result in the projected water quality improvement, but they themselves have little recourse to assure nonpoint source control implementation. Under the Clean Water Act and other relevant statutes, nonpoint source reduction programs are voluntary, incentive-based, and are normally not enforceable. Therefore, trading programs involving nonpoint sources may have to rely on similar mechanisms to encourage buy-in and participation.

Additionally, due to the differences in point and nonpoint source controls enumerated earlier, it may be more difficult to arrive at an appropriate trading ratio, as compared to point/point source trading. When trading for nonpoint source controls, some uncertainty about the consistency and longevity of nonpoint source controls is likely to remain.

3. Nonpoint/Nonpoint Source Trading

Nonpoint/nonpoint source trading provides a mechanism to achieve nonpoint source reductions beyond those obtainable through point/nonpoint source trading. New nonpoint sources are occasionally subject to stricter erosion and runoff standards under state and local law than are existing nonpoint sources. Where such requirements exist (e.g., for new urban development) nonpoint/nonpoint source trading allows new nonpoint sources to satisfy nonpoint source control requirements through a combination of on-site controls and off-site controls, affording the new nonpoint source the opportunity to meet its requirements at least cost. Presumably, on-site controls will be less expensive than off-site controls up to some level of control; at that level, off-site controls will become relatively cheaper than equivalent on-site management practices. With a trading ratio of greater than 1:1, it is possible to achieve a greater level of nutrient reduction than the regulations for new sources provide at a lower cost to the new nonpoint source.

In practice, nonpoint/nonpoint source trading has evolved from the point/nonpoint source scheme originally adopted for Dillon Reservoir. Due to improved operational efficiency of existing technology, the point sources discharging into Dillon Reservoir did not need reduction credits. The Dillon Reservoir trading program is now driven by reservoir phosphorus limits and a desire to offset new nonpoint source phosphorus with reductions elsewhere in the watershed. The experience at Dillon is described in more detail in Section III, and in the appended case study.

Nonpoint/nonpoint source trading provides opportunities to achieve water quality goals at least cost where new nonpoint sources are entering a basin, where such new sources are regulated by state or local law, and where there is a sufficient number of existing nonpoint sources with which to trade. In combination with point/nonpoint source trading, nonpoint/nonpoint source trading maximizes the opportunities for meeting pollutant loading goals at the lowest cost per pound. The combination also relieves point sources of some of the financial burden of accommodating growth because it allows point/nonpoint source trading ratios to be set so as to only incorporate a safety/uncertainty factor. The nonpoint sources are responsible for mitigating the additional runoff they generate (see discussion of 2:1 trading ration in description of Dillon Reservoir program in Section III).

Nonpoint/nonpoint source trading does not entirely solve the problems relating to uncertainty about the consistency and permanency of nonpoint source controls, either by itself, or in combination with one or more other components. Neither does the nonpoint/nonpoint source trading program eliminate concerns about the ability of the organizations that currently have oversite responsibility for rural and urban nonpoint source control installation and maintenance as discussed above in the point/nonpoint source trading description. Despite these drawbacks, on-site and off-site controls are likely to be better substitutes than point and nonpoint sources.

4. Offsets

The use of offsets, alone or in conjunction with other trading scenarios, provides a mechanism to accommodate new sources and expansions of existing sources without exceeding the established nutrient loading allowance. Under an offset provision, new and expanding sources must obtain sufficient reductions from other sources to offset the additional loading they will generate. Unless point sources are substantially under their loading allowance, and/or existing nonpoint source loads are relatively low, new sources may face difficulty locating in the trading area and existing sources may face difficulty expanding because the loading allowance for the trading area effects a no-net-increase in loading. In fact, in some areas the goal will be to achieve a net reduction in loading. Under either policy, growth will not be possible without offset provisions or without revisions in the aggregate loading allowance and loading allocations.

Offset ratios are arrived at in a manner similar to that for trading ratios, i.e., a 1:1 ratio provides an equivalent offset, while a greater than 1:1 provides a safety factor and/or additional reduction.[12] Setting offset ratios for nutrient loads at greater than 1:1 would serve several purposes. Assuming new or expanded point source offset additional loads with nonpoint source reductions available under a trading program, a greater than 1:1 offset ratio would incorporate a safety factor and account for the uncertainty about the equivalence of nonpoint source reductions. A greater than even ratio could also help offset additional nonpoint source loading associated with the growth necessitating additional point source capacity. Where new or expanding nonpoint sources are required to offset additional loading as a condition of siting or building permits, the offset ratio may more appropriately be set at 1:1, according to the substitutability of on-site and off-site nonpoint source controls. For nonpoint sources requiring offsets, a ratio of greater than 1:1 would likely have the effect of exacting an entry or expansion premium in the absence of other reasons for a greater than 1:1 exchange rate.

When designing new or modified point or nonpoint sources, the owner will attempt to reduce loadings at any cost per kilogram up to the going rate for a kilogram reduction credit (reduction cost per kilogram multiplied by the trading ratio). New and modified sources thus meet permit conditions at least cost, using a combination of on and off-site controls. While marginal cost analysis applies in most cases where offsets are considered, it may not always apply. In addition to comparing the marginal cost for on- and off-site reductions, a point source or nonpoint source may also consider the expected return on investment, and, under some circumstances, may be willing to purchase more offsets than marginal cost analysis indicates is economical because the total return on investment will cover the additional expenditure.

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[12] A trading ratio of greater than 1:1, e.g., 2:1 means that the new source must arrange for two pounds of load reductions for each pound it will discharge. Under the Clean Air Act, offsets must provide a greater than 1:1 counterbalance against new emissions.

III. EXPERIENCE TO DATE IN TRADING PROGRAMS

A. CASE STUDIES OF EXISTING TRADING PROGRAMS

An evaluation of established trading programs confirms the importance of the conditions this report identifies as keys to the success of trading programs. Three programs have developed beyond the planning stage: Cherry Creek Reservoir and Dillon Reservoir in Colorado, and Tar-Pamlico River Basin in North Carolina. While none of these programs has met all the conditions necessary for a successful trading program, Dillon Reservoir's has developed into a successful basinwide nutrient management strategy. Tar-Pamlico appears to meet many of the conditions for success, but trading has not yet been necessary. A fourth trading program between point sources has been in place for the Fox River in Wisconsin for ten years, but has resulted in only one trade. It appears that a fifth program is in the development and planning stages at Chatfield Basin in Colorado. Information is presented on each of these programs; as they provide generally useful lessons for a trading option under the CWA.

1. Chatfield Basin, Colorado

Increased total phosphorus (TP) loading to the Chatfield Basin could greatly degrade the future water quality of the Chatfield Reservoir, the surface water body to which the Basin is a tributary. The Chatfield Basin is a 3,000 square mile area that includes portions of six counties in the Denver Area. In 1989, a phosphorus effluent limit of 0.2 mg/l total phosphorus (TP) was imposed on point source dischargers in one sub-basin. This restriction was anticipated to be protective of the TP standard until the year 2000, after which time nonpoint source controls would be necessary, perhaps coupled with further tightening of point source limits. Presently, no nonpoint source measures have been implemented specifically to control total phosphorus. Increasing development pressures in the Chatfield area will increase TP loads to the Basin beyond acceptable levels if specific controls are not implemented.

To investigate the sources and extent of the phosphorus loading, a basinwide TP simulation model was developed to predict monthly and annual loads originating from each of 30 sub-basins from the following sources: groundwater, point sources, developed land use nonpoint sources, and undeveloped land use nonpoint sources. The model was developed as part of the 1991 Chatfield Basin Nonpoint Source Management Program.

A project is now being proposed to develop a mathematical model to determine economically optimal wasteload allocations among point and nonpoint sources based on their respective control option costs.[13] The TP simulation model would be incorporated in the optimization model so that the effects of alternative wasteload allocations on reservoir loads are quantified.

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[13] *Concept for Wasteload Allocation Modeling in Chatfield Basin, Colorado.* Woodward-Clyde Consultants, January 1992; and personal communication with Bruce Zander, US EPA Region VIII, March 18, 1992.

The results of the optimal allocation model could be used to facilitate a point/nonpoint source trading program for phosphorus in the Chatfield Basin. Thus, the model is being advocated as a necessary precursor to the trading program, providing marginal cost information and serving as the basis for determining optimal trading ratios for point and nonpoint source controls.

A number of conditions exist in the Chatfield Basin that would facilitate a successful point/nonpoint source trading program to reduce phosphorus. In particular, it has been determined that existing facilities contributing to increased phosphorus loads do not have the capability to significantly reduce discharges without major capital improvements. Although the State of Colorado has generally approved pollutant trading, the administrative framework to institute a point/nonpoint source trading program in the Chatfield Basin is not fully developed to date.

2. Cherry Creek Reservoir, Colorado

Several years ago, the Cherry Creek Reservoir in Colorado was experiencing strong development pressure and planners anticipated a population increase from 90,000 to 302,000 between 1990 and 2010.[14] In 1985, the Denver Regional Council of Governments (DRCOG) sought to prepare for the anticipated growth and its effects on water quality by developing a management plan that would prevent accelerated eutrophication in the reservoir. The Cherry Creek Reservoir is Colorado's most heavily used recreation area with 1.5 million annual visitors. The surrounding area derives substantial economic benefits from this tourism.

Phosphorus was identified as the critical pollutant. The Council estimated that the total annual loading of phosphorus from both point and nonpoint sources should not exceed 14,270 pounds in order to meet the phosphorus standard of 0.035 mg/L established by the Colorado Water Quality Control Commission. Under growth projections at the time of program development, it was anticipated that the critical load of 14,270 pounds would be exceeded by about 1990.[15]

The Cherry Creek Reservoir trading program was designed to allow point sources to earn waste load allocation credits by installing, operating, maintaining, and monitoring nonpoint source phosphorus controls, enabling the point sources (POTWs) to accommodate population growth without expensive in-plant changes. Because nonpoint source nutrient loading was the greatest source of phosphorus, urban nonpoint sources were required to reduce their loading by 50 percent before point sources would be allowed to contribute to nonpoint source reductions and trade them for point source waste load allocation credits. Nonpoint source reductions have not yet reached 50 percent, nor have total loading limits been exceeded because the region has not experienced the level of growth anticipated. Consequently, point/nonpoint source trades have not yet developed.

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[14] Denver Regional Council of Governments, *Cherry Creek Basin Water Quality Management Master Plan*, September 1985, Table 3.

[15] Denver Regional Council of Governments, *Cherry Creek Basin Water Quality Management Master Plan*, September 1985, page 7.

When phosphorus loading does approach the basinwide limit, point source effluent limits will directly depend on the success of efforts to control nonpoint source loading. At that time, if the nonpoint source reduction goal is not achieved, the POTWs will be unable to accommodate anticipated growth and development and the Colorado Water Quality Commission could reduce permitted point source effluent limits to compensate for unachieved nonpoint source loading goals.

3. Dillon Reservoir, Colorado

The trading program for Dillon Reservoir was the first such program established in the nation.[16] It was designed to enable a small reservoir to meet water quality standards despite increasing levels of urban nonpoint discharges of phosphorus. For the Dillon Reservoir, the cost of further reducing phosphorus loadings from point sources was relatively high because the four publicly owned treatment works (POTWs) in the watershed required advanced technologies to meet stringent water quality standards.

A 1984[17] study of the relative costs of point and nonpoint source control options for Dillon Reservoir concluded that appropriate incentives for point sources to trade appeared to exist; point sources and the cost of nonpoint source controls was significantly less than that of point source controls. The estimated cost per pound of phosphorus removed due to upgrading POTWs for phosphorus removal ranged between $860 and $7,861 compared to $119 to remove a pound of phosphorus with urban runoff controls (based on a demonstration project).[18] The study also concluded that point/nonpoint source trading under a 2:1 ratio would result in an estimated 51% savings in total annual treatment costs compared to the base case of no trading (calculated by extending the cost comparison results to the entire drainage basin and incorporated the assumption of diminishing marginal returns for each additional level of reduction by nonpoint source controls).

In 1984, Summit County adopted a point/nonpoint source trading system that allowed the four POTWs to receive phosphorus reduction credits by funding controls to reduce phosphorus loadings from *existing* urban nonpoint sources. Each of the point sources was allocated a level of phosphorus loading, based on an overall allocation to point sources and historic individual point source loadings. The program established a 2:1 trading ratio, wherein point sources received a credit of one additional pound of phosphorus above their allocation for every two pounds of phosphorus removed from a nonpoint source that existed before 1984.

The 2:1 trading ratio was not established primarily to achieve an environmental safety margin per se, but rather as a result of the potential for additional POTW discharges to be

[16] Kashmanian, Jaksch, Niedzialkowski, and Podar, "Beyond Categorical Limits: The Case for Pollution Reduction Through Trading," paper presented at the 59th Annual Water Pollution Control Federation Conference/Exposition, Los Angeles, California, October 6-9, 1986.

[17] Industrial Economics, Inc., *Case Studies on the Trading of Effluent Loads in Dillon Reservoir*, 1984. Prepared for the U.S. EPA.

[18] 1983 dollars.

associated with additional *new* nonpoint sources. New growth will contribute new nonpoint source runoff and increase point source loads; the 2:1 ratio helps offset the increase from new nonpoint sources. Furthermore, post-1984 nonpoint sources are subject to strict regulations that are expected to reduce discharges from these sources by at least half. As a result, one pound of point source discharge is expected to result in two pounds of new nonpoint source phosphorus loading in the absence of these strict controls, and less than one pound of phosphorus loading as a result of the controls. In order to achieve a net *reduction* in phosphorus loading, therefore, two pounds of old nonpoint source phosphorus must be reduced to offset one pound of credited point source loading and its associated pound of new nonpoint source loading.[19]

By 1990, the approach and philosophy of the trading program had changed significantly. The sewage treatment plants, through improved operating efficiency of existing tertiary treatment technology, achieved the highest phosphorus removal capabilities in the nation. In contrast to the early 1980s, point source discharge is now only 2 percent of total reservoir phosphorus loading.[20] Consequently, the treatment plants, discharging substantially less than their annual phosphorus allocations, do not face an immediate need for phosphorus credits, and so have no economic incentive to initiate trades at this time.

Because the need for trading did not materialize, the focus of phosphorus control in the basin shifted away from the economic incentives of achieving point source reductions through cheaper nonpoint source phosphorus control. None of the three trading projects were undertaken by point source dischargers needing additional phosphorus credits to meet permit conditions. The trading program in Dillon is now driven by the reservoir's phosphorus limit and a perceived need to offset new nonpoint sources of phosphorus with phosphorus removals elsewhere in the watershed -- some of the credits generated by trades will be used for this purpose. In effect, two of the three trades that have developed have been nonpoint/nonpoint source trades to offset new nonpoint source discharges to the reservoir, rather than point/nonpoint source trades to permit publicly-owned treatment works (POTWs) to receive discharge credits in excess of their wasteload allocations.

4. Fox River, Wisconsin

Although it is not an example of point/nonpoint source trading, a point/point source trading program implemented in Wisconsin provides useful insights for the design and successful implementation of point/nonpoint source trading programs. A description of this program is included here for that purpose.

Since 1981, Wisconsin has allowed point sources (primarily paper mills and POTWs) along the Fox River to trade effluent allocations. To date, however, only one trade has occurred because several features of the program's design have prevented interest in trades between mills from translating into actual trades. The single trade involved a paper mill that shut down its

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[19] Industrial Economics, Inc., *Case Studies on the Trading of Effluent Loads in Dillon Reservoir*, 1984. Prepared for the U.S. EPA.

[20] Personal communication with Bruce Zander, EPA Region 8, July 25, 1991.

treatment operation and traded its discharge allowance to the municipal wastewater facility that began receiving the mill's wastewater.

The Wisconsin Department of Natural Resources (WDNR) developed the program because existing technological controls on biological oxygen demand (BOD) were insufficient to assure compliance with applicable water quality standards. The Department prepared a total waste load allocation and imposed more stringent limits on what individual sources could discharge. In adopting stricter regulations, the WDNR included a limited program for cooperative modification of administratively determined waste load limits, allowing point sources to trade discharge allowances among themselves under certain circumstances.

WDNR only allows trading if the facility buying the rights is new, is expanding production, or cannot meet the discharge limits in its permit even with the use of the required abatement technology; trades for which the sole justification is cost savings are prohibited. Trades are effective for a minimum of one year, but for not more than the amount of time remaining on the seller's discharge permit (at most, five years). There is also no guarantee that discharge allowances which were sold would be reassigned to the original permit holder after the sale period, making the sold allowances temporary rather than permanent. As a result discharge allowances are not freely tradeable, diminishing their value. These restrictions also create difficulties for the point sources in planning and making capital investment decisions.[21]

Numerous administrative requirements also added to the cost of trades and decreased incentives for facilities to participate. WDNR must approve the proposed trades and modify the permits of the trading facilities. This process can take a minimum of six months. The lengthy permit revision process further reduces the value of the potential discharge allocations. Additionally, transaction costs from trading became prohibitively high because there is no brokering or banking function. The administrative approval process is also complicated by the fact that the pollution problem is not limited to BOD, but includes toxic organic compounds from paper mill effluents. Some proposed trades might have led to high local concentrations of toxic pollutants and may not have passed administrative review.[22]

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[21] The difference between the life of the traded permits (minimum one year, maximum five), and the normal life of capital investments in treatment facilities reduces incentives for trading. For example, in considering a trade, a discharger would measure the cost of reduction credits over the permit period against the cost of reduction technology over the life of the technology. If the control technology costs $8 million (present value, PV), and credits cost $5 million (PV) over the life of the control technology, then the discharger would buy credits. However, if the discharger believes technology will be necessary in 5 years at a cost of $8 million (PV), regardless of whether or not credits are purchased, the relevant cost comparison is $8 for technology now or $13 million (PV) for credits now and technology later; here the discharger is better off buying the equipment now and foregoing trading.

[22] The use of BOD as a surrogate for toxic compounds in the absence of specific effluent standards for these compounds appears to have the potential to impede the use of BOD trading programs.

5. Tar-Pamlico River Basin, North Carolina

A point/nonpoint source trading program has been developed as part of the overall nutrient management strategy to protect the water quality of the Tar-Pamlico River Basin. Development of the program was a cooperative effort between the Basin Association, a coalition of publicly owned treatment works (POTWs), one industrial facility in the basin, state agencies and environmental groups. The state agencies with key roles in the program are the Division of Environmental Management (DEM) and the Division of Soil and Water Conservation (DWSC). The DEM is responsible for determining the adequacy of point/nonpoint source tradeoffs, compliance and surface water quality monitoring, and assisting in targeting nonpoint source controls to reduce associated nutrient loadings to the basin. The DWSC is responsible for the administration and allocation of funds generated from point/nonpoint trades to implement nonpoint source controls.

The trading program adopts a broad approach to point/nonpoint source trading in that the Association of point source dischargers are considered a single unit for nutrient load accounting purposes. Further, monies generated by trading go to a fund, and are then dispensed to implement nonpoint source controls in the basin, rather than being channeled directly to specific projects. The fund is administered through the existing state agricultural cost-share program that provides monies to local soil and water conservation districts to implement best management practices (BMPs) that reduce nutrient loadings.

The Association's annual nutrient loading allowances have been determined for the first phase of the nutrient management strategy (1991-1994). Annual loading allowances gradually descend, with the 1994 amount reflecting a nutrient reduction goal of 200,000 kilograms per year. The Association must offset discharges that exceed their total allowance in any given calendar year with nutrient reduction credits obtained by making monetary contributions to the BMP fund. Nutrient credits are available to the Association for $56 per kilogram of nutrient. The credit figure was determined based on a 3:1 trading ratio and an average cost of nonpoint source controls. Existing facilities that are not members of the Association which expand their operations are subject to more stringent effluent limits, rather than a load allowance. Non-Association members are eligible to participate in the trading program at a slightly higher rate; their effluent limits will be adjusted based upon a rate of $62 per kilogram of nutrient.

To date, the Association has not reached its allowance -- the 1991 nutrient load was 20 percent below the allowance due to relatively low-cost operational and capital improvements that were implemented at the POTWs. This alleviated the need to make an excess loading payment or allocate the loading allowance among member facilities. In the future, however, allocation of member facilities' loading allowances or the cost to offset excess discharges will likely be based on facilities' permitted flows as a percentage of the Association's aggregate permitted flow.[23]

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[23] Personal communication with Malcolm Green, General Manager, Greenville Utilities Commission, and Chair, Tar-Pamlico Basin Association, March 12, 1992.

The Association's responsibility for offsetting excess discharges ends with its payment to the BMP fund. The DWSC maintains implementation and compliance authority for BMPs, relying on local Water and Soil Conservation Districts to work with farmers to ensure proper implementation and to conduct spot inspections to assure maintenance of BMPs. The DEM is the regulating authority for the point source discharge community, requiring compliance monitoring and submission of an annual report from the Association detailing nutrient loadings for each member facility. The DEM also has final decision making authority with regard to the adequacy of nutrient tradeoffs and allocations. This authority is exercised in DEM's responsibility for NPDES permitting. The DEM has the responsibility to impose strict effluent limits on the point sources in the program if water quality problems persist or increase because of (or in spite of) trading.

The terms agreed to in the nutrient management strategy also call for the development of a estuarine computer model funded by the Association, and Association minimum payments to the BMP fund during the first phase in the event that trades do not occur. The results of the computer model will be used to establish total nutrient load targets and identify appropriate nutrient management practices in Phase II of the strategy, which will begin in January 1995.

B. LESSONS LEARNED FROM PROGRAMS IMPLEMENTED TO DATE

Point/nonpoint source trading has not yet been extensively demonstrated in practice. Real world complexities, such as variations in the effectiveness of nonpoint source controls, the number of point sources, and likely point source load reductions due to operational changes, make it difficult to estimate the potential impact of trading. It is clear, however, that the "necessary conditions" outlined in Section II will play a major role in determining whether a locality can benefit from developing a point/nonpoint source trading program (or variation thereon).

1. The Absence of One or More Necessary Conditions Results in Delay of Trading

Without exception, the absence of one or more necessary conditions (as identified in Section II) has resulted in a delay in trading or necessitated a shift in program design in order for trading to occur.

- **At Dillon and Tar Pamlico, the marginal cost of point source reductions has not yet exceeded that of nonpoint source reductions. As a result, there is not yet an economic incentive to trade.**

Through operational changes and minor capital improvements, point sources at Dillon and Tar-Pamlico were able to significantly reduce their loadings prior to turning to nonpoint sources for reduction credits. This opportunity was identified by engineering studies that were part of the development of each program.

At Fox River (a point/point source trading program), the marginal cost of in-plant loading reductions never exceeded the marginal cost of the tradeable reductions. Administrative and transaction costs associated with trading appeared to have played a significant role in increasing the potential cost of trading above the level where trading might otherwise be viable.

- **At Cherry Creek, Dillon, and Tar-Pamlico, point source loads are not yet limiting, i.e., actual load is less than allowed load. As a result, there is no need to trade to offset excess loading.**

As a result of the improvements at point sources at Dillon and Tar-Pamlico, the point source discharges are below their allowed levels and trading is not necessary. The Tar-Pamlico point source load is currently 13 percent below that allowed. Over the next several years, however, the allowed load decreases, potentially constraining point source discharges, compelling them to meet their allowed load through improved treatment or offset their excess load by funding nonpoint source controls.

Cherry Creek point source loads have not yet approached allowed loads as a result of slower than anticipated population growth. It was originally anticipated that established levels would be exceeded in 1990. An additional condition for trading at Cherry Creek has also not been met (i.e., nonpoint source loads have not been reduced by 50 percent).

- **At Dillon, point source loads are not considered significant. As a result, point/nonpoint source trading has been delayed, and the program is now focussing on nonpoint source reductions.**

Point source phosphorus loads at Dillon now account for only 2 percent of total basin loading. This acts as a constraint to the volume of existing nonpoint source phosphorus that can be controlled through trading -- there is not point source phosphorous to "leverage" against existing nonpoint source loadings. Even under a hypothetical zero discharge limit for point sources, a functioning point/nonpoint source trading program in Dillon would remove only 400 pounds of nonpoint source phosphorus -- out of an allocation of approximately 2,000 pounds – based on current point source discharges and a 2:1 trading ratio.

As a result, the Dillon program now focuses on mitigating new nonpoint source loads through nonpoint/nonpoint source trading and offset requirements. For example, in one completed trade, reductions obtained through nonpoint source controls will be credited to a new public golf course under an offset program that requires any projects that contribute new nonpoint source phosphorus to obtain equivalent nonpoint source phosphorus removals elsewhere.

In the design stages, it appeared that the necessary conditions for trading would be met and trading would begin soon after the three programs -- Cherry Creek, Dillon, and Tar-Pamlico -- were implemented. Certainly, the programs meet other important conditions, including: an appropriate waterbody with point and nonpoint sources of nutrients, suitable water quality data, water quality targets and established load allowances, technology standards, administrative framework, and enforcement mechanisms. At Cherry Creek and Dillon, anticipated population growth that would have driven point source loads to their limit has not yet materialized. At Dillon and Tar-Pamlico, point source engineering modifications unanticipated at the outset of the program have enabled point sources to stay well below their allocated load.

2. The Presence of Necessary Conditions Supports Watershed-Based Water Quality Management and Provides an Administrative Framework for Future Trading

Despite limited trading, the experiences at the programs to date affirm the importance of the identified necessary conditions that were present in these programs and provide broad and useful lessons for program planning, design, administration, and enforcement.

- **Total maximum daily or annual pollutant loads provide a practical base against which to establish and measure load reductions.**

At Tar-Pamlico, annual maximum loads were established for the point sources, making it clear when trading will be necessary: when actual loads exceed allowed loads. At Dillon, the establishment of the maximum load was, in some respects, more effective as a proactive planning tool, rather than as the primary method to improve water-quality limited waterbodies, because an independent strategy to control nonpoint sources became necessary.

- **Sufficient data and information about pollutant loading and water quality effects must be available to develop water quality targets and translate the targets into nutrient reduction goals and allowable loads.**

Both the Dillon and Tar-Pamlico programs illustrate the importance of these conditions, not only in designing the trading program, but also in establishing a basinwide approach to water quality planning and management. At Dillon, monitoring data are used in conjunction with the Dillon Water Quality model to evaluate current control strategies and predict the impact of future development. As modeling capabilities become more sophisticated and monitoring data accumulates, the load allocation process can be tailored more effectively to address the water quality problem. At Tar-Pamlico, program developers were able to translate a water quality--based goal into a nutrient reduction goal and a declining schedule of allowable point source nutrient loading.

The importance or accurate and comprehensive data is reflected by Tar-Pamlico's investment (supported by significant EPA funding) in a more sophisticated estuarine computer model to provide information for the next phase of the program, and in Chatfield's investment, prior to formal consideration of trading, in basin modeling. The availability of monitoring data and sufficient models will directly affect the amount of time required to develop and allocate a maximum daily load and, if necessary, a trading program.

A water quality-based regulatory approach, above and beyond technology-based requirements is only possible with adequate monitoring data and computer modeling capabilities. Water quality data and appropriate models must be available to evaluate relative impacts from point and nonpoint source loads along with the implications of alternative control strategies to meet a water quality standard.

- **It is necessary to have detailed information about point source facilities in order to determine the relationship between the marginal costs of point and nonpoint source controls.**

The engineering evaluation of the dischargers' facilities showed that the Tar-Pamlico basin could achieve significant nutrient reductions through relatively simple and inexpensive POTW modifications. This is an important condition of the trading program because it provides the regulator and the regulated community with better information about the types of available reductions and their costs. It also establishes an accurate marginal cost basis for trades, providing a starting point from which to develop appropriate nutrient reduction targets and reduction credit fees.

- **A comprehensive basinwide management approach, rather than a focus on point sources in isolation, provides opportunities to achieve least-cost pollutant reductions.**

By including nonpoint source load reductions as alternatives for point source load reductions, load reductions can be achieved at least cost. For example, at Dillon, the least expensive in-plant upgrades were initially estimated at $730/lb reduction while nonpoint source load reductions appeared to be available for slightly over $200/lb (accounting for the 2:1 trading ratio). At Tar-Pamlico, point source upgrades were anticipated to cost between $50 and $100 million, $250 to $500/kg reduction, while nonpoint source load reduction could be achieved for $56/kg (accounting for an average 2.5:1 trading ratio). When trading begins at these two programs, cost-savings could be substantial.

- **A comprehensive approach also provides opportunities for targeting reductions to areas where they will be most effective and are most needed.**

The Dillon experience illustrates this point. By considering the relationship between point, nonpoint, and background sources of phosphorus to the reservoir, local officials determined acceptable maximum pollutant loadings to meet an in-lake standard. As a result of this approach, it was determined that nonpoint sources pose the greatest threat to water quality. The consequent shift in the focus of the program will concentrate phosphorus removal at nonpoint sources.

At Tar-Pamlico, the administration of the trading program includes instructions to the agency implementing the nonpoint source load reductions to prioritize installing controls that have the highest potential and efficiency for nutrient removal. The program includes institutional mechanisms to facilitate targeting nonpoint source controls to local trouble spots and provides for annual report and evaluations.

- **The administrative framework for the trading program is not only important for the development of the basinwide approach, but may be critical for achieving desired nutrient reductions through trading.**

When trading begins at Tar-Pamlico, it appears that the prospects for success are partially dependent on close cooperation between multiple control authorities, including a department responsible for water quality management and a department responsible for agricultural nonpoint source control.

- **Enforcement mechanisms are important in creating compliance incentives where economic incentives are absent or fail.**

At the Tar-Pamlico program, the regulating agency reserves the right to impose strict effluent limits on point sources participating in trading if local water quality problems persist or arise as a result of trading. This is important because in this program, the point sources bear no direct responsibility for the implementation and maintenance of the nonpoint source controls installed in exchange for point source load reductions.

- **The local community, including environmental organizations, must support a trading program as a method to achieve water quality objectives.**

An unusual coalition of traditional adversaries came together to develop Tar-Pamlico's nutrient trading program as a creative approach to overcoming water quality problems. Support from interested parties, particularly the regulated community, has traditionally been an important element in successful pollution control programs.

- **If the program involves agricultural BMPs and will be implemented through a cost-share program, there must be sufficient farmer demand for funding in excess of any ongoing cost-share program to support point/nonpoint source trades in order to supplement, not supplant, ongoing nonpoint source control efforts.**

In the Tar-Pamlico basin, the trading program is designed to achieve specified load reductions from nonpoint sources in addition to whatever reduction is being brought about through other nonpoint source control programs (specifically the effect of the existing cost-share program). Therefore, it would be inappropriate for the new funding from point sources to replace (and thereby reduce) state funding for the existing nonpoint source control programs.

Additionally, farmers typically participate in voluntary nonpoint source load reduction programs to the extent that it is cost-effective to do so, although profitability is not the only criteria that the farmer considers. Compliance with existing regulations is also an important factor.

- **Regulatory requirements that increase the transaction costs associated with trading but that fail to provide an offsetting value in terms of compliance and enforcement may be sufficient to cause a trading program to fail.**

Under some level of regulation, transaction costs and uncertainty about approval of trades will drive the marginal cost of the reduction credit above that for point source controls, impeding the development or continuance of a trading program. Careful consideration should be given to the tradeoff between regulatory constraints on trading and the cost-effectiveness of trading and provisions that ensure compliance with environmental standards with a minimum of transaction cost.

- **Trading ratios that account for uncertainty can be established without eliminating economic incentives to trade.**

The Dillon program established a trading ratio of 2:1 to account for new nonpoint source loads, typically accompanying development, that produce additional point source loads that necessitate trading. The Tar-Pamlico program established a 3:1 trading ratio for cropland nonpoint source controls and 2:1 for animal and animal waste nonpoint source controls in order to provide a safety factor and account for the uncertainty in the effectiveness of the nonpoint source controls.

- **It may be important to build flexibility into the trading program design, as conditions may change over the course of the program.**

The Dillon program was flexible enough to continue pursuing nutrient load reductions even after point source reductions were no longer the most necessary and cost-effective option. The administrative framework was flexible enough to recognize and manage nonpoint/nonpoint source trading and an increased dependence on offsets to achieve nutrient reduction goals.

3. Costs and Benefits Associated with Point/Nonpoint Source Trading Programs

While the dollar values of costs and benefits of point/nonpoint source trading programs will vary across waterbody size and program design, the categories of costs and benefits are common among most trading programs. One example, is the category of transaction costs, which includes the costs of program development. These costs can be significant. For example, EPA and point sources at Tar-Pamlico have respectively contributed $500,000 and 400,000 thus far to the development of an estuarine computer model of the basin, and point sources will contribute $150,000 for two additional staff positions at the agency implementing nonpoint source reductions, and a minimum of $500,000 for nonpoint source reductions even if they do not require point source load reduction credits through 1994. EPA also contributed approximately $453,000 to the Tar-Pamlico program: $400,000 for the development of the basin nutrient model, and $53,000 for the monitoring and tracking of nonpoint source pollutants.

Benefits can be gauged by comparing marginal costs for point source load reductions to those for nonpoint sources. At Dillon, it was estimated that further point source reductions would cost between $860 and $7,861 per pound reduced, while nonpoint source load reductions would cost between $67 and $119 per pound. At Tar-Pamlico, extensive point source upgrades were estimated to cost between $250 and $500/kg reduced, while nonpoint source reductions were priced at $56 per kilogram point source credit for Association members and $62 for non-members.[24]

The most common categories of costs and benefits are listed below.

[24] Actual costs for nonpoint source reduction are approximately $19 per pound on cropland and $28 per pound for animal waste; the trading ratios are 3:1 and 2:1, respectively.

COSTS OF POINT/NONPOINT SOURCE TRADING

- **Initial modeling to determine pollutant sources and wasteload allocations.**[25]

- **Permitting costs to establish discharge levels in permits with and without trading ("without" levels would be set in the absence of a trading program).**

- **Review and approval of individual trades by a control agency.**

- **Administration of both trading and nonpoint source control programs to ensure compliance (assuming that nonpoint source control programs would not otherwise be pursued).**

- **Cost of negotiating and transacting trades.**

BENEFITS OF POINT/NONPOINT SOURCE TRADING

- **Direct cost-savings to the dischargers from being able to take advantage of lesser-cost pollution control options.**

- **Providing a greater level of nonpoint source pollution control than would have occurred in the absence of trading.**

- **The primary social benefit is the achievement of a desirable level of water quality at least cost. This has positive implications for fishermen, recreational users, commercial and industrial users of water, etc.**

- **Increased awareness and use of nonpoint source control options, and some degree of regulatory involvement in ensuring the effectiveness of nonpoint source controls.**

An additional benefit may be increased emphasis on water quality standards and overall basin-wide cooperation in pollution abatement. Point/nonpoint source trading provides a framework and mechanism for instituting a watershed or water-segment approach to water quality management and planning. These types of benefits are not quantifiable from a benefit-cost perspective, but in the long run, it will probably result in more sustainable environmental protection, thereby producing diverse future benefits that could be quantified.

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[25] This is not necessarily a cost of a trading program because models are needed for any TMDL approach. Costs for modeling are often site-specific depending on size and complexity of the watershed and the number of dischargers.

IV. POTENTIAL SCOPE OF POINT/NONPOINT SOURCE TRADING

While not all waterbodies are likely to fulfill the necessary conditions for implementing a trading program, it is possible to estimate the universe of waterbodies that could *potentially* benefit from trading. These waterbodies fall into two general groups -- those that currently have water quality problems, and those that are likely to develop water quality problems as a result of rapid growth and associated increases in loadings. To be likely to benefit from trading, either type of waterbody must have both point sources and nonpoint sources contributing to the actual or potential water quality problem in the waterbody.

A. USING THE WATERBODY SYSTEM TO ESTIMATE TRADING POTENTIAL

The data available for evaluating the characteristics of waterbodies for policy and planning purposes is reported in biennial status reports -- called Clean Water Act Section 305(b) reports -- on the quality of surface and ground waters. EPA has developed a databank known as the Water Body System (WBS), designed to track state assessments of water quality for surface waters using information prepared for 305(b) reports. The WBS currently contains 41,733 waterbodies;[26] Table 3 identifies the states and territories that report in the WBS and those not in the system. One "waterbody" may be an entire creek, river, lake, or estuary, or a segment or reach of a creek, river, lake, or estuary (depending on each state's reporting method). For example, Long Island Sound is reported as one data item (one "waterbody"), whereas the St. Johns River comprises five data items.

For each waterbody assessed, states provide information on whether waterbodies are fully supporting their state-defined designated uses and on the general causes and sources of pollution. These designations are the only available measure for identifying water-quality limited waterbodies. Ambient water quality monitoring in specific waterbodies is the method of gathering the raw data used by the states to make water quality assessments. Despite several limitations of the WBS (detailed below), the WBS provides the only national database to assess the number of waterbodies that might benefit from trading.

1. Potential Trading Scope in Waterbodies with Current Water Quality Problems

Several retrievals were made from the WBS to estimate the number of waterbodies in the country that may benefit from pollutant trading. Retrievals were made for waterbodies impacted by nutrients, toxics/general (including pesticides, organics, metals, ammonia and pollutants of unknown toxicity), toxics/metals only, pathogens, and salinity. As stated earlier in this report, toxics trading is not being investigated by the EPA; the two estimates for toxics were retrieved and are provided for illustrative purposes only. Table 4 presents the potential universe of

[26] The WBS contains a total of 54,566 waterbodies, but does not have assessment information for 12,833 of them.

currently water quality-limited waterbodies that could benefit from trading as identified by the WBS. An explanation of the selection criteria used for each retrieval follows the table.

TABLE 2

WBS Participants and Non-Participants

States & Territories In the WBS			*Not in* the WBS
Arizona	Minnesota	Rhode Island	*Alabama*
Connecticut	Mississippi	South Carolina	*Alaska*
Delaware	Missouri	South Dakota	*Arkansas*
Dist. of Columbia	Montana	Tennessee	*California*
Florida	Nebraska	Texas	*Colorado*
Hawaii	Nevada	Vermont	*Georgia*
Illinois	New Jersey	Virgin Islands	*Idaho*
Iowa	North Carolina	Virginia	*Indiana*
Kansas	North Dakota	Washington	*Louisiana*
Kentucky	Ohio	West Virginia	*New Mexico*
Maine	Oklahoma	Wisconsin	*New Hampshire*
Maryland	Oregon	Wyoming	*New York*
Massachusetts	Pennsylvania		*Utah*
Michigan	Puerto Rico		

TABLE 3

Number of Waterbodies in WBS Not Fully Supporting Designated Uses That Could Benefit From Point/Nonpoint Source Pollutant Trading

Type of Pollutant for Trading	Potential Waterbodies benefitting
NUTRIENTS	943
TOXICS - GENERAL	1,288
TOXICS - METALS ONLY	835
PATHOGENS	835
SALINITY	79

The universe of water quality-limited waterbodies that might benefit from trading for various types of pollutants was retrieved from WBS using the following selection criteria:

1. State designated uses partially or not supported, or overall use partially or not supported; and
2. Industrial or municipal point sources present; and

3a. For NUTRIENT retrieval -- agriculture, or silviculture, or construction, or urban runoff/storm sewers, or resource extraction, or land disposal, or hydromodification sources present;

3b. For all other retrievals -- construction, urban runoff/storm sewers, or hydromodification pollution sources present; and

4. For each respective specific pollutant, causal factors of
   a. Nutrients
   b. Pesticides, priority organics, nonpriority organics, total toxics, metals, pollutants designated as "unknown toxicity", and ammonia
   c. metals only
   d. pathogens
   e. salinity/total dissolved solids/chlorides

It is estimated that 943 waterbodies could potentially benefit from nutrient trading. This estimate includes waterbodies with: (1) designated uses not supported; (2) industrial or municipal point sources present; (3) nonpoint sources including agriculture, urban runoff, and land disturbing activities; and (4) nutrients as a causal factor. Map 1 on the next page graphically depicts the distribution of these 943 waterbodies. Table 5 identifies the number estimated for each state for which at least one waterbody was retrieved. An itemized list of these waterbodies appears in Appendix C.

TABLE 4

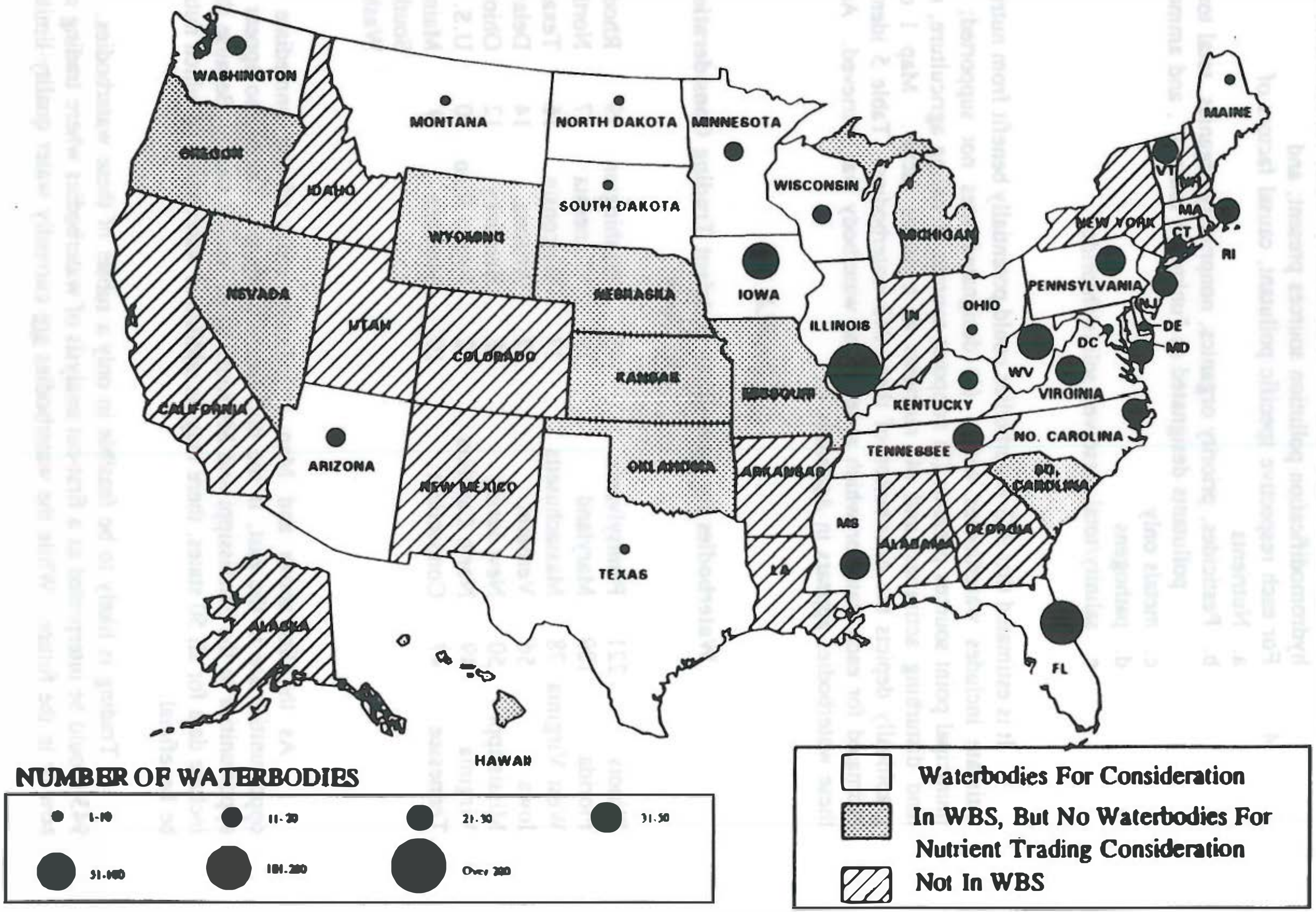
Waterbodies for Immediate Nutrient Trading Consideration by State

Illinois	221	Pennsylvania	45	Washington	19	Rhode Island	7
Florida	129	Maryland	29	Minnesota	17	North Dakota	5
West Virginia	78	Massachusetts	27	Wisconsin	16	Texas	4
Iowa	56	Vermont	27	Arizona	14	Delaware	2
Mississippi	50	New Jersey	22	Kentucky	12	Ohio	2
Virginia	49	North Carolina	22	Puerto Rico	10	U.S. Virgin Islands	2
Tennessee	47	Connecticut	19	Montana	9	Maine	1
						South Dakota	1
						Washington D.C.	1

As the list above and Map 1 indicate, most of the immediate nutrient trading opportunities are in the east, in the mid-Atlantic region. There also appear to be significant opportunities in the Mississippi and Missouri River Valley states. Because the WBS does not include data for all 50 states, there may be additional waterbodies in which nutrient trading may be beneficial.

Trading is likely to be feasible in only a subset of these waterbodies. This estimate of 943 should be interpreted as a first-cut analysis of waterbodies where trading may be beneficial now or in the future. While the waterbodies <u>are</u> currently water quality-limited and have

DISTRIBUTION OF WATERBODIES FOR WHICH POINT/NON-POINT SOURCE NUTRIENT TRADING APPEARS APPLICABLE NOW



nutrient pollution present, they are not necessarily water quality-limited due to nutrients -- some other pollutant may be responsible for this designation. Furthermore, while these waterbodies have nutrient pollution and both point and nonpoint sources, they do not necessarily receive nutrient discharges from both types of sources. Consequently, all of the 943 waterbodies may not meet the conditions necessary to benefit from trading.

To obtain a complete set of waterbodies where nutrient trading may prove to be beneficial, it is also necessary to estimate the number of waterbodies that are not currently water quality-limited for any pollutant, but have met all other criteria for trading. These waterbodies were retrieved from WBS and are discussed below.

2. Potential Trading Scope in Waterbodies Not Currently Water Quality-Limited

The WBS contained only 142 waterbodies that are currently *not* water quality limited and have point sources. Of these, 65 had nutrients as a causal factor; of the 65, only 17 had nonpoint sources present and could potentially benefit from trading for nutrients. This retrieval was made using the following selection criteria:

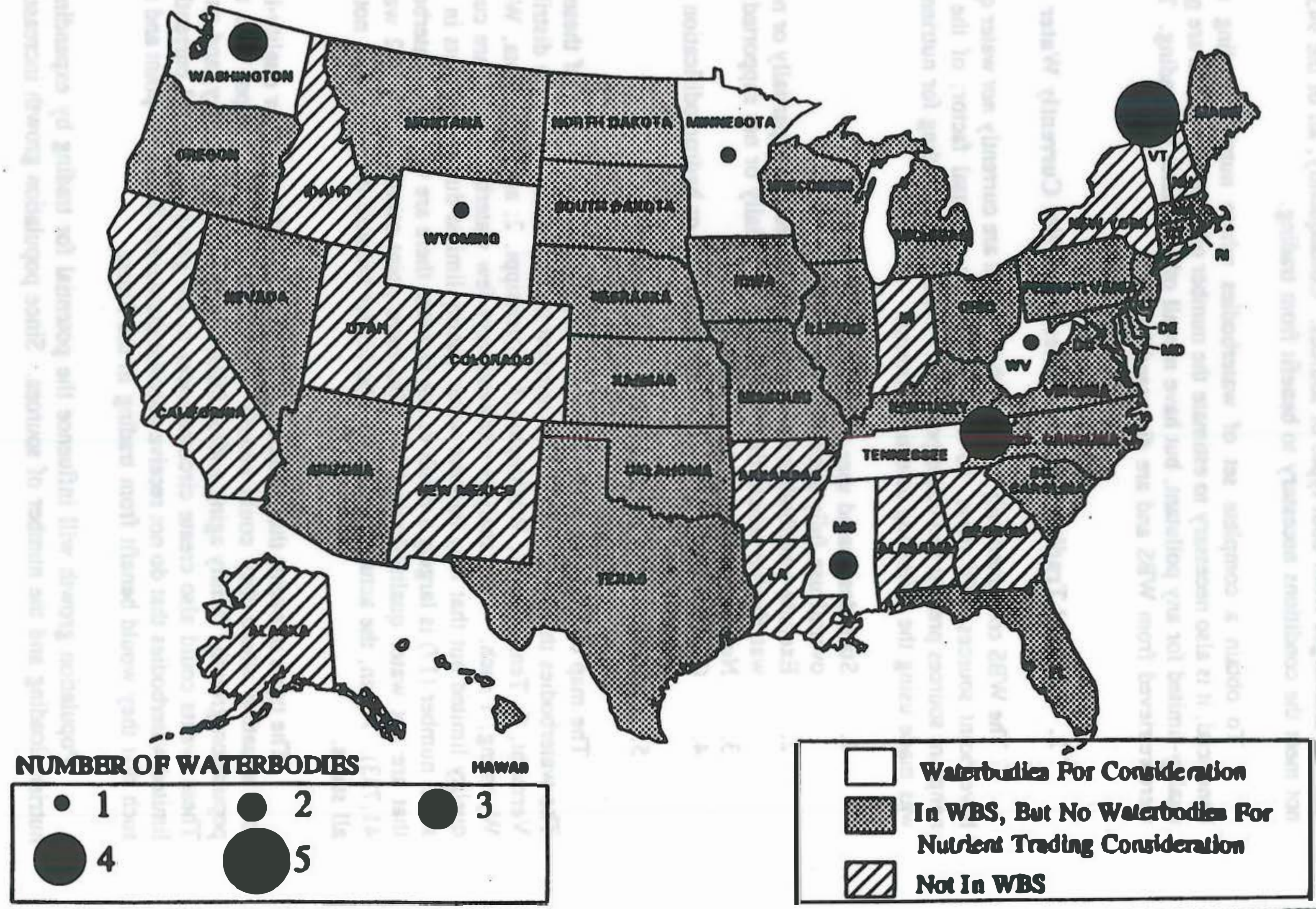
1. State designated uses supported or threatened; or overall use fully supported or threatened;
2. Exclude waterbodies where state designated use is partially or not supported, and waterbodies where the overall use is partially or not supported;
3. Nutrient loading a causal factor;
4. Construction, urban runoff/storm sewers, or hydromodification pollution sources present; and
5. Industrial or municipal point sources present.

The map on the next page graphically depicts the distribution of these 17 waterbodies. The waterbodies that may benefit from nutrient trading in the future are distributed as follows: Vermont, 5; Tennessee, 4; Washington,3; Mississippi, 2; and Minnesota, West Virginia, and Wyoming, 1 each. This analysis retrieved very few waterbodies that are currently not water quality limited but that may become water quality limited due to nutrients in the future. This small number (17) is largely a result of the fact that there are very few waterbodies in the WBS that are not water quality-limited and also have point sources (only 142 waterbodies out of 41,733). Again, the actual number may be higher because the WBS does not contain data for all states.

The types of events that could drive these waterbodies to water quality-limited status and to a situation where they could benefit from trading can be grouped into three categories: population growth, facility aging and/or failure of existing technology, and exogenous factors. These events could also create circumstances in the group of the 943 currently water quality-limited waterbodies that do not receive nutrient discharges from both point and nonpoint sources such that they would benefit from trading in the future.

Population growth will influence the potential for trading by expanding the amount of nutrient loading and the number of sources. Since population growth increases wastewater

WATERBODIES FOR WHICH POINT/NON-POINT SOURCE NUTRIENT TRADING APPEARS APPLICABLE IN THE FUTURE



volume and greater nutrient loading, it may become necessary to expand existing facilities or build new ones. Expansions in industrial and commercial nutrient loadings may also accompany population growth, resulting in increased point source discharges of nutrients. New nonpoint sources and expansions of existing nonpoint sources almost always accompany population growth.

Facility aging or failure could result in the need for expensive upgrades in order to meet technology-based and water quality standards. In lieu of expensive upgrades, it may be possible in some situations to make less expensive repairs to point sources and permit point-nonpoint source nutrient trading to meet established standards.

Exogenous factors that may result in opportunities for trading include a pattern of severe weather events and/or land disturbances unrelated to population growth.

3. Limitations of the WBS Data

The WBS data are limited in several respects that affect the quality of the estimates presented above. Limitations include: inability to link causal factors with sources; an incomplete data set; counting segments of the same watershed as separate waterbodies; and incomplete or missing information about the number of sources.

It is important to note that the waterbodies cited above were identified solely on the basis of data defining existing factors -- specifically, the presence of point sources, nonpoint sources and the specified type of pollutant. While selection can be made on the basis of one or more causal factors (e.g., nutrients), the fact that a waterbody is selected on the basis of causal factors and sources does not necessarily indicate that the waterbody is water-quality limited as a result of the type of pollutant being evaluated. It is also not possible to link the cause of pollution to the sources of pollution -- while both point source and nonpoint source may be present, they may not both contribute to all pollutant types present. The estimate, therefore, is most useful as a guide to the largest number of waterbodies where trading might be feasible, within a limited data set.

The indication of potential waterbodies that could benefit from trading is not a complete representation of the nation-wide potential for two reasons: the WBS does not include all states; and the data for the participating states may be incomplete. Participation in the WBS is voluntary, so not all states have data in the WBS. The WBS currently includes 37 states, the District of Columbia, two of the four trust territories, and two interstate water commissions, the Delaware River Basin Commission and the Ohio River Valley Sanitation Commission (see Table 3).

On the other hand, the WBS retrieval may over-report the potential waterbodies for trading in the participating states for two reasons. First, waterbodies are defined in the WBS as one or more reach segments which can vary in size, (e.g., the Peace River in Florida is 13 separate data items) so many of the "waterbodies" retrieved from WBS may be segments of the same waterbody and units smaller than a watershed. Second, the WBS cannot link the cause of pollution (i.e., nutrients) to the sources of pollution so the waterbodies retrieved from WBS may not have both point and nonpoint source contributions to nutrient loadings (neither all point sources nor all nonpoint sources can be assumed to contribute nutrients).

The WBS is useful for identifying waterbodies where trading may be beneficial. It cannot, however, be used to determine the actual pollution reduction benefits that might accrue due to trading. Important information that is not available through the WBS includes: (1) number of point and nonpoint sources in a waterbody; (2) the volume of discharge from each point or nonpoint source; (3) nutrient and other pollutant loadings from each source; and (4) the current level or technology employed for treatment. Once waterbodies have been identified, however, it may be possible to use other sources of data collected on the state or local level to determine whether trading is, in fact, a possibility, and what the potential benefits from trading might be.

B. ALTERNATE DATABASES EVALUATED FOR ASSESSING THE POTENTIAL UNIVERSE OF WATERBODIES FOR POINT/NONPOINT SOURCE TRADING

Despite the limitations outlined above, the WBS provided the best existing information for evaluating the potential scope of point/nonpoint source trading. There are other databases that contain water quality information, but for one reason or another cannot currently provide information in a form that is usable to estimate the potential trading universe or the benefits from trading. Other databases investigated are listed below, accompanied by comments about their primary drawback or limitations.

RFF National Water Quality Model. The RFF Model covers individual point source and nonpoint sources at the county level. While the model is useful for modeling nonpoint source runoff from specific land areas, it is not useful for the purposes of assessing a national estimate of trading opportunities.

Environmental Data Display Manager (EDDM). EDDM is not designed to make global searches for specific water quality characteristics. Consequently, the data retrieved from EDDM would be highly disaggregated on a site-specific basis and not in usable form for an estimate of the potential universe of waterbodies. EDDM is an interactive program to retrieve water quality data on a site-specific basis. Using EDDM, water quality data can be retrieved from STORET and EPA's Permit Compliance System (PCS) for specific industrial/municipal dischargers by concentration (minimum, average, or maximum) or loading (average, maximum). Both permit limits and discharge monitoring reports can be retrieved from PCS. Finally, EDDM provides five selection criteria to retrieve water quality data: reach number, NPDES permit number, reach name and state, city name and state, or STORET station and agency code. The loading data available in EDDM appears to be from PCS. EDDM does not, however, include data on state water quality standards, which would be necessary to determine if trading is, in fact, potentially beneficial, or the extent of potential benefits.

STORET. This data base could be used to retrieve ambient monitoring data for selected waterbodies for specific water quality parameter codes representing nutrient discharges. Although information on ambient water quality can be aggregated through customized STORET retrievals, it can be difficult to get such aggregate information from STORET. Without information on state water quality standards for nutrients, aggregate information from the database may be of limited use in identifying waterbodies that are violating state water quality standards for nutrients, if such standards have been adopted.

Permit Compliance System (PCS). This database includes information about permit limits and discharge monitoring reports. Information can be retrieved on the basis of specific industrial/municipal dischargers by concentration (minimum, average, or maximum) or loading (average, maximum). Much of the point source discharge monitoring data is reported as concentration rather than loadings. To the extent that loading information is incomplete, PCS is of limited value for a broad nationwide analysis of potential trading.

Agricultural Nonpoint Source Tracking System (AGTRACK). AGTRACK can identify specific waterbodies for which an agricultural impairment was reported in the 1988 section 319 or 305(b) reports. For those waterbodies, all reported water quality impairments in addition to agricultural impairments also are cited in AGTRACK. The major limitations of AGTRACK are: it provides information only for agricultural impairments; its coverage and quality varies from state to state; and it does not contain nutrient loading data (although it does report the contribution of nutrients to waterbody pollution in ordinal categories, i.e., high, moderate, slight).

Section 319 List. These are state 319 nonpoint source pollution assessment reports. It is difficult to compare these lists among the states because each state compiled its list of waters with nonpoint source impairments in a different way.

Section 304(l) List. This 304 (l) Long List refers to those waterbodies identified by states (and approved by EPA) where water quality standards are violated for any pollutant at any time. While this list contains those waterbodies with a longstanding pattern of failure to meet water quality standards, the water quality problem that resulted in a waterbody's appearing on the 304 list may or may not have resulted in its appearing in the WBS, and it is not clear there is good translation between the 304(l) and WBS universes.

V. POINT/NONPOINT SOURCE TRADING UNDER THE CLEAN WATER ACT

A. BACKGROUND

The Clean Water Act does not directly authorize (nor does it prohibit) effluent trading. Nonetheless, existing trading programs involving nonpoint sources have not encountered difficulty in being established in a form that conforms to the existing CWA regulatory framework. The Act does contain provisions that help programs to meet the necessary conditions for success, and EPA and some states have taken initial steps to facilitate trading within their respective water quality and nonpoint source control programs.

Both federal regulations and EPA guidance developed to implement TMDLs permit the use of trading within the initial wasteload/load allocations. EPA's TMDL guidance explains the TMDL process for point and nonpoint sources, establishing the basis for point/point, point/nonpoint, and nonpoint/nonpoint source trading.[27]

B. THE TMDL PROCESS

For those waterbodies where water quality standards have not been met through effluent limitations, the next step is for states to establish a total maximum daily load for certain pollutants "at a level necessary to implement the applicable water quality standards with seasonal variations and a margin of safety which takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality" [§ 303(d)(1)(C)]. States must also provide a system for allocating those maximum loadings among all dischargers in the affected waters [40 CFR 130.1 - .15]. To do this, states establish wasteload allocations (WLAs) for point sources -- the portion of a receiving water's loading capacity (the greatest amount of loading that a waterbody can receive without violating water quality standards) that is allocated to one of its existing or future point sources of pollution -- and load allocations (Las) for nonpoint sources and natural background (the portion of a receiving water's loading capacity that is allocated to one of its existing or future nonpoint sources of pollution) in order to determine the TMDL. The TMDL is the sum of all WLAs and Las.

The TMDL process fulfills many of the conditions necessary for establishing a trading program -- particularly the establishment nutrient reduction goals to achieve a water quality target and limiting allocations to point sources and nonpoint sources, as well as the need for comprehensive data and modeling.

The regulatory definition of total maximum daily load expressly states that "if best management practices or other nonpoint source pollution controls make more stringent load allocations practicable, then wasteload allocations can be made less stringent. *Thus, the TMDL process provides for nonpoint source control tradeoffs*" [emphasis added, 40CFR 130.2(i)].

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[27] *Guidance for Water Quality-based Decisions: The TMDL Process*. U.S. EPA, April 1991.

Here, too, the regulations implementing section 303(d) of the CWA approach recognize trading can be used to achieve water quality standards. The concept of *tradeoffs* here refers to trades between point source and nonpoint source load allocations as the allocations are being initially established in the development of the TMDL. The concept of *trading* is not explicit in these regulations; the use of the term "trading" in this context means that additional allocation shifts could occur *after* the TMDL was established, and would be a mechanism to meet the TMDL in the most cost-effective manner. This concept is outlined in Appendix D of the *Guidance for Water Quality-based Decisions: The TMDL Process.*[28] Without language referring to trading, and in the absence of other language elsewhere in regulation or in the CWA, load allocations under a TMDL otherwise appear to be fixed. Language referencing trading could make the variable allocations (i.e., trading) a clearer option to states implementing programs to meet water quality standards.

C. THE CLEAN AIR ACT: A TRADING MODEL

The Clean Air Act contains language in several sections concerning emissions trading that could be used as a model in the CWA to permit point/nonpoint source trading. The most detailed language is found in § 403(b) (acid deposition). Here, new language (adopted in the 1990 CWA amendments) specifically states that "allowances allocated under this title may be transferred among designated representatives of . . . affected sources." Detailed requirements outlining allowance distribution, trading, tracking and other features of the program are outlined in the Clean Air Act. Title IV of the CAA amendments also includes market-based approaches to regulation. Language in Title IV permits utilities achieving emissions levels below legal standards to trade, auction, or sell emissions allowances to other utilities unable to reduce emissions more cheaply.

More generally, there are other sections of the CAA that contain language that could be effective in the context of the CWA. "Economic incentives such as fees, marketable permits, and auctions of emissions rights" are included as options for control of standard air pollutants (i.e., not acid deposition) in state implementation plans [§ 110(a)(2)(A) and (C)]. Plans for areas that do not attain air quality standards may include provisions for "economic incentives such as fees, marketable permits, and auctions of emissions rights." In "Serious" and "Severe" nonattainment areas, states may elect to adopt an economic incentive program that may include ". . a nondiscriminatory system . . . of marketable permits"[§ 182(g)(3)(C) and (4)(A)].

The CAA also contains some language about offsets for new sources that may be applicable to effluent trading, particularly for point/point source and nonpoint/nonpoint source trading [for example, see §173(b), (c)]. Under a TMDL, new sources will not have any allocation. Thus, authorities may not grant permits to facilities in water quality limited segments unless that facility will not cause or contribute to the violation of applicable water quality standards. This approach is similar to that now applied to the location of new facilities under the Clean Air Act, where pressure for new industrial growth results in the imposition of increasingly stringent requirements on existing sources in order to permit new facilities to

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[28] U.S. EPA, April 1991.

operate without violation of applicable standards. Under the CAA, if a proposed new source will increase a facility's cumulative annual emissions above the established amount for a given pollutant, an operating permit will be denied unless the applicant can buy emissions offsets from a nearby facility. This approach could apply to both point source WLAs and to nonpoint sources Las under the CWA.

D. ALTERNATIVE APPROACHES FOR CLEAN WATER ACT REAUTHORIZATION

1. Guidance

EPA could draft guidance concerning the implementation of trading programs to meet water quality standards. Even in the absence of statutory changes, guidance that assists local agencies to implement trading programs, in addition to that already provided in establishing TMDLs, might be useful to those jurisdictions that determine that point/nonpoint source trading could help them to resolve nutrient pollution problems. Guidance would cover, at a minimum, the following topics:

- The theoretical basis and rationale for trading;
- Reference to existing TMDL guidance and a discussion of the role of a trading program in relation to TMDLs;
- Data requirements to establish a trading program, including water quality standards, potential point source reductions under existing technology, wasteload allocations, and anticipated nonpoint source reductions;
- Program design options, including delineation of the trading area and the potential impact of regulatory requirements;
- The selection of appropriate trading ratios
- Necessary permit requirements, including meeting CWA requirements and wasteload allocation regulations;
- Monitoring and enforcement of permit requirements;
- Nonpoint source control monitoring and implementation;
- Community acceptance issues; and
- Achievement of water quality standards under a trading program, including the need for permit re-opener clauses.

2. Policy

The Clean Water Act could state that point/nonpoint source trading is an approved approach to meeting water quality standards. Alternatively, EPA could proactively establish a clear policy in the form of testimony before Congress, public addresses made by Agency officials, and published articles and reports.

3. Technical Assistance

EPA could be required to provide technical assistance to jurisdictions that are considering implementing a trading program. Such assistance could include: publications analyzing examples of existing trading programs; developing models of state and local laws and regulations that may be necessary to implement a trading program; providing information on types of local governmental jurisdictions that can oversee and implement trading programs; providing assistance with water quality modelling to determine maximum load targets; and providing assistance with cost-effectiveness evaluations to determine whether adequate incentives for trading are likely to exist. Again, EPA could proactively pursue this option as resource constraints allow.

4. Funding

Funding for some aspects of implementing point/nonpoint trading programs may be available under a variety of existing EPA programs, especially training and demonstration grants available under Section 104(b)(3), Clean Lakes program grants under Section 314, or nonpoint source pollution control grants under Section 319. Identification of existing programs, their role in a trading program, and steps necessary to apply for funding would be useful to a local jurisdiction that is interested in implementing a trading program. Another option that could stimulate point/nonpoint trading programs would be a CWA change that specifically expands the eligibility of such programs to coverage under the State Revolving Fund (SRF) program.

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APPENDICES

A. Case Study of Nutrient Trading in the Dillon Reservoir

B. Case Study of Nutrient Trading in the Tar-Pamlico River Basin

C. Itemized List of Waterbodies Currently Water Quality-Limited For Which Point/Nonpoint Source Nutrient Trading Appears Applicable

D. Itemized List of Waterbodies Currently Not Water Quality-Limited For Which Point/Nonpoint Source Nutrient Trading Appears Applicable in the Future

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APPENDIX A

NUTRIENT TRADING IN THE DILLON RESERVOIR

INTRODUCTION

Point/nonpoint source nutrient trading was developed as part of an innovative nutrient reduction strategy to prevent eutrophication of Dillon Reservoir, a man-made impoundment 70 miles west of Denver, Colorado. Situated in mountainous Summit County, one of the fastest growing counties in the nation, Dillon Reservoir provides several million dollars of economic benefits to the region in addition to over one-half the water supply needs of the Denver Water Board, owner and operator of the reservoir.[1]

When phosphorus accumulation threatened the integrity of the reservoir in the early 1980s, local officials developed the Dillon Water Quality Management Plan to protect future water quality. The plan includes limits on total phosphorus loadings to the reservoir (allocating the total load among all sources) and the nation's first point/nonpoint source phosphorus trading program. The trading program was adopted as part of the plan after an economic study and erosion control demonstration project showed the greater cost-effectiveness of nonpoint source controls compared to available upgrades in wastewater treatment.

Since 1990, however, the approach and philosophy of the trading program has changed significantly as a result of shifts in economic incentives. Wastewater treatment plants, through improved operating efficiency of existing tertiary treatment technology, have achieved some of the highest phosphorus removal capabilities in the nation. In contrast to the early 1980s, point source discharges are now only a small fraction of total reservoir phosphorus loadings. Consequently, the treatment plants discharge substantially less than their annual phosphorus allocations and do not face an immediate need to obtain phosphorus reduction credits. None of the three trading projects that have been undertaken were initiated by point source dischargers in need of phosphorus credits to meet permit conditions.

Because the need for point/nonpoint source trading did not materialized, the focus of phosphorus control in the basin has shifted away from the economic incentives of point sources achieving reductions through cheaper nonpoint source phosphorus control. Instead, the trading program in Dillon has been driven by the reservoir's phosphorus limit and a perceived need to offset new nonpoint sources of phosphorus with phosphorus removals elsewhere in the watershed. In effect, two of the three trades that have developed have been between nonpoint sources to offset new nonpoint source discharges to the reservoir, rather than point and nonpoint sources to offset point sources' (POTWs) excess wasteloads.

The following discussion explains the nutrient problem in Dillon, the cost efficiencies that initiated the original trading program, and subsequent events that reduced the need for point/nonpoint source trading to mitigate the phosphorus problem. In 1992, Dillon Program will undergo its triennial review and new strategies will be analyzed. Though the initial vision of

[1]*Fiscal Impact Statement on the Assignment of a Phosphorus Standard to the Dillon Reservoir, Segment 3 of the Blue River*. Adopted June 12, 1984; effective July 30, 1984.

point/nonpoint source trading has yet to emerge as originally intended, a cooperative spirit in the basin allows growth to continue while maintaining ambient water quality in the reservoir.

BACKGROUND

Dillon Reservoir, owned and operated by the Denver Water Board, is located 70 miles west of Denver in mountainous Summit County (see Map A-1). Throughout the 1970s, Summit County had one of the highest growth rates in the nation. Although approximately 60 percent of the land in Summit County is managed by the U.S. Forest Service[2], private lands in the valleys are experiencing strong development pressures.

Economic and Recreational Value

Since its construction in 1963 to meet growing water needs for the city of Denver, Dillon Reservoir has become a major recreation center. Several of Colorado's major ski resorts -- Copper Mountain, Breckenridge, and A-Basin -- surround the reservoir, making it the focal point for Summit County's recreation-based economy. During the winter ski season, the basin's permanent population of 10,000 swells to over 60,000.

In 1984, the Northwest Colorado Council of Governments (NWCCOG) estimated that the reservoir provides substantial economic benefits to the county including $500,000 in direct expenditures annually from recreationists, $4 million annually in additional sales as a result of these direct recreation expenditures (usually referred to as "multiplier" effects), and $11 million in real property value due to location and quality of the reservoir.[3]

Nutrient Problem

Population growth and extensive land use changes in the basin resulted in increased phosphorus loading to the reservoir. New developments create new phosphorus loads through greater treatment plant discharge as well as the additional erosion and runoff associated with developing new sites. By the early 1980s, accelerated algal growth from the increased phosphorus transformed the deep blue waters to green and diminished reservoir oxygen levels. Dillon's economic value to the region, threatened by these changes, made its protection particularly important.

After the Copper Mountain wastewater treatment plant (one of four dischargers in the basin) received one of the largest fines levied by EPA for violating its phosphorus limits, EPA funded a Clean Lakes study of the reservoir. The study, completed in 1983, identified phosphorus as the primary contributor to Dillon's eutrophication problem. Over half the

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[2]*Recommended Water Quality Management Plan for the Colorado Water Quality Control Commission*. January, 1984. Submitted for the Summit County Phosphorus Policy Committee by the Northwest Colorado Council of Governments.

[3]See <u>Supra</u> note 1.

phosphorus entering the reservoir was attributed to precipitation, ground water and natural runoff. Naturally high "background" levels of nutrients in the reservoir result from spring snowmelt laden with heavy sediment from the mountain slopes. Human activities in the basin, through point and nonpoint sources, further exacerbate the phosphorus problem.

According to the Clean Lakes study, which evaluated 1982 reservoir levels, nonpoint sources contributed over 20 percent of total phosphorus -- over half of the phosphorus attributed to human activities. Sources of nonpoint source phosphorus include runoff from parking lots, golf courses, ski developments, and construction sites, along with seepage from domestic septic systems and other diffuse sources. Regulated point sources, primarily four publicly-owned treatment works (POTWs) that employ advanced treatment, discharged 18 percent of the total phosphorus load. These plants handle the wastewater treatment needs of the region. The Snake River plant in the Keystone area is managed by Summit County; the remaining plants -- Breckenridge, Copper Mountain, and Frisco -- are part of special sanitation districts created to provide wastewater treatment for their respective municipalities.

The Clean Lakes Study concluded that reliance on point source control alone, even at zero discharge, would be insufficient to prevent reservoir eutrophication if rapid regional growth continued. Consequently, nonpoint source phosphorus control would be necessary in order to prevent a sewer tap moratorium that would effectively freeze regional growth and put a cap on the point source load. All interests in the basin -- industry, municipalities, and environmentalists -- were equally threatened by either growth restrictions or continued degradation of the reservoir's water quality.

Nutrient Control Strategy

In 1983, faced with impending eutrophication and a potential regional growth moratorium, the Colorado Water Quality Control Commission asked local agencies to design a basinwide phosphorus reduction strategy that would accommodate future development without degrading Dillon Reservoir's water quality. Committee members, under the leadership of the Northwest Colorado Council of Governments, included representatives from the state and county, six surrounding municipalities, two unincorporated urban areas associated with ski developments, three sanitation districts, one mining company, the Denver Water Board, environmental groups, EPA officials, and other parties with a significant stake in Dillon's water quality.[4]

The Dillon Water Quality Management Plan is the result of these efforts. Adopted by the Colorado Water Quality Control Commission in 1984, the plan emphasized point and

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[4]*Point Sources-Nonpoint Sources Trading in the Lake Dillon Watershed: A Final Report.* Northwest Colorado Council of Governments. p. 4.

nonpoint source phosphorus controls in order to maintain 1982 water quality conditions.[5] In order to effectively control phosphorus levels in the reservoir, total phosphorus loading from all sources -- background, point, and nonpoint -- was limited to the 1982 level of 10,163 pounds, an amount considered acceptable to meet the reservoir's 0.0074 mg/l in-lake phosphorus standard. Point source dischargers received a share of the total available phosphorus load using 1982 discharge levels as a guide. The consideration of total basinwide phosphorus loading to meet an in-lake standard marked a shift from the previous, and more traditional, approach that allocated phosphorus based on reservoir segments, an approach insufficient to protect water quality.

Through the wasteload allocation process, the available point source phosphorus load (1,510 pounds), was distributed among the four individual dischargers based on total flows in 1983. At that time, point sources discharged substantially less than their allocations due to new tertiary treatment technology. The gap between actual discharge and allocated levels of phosphorus was expected to allow treatment plants to extend service to a greater population, thereby allowing regional growth to continue at a time when Summit County was experiencing one of the highest growth rates in the nation.

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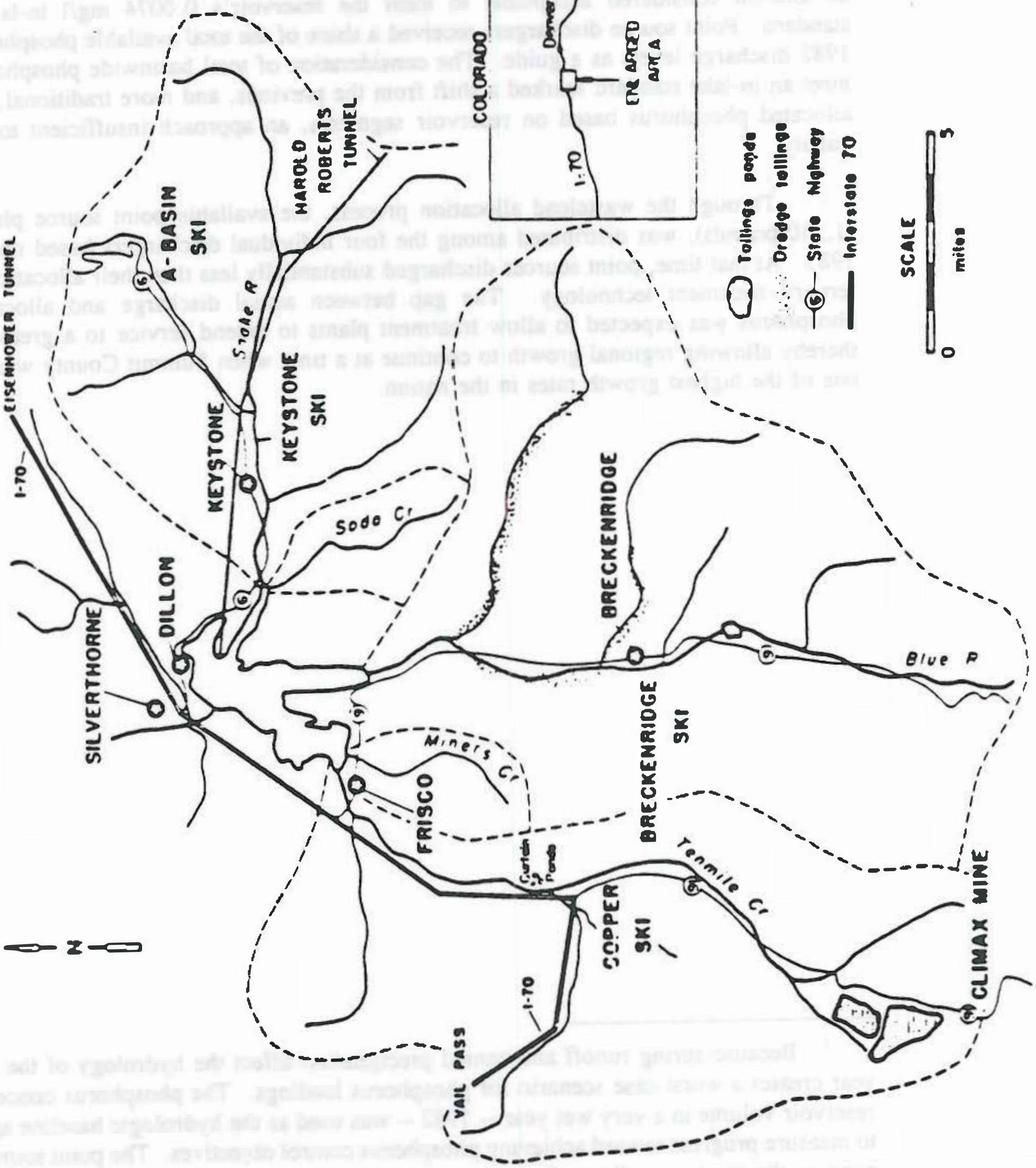
[5] Because spring runoff and annual precipitation affect the hydrology of the basin, a wet year creates a worst-case scenario for phosphorus loadings. The phosphorus concentration and reservoir volume in a very wet year -- 1982 -- was used as the hydrologic baseline against which to measure progress toward achieving phosphorus control objectives. The point source allocation remains the same regardless of precipitation, but the nonpoint source contribution is indexed to flow levels.

Map A-1: Dillion Reservoir and Its Watershed



IMPLEMENTATION OF NUTRIENT TRADING PROGRAM

Objective

Nutrient trading between point and nonpoint sources was incorporated into Dillon's basinwide phosphorus control strategy to encourage the most cost-effective means of preventing future nutrient loading increases. It was determined to be the most cost-effective means based on cost estimates of alternative phosphorus control strategies and the projection that treatment plants' phosphorus allocations would be exceeded by 1990, restricting the availability of future sewer taps extended to new developments. A point/nonpoint source trading program would give POTWs two options to accommodate loads exceeding their allocation. They could either install additional treatment technology to reduce their own phosphorus load levels (the only option available to them in the absence of trading) or maintain their existing levels of treatment while at the same time controlling existing nonpoint source phosphorus to receive credit toward their allocation.

The trading program provided a means to consider the cumulative impact of all phosphorus sources, including the contributions from new developments, which create new phosphorus loads through sewer connections to the treatment plant as well as increased runoff associated with a change in land use (phosphorus is carried in dissolved form and is attached to soil particles).

Economic Justification

Both Summit County and EPA were interested in the relative costs of point and nonpoint source control options to accommodate point source phosphorus loads in excess of allocations. In 1982, EPA funded a demonstration urban runoff control project that removed nonpoint source runoff at a minimum annual cost of \$67 per pound.[6] Through its Office of Policy, Planning and Evaluation, EPA funded a study in 1984 that compared nonpoint source control costs to advanced wastewater treatment technologies in order to estimate the potential cost savings generated by a trading program.[7]

Application of point/nonpoint source trading to Dillon Reservoir required several assumptions regarding future point source loads and available nonpoint source controls. For

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[6]Initial monitoring data from the project yielded an annual cost of \$119 per pound, which was used for calculations in the economic studies. However, with additional monitoring data, this cost was reduced to \$67 per pound. See *Point Sources-Nonpoint Sources Trading in the Lake Dillon Watershed: A Final Report*. Northwest Colorado Council of Governments, September 1984. p10.

[7]*Case Studies on the Trading of Effluent Loads in Dillon Reservoir*. 1984. Prepared for Office of Policy Analysis, U.S. Environmental Protection Agency by Industrial Economics, Inc.

example, 1985 phosphorus load calculations were based on facilities' estimated service population and a per capita phosphorus loading factor that reflected 1981-1982 treatment capabilities. However, discharge levels in those years were extremely high, due to the fact that tertiary treatment, which was already installed at the facilities and anticipated to reduce phosphorus loadings by 70 percent, was not yet fully functional. Consequently, 1985 calculations estimated point source loads substantially above allocations -- 2,744 pounds compared to an allocation of 1,313 pounds[8] -- and, hence, a large potential for trading.

Based on anticipated large point source loads, several treatment technologies reserved for drinking water purification were the only alternatives considered to achieve the necessary load reductions. Estimated annual costs for activated alumina, the lowest cost alternative, averaged $730 per pound across all plants.[9] Due to "lumpiness" of treatment technologies, advanced treatment at all plants would reduce phosphorus loading substantially below allocated levels.[10]

Nonpoint source removal costs were derived solely from the urban runoff demonstration project. Results from this project were extrapolated to the entire basin assuming diminishing effectiveness -- and, as a result, increasing costs per pound -- for the smaller, less desirable sites. With diminishing marginal returns, however, the point source loadings that were anticipated to exceed wasteload allocations ("excess load") could not be reduced through trading alone, thereby requiring a combination of point source upgrades and nonpoint source controls to achieve the necessary load reduction.

Using a cost minimization model, treatment plants in the basin would achieve their required phosphorus reductions through lower cost nonpoint source controls until the point at which the costs of such controls, on a per pound basis, surpassed the least expensive advanced treatment alternative. The least-cost combination of controls, using the assumptions above, would require one plant to upgrade its facility, with the balance of phosphorus reductions derived from nonpoint source controls, at an estimated total annual cost of $241 per pound, a 66 percent savings (on a per pound basis) over advanced treatment alone.[11]

The choice of a trading ratio further affects the maximum load reduction and cost-savings achieved through trading. Under a 2:1 trading ratio, for instance, a point source receives one

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[8]The initial 1,313 pound allocation, used in calculations, was later raised to 1,510 pounds in regulations governing the trading program. See Supra note 2 at p.3.

[9]Annual costs (before tax) for all calculations are based on conversion of one-time capital costs to annual equivalent capital costs using a 10 percent discount rate and ten year capital recovery period. Selection of the discount rate was based on Office of Management and Budget Circular A-94, which recommends use of a 10 percent discount rate for analysis of federal projects. See Supra note 7 at p.2-2.

[10]See Supra note 7 at p.3-10, and Exhibit 3-7.

[11]See Supra note 7 at p.3-13, and Exhibit 3-12.

pound of credit for each two pounds of existing (i.e., pre-1984) nonpoint source phosphorus reduced. Without sufficient nonpoint sources with which to trade, maximum reductions will be limited to the availability and relative proportion of nonpoint sources. Additionally, from the perspective of the point source discharger, the cost-effectiveness associated with nonpoint source control is less under a higher trading ratio because (assuming a 2:1 ratio) every two pounds of nonpoint source phosphorus removed results in only one pound credited to the point source reduction requirement. Therefore, a point source must control twice as much existing nonpoint source phosphorus as would be necessary in a 1:1 trading ratio (a discussion of the ratio selected for the Dillon program and its rationale is presented in "Program Details" below). Using the assumptions described above, the least-cost combination of controls necessary to reduce the excess phosphorus load would result in an annual average cost of $508 per pound of phosphorus credited to the point source allocation, 30 percent cheaper (on a per pound basis) than advanced treatment alone.[12]

All of the calculations described above assume that dischargers are required to meet the *aggregate* point source limit imposed on them, rather than individual wasteload allocation limits. That is, the least-cost combination of controls reflects the lowest cost to the point source dischargers as a group, not to the individual discharger. However, the Dillon trading program is structured such that each discharger must meet its *individual* limits by either further reducing its discharge or controlling nonpoint sources in order to maintain existing levels of point source discharge. Using the model employed for the initial cost-effectiveness estimates, it is not possible to develop comparable estimates for the program implemented at Dillon.[13]

Program Details

The trading program developed for Dillon involves the four POTWs in the basin and nonpoint sources that existed prior to adoption of the plan in 1984. By granting POTWs credit for operating and maintaining controls on existing urban nonpoint sources while at the same time continuing advanced treatment for phosphorus removal, additional development can occur

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[12]See Supra note 7 at p.3-17, and Exhibit 3-16. This combination of point and nonpoint source controls reflects the costs associated with twice as much nonpoint source control as is reflected in credits. For instance, the least-cost combination required 518 pounds nonpoint source credit, which resulted from the control of 1,036 pounds of nonpoint source phosphorus.

[13]The analysis assumed that there was a limit to the total pounds of possible nonpoint source reductions. Further, the total was estimated to be less than the required point source load reductions. For this reason the assumption of a perfectly functioning market was the only basis for determining which point source dischargers may be able to purchase sufficient credits and which will be required to implement facility upgrades. In a perfect market, nonpoint source control "prices" reflect the value to the point source discharger with the highest-cost facility upgrades. In fact, purchase of nonpoint source controls is likely to be on a first-come-first-served basis, with prices not bid up by individual facilities.

without limiting future sewer taps. Dillon's trading program includes four major elements; they are described below.

Baseline. 1982 levels of phosphorus were used as the common basis for measuring progress in controlling basinwide phosphorus loading. Water volume was very high that year, and nonpoint source loads would also have been high. Point source allocations are based on 1982 loadings, and nonpoint source reductions will be indexed to 1982 water volume and loadings.

Trading Ratio. A 2:1 trading ratio, chosen for technical and economic reasons, requires that a treatment plant control two pounds of phosphorus from an existing nonpoint source for each pound of phosphorus it discharges above its allocation. For instance, installation of a nonpoint source control device that removes 100 pounds of phosphorus would generate 50 pounds of phosphorus credit toward a point source's total allocation. Available data indicated that a 2:1 ratio would offset the increased new nonpoint source phosphorus loading that would result from new development generated by a one pound credit at the point source. As noted above, it also represented a 30 percent savings, on an annual cost per pound (of phosphorus credit) basis, over the cost of meeting phosphorus limits through point source control upgrades alone.

Controls on New Nonpoint Sources. Nonpoint source loads from new development occurring after the plan was adopted in July 1984 are controlled separately, and cannot generate phosphorus credits. As part of the plan, local governments are required to adopt regulations that control nonpoint source runoff from all new developments, resulting in a 50 percent reduction below anticipated nonpoint source loadings. Trading will only be considered in localities with appropriate land use and erosion control ordinances.

NPDES Permit. Each discharger involved in a trade will be given an NPDES permit that incorporates its phosphorus credit and notes the party responsibility to operate, maintain, and monitor the nonpoint control device(s) for which credit will be granted (responsibility assigned by the Water Quality Control Commission). These permits must contain, at a minimum, the following provisions: (1) a record of the point source credit amount and the original phosphorus allocation; (2) construction requirements for the nonpoint source control devices; (3) monitoring and reporting requirements for the party responsible for the nonpoint source controls; and 4) operation and maintenance requirements to assure continuous nonpoint source control.

Enforcement and Compliance

When a trade is approved, a treatment plant's NPDES permit is modified to include two levels of discharge limits -- one, considerably more stringent, in the event that trading is not used or is not successful, which is equal to discharge limits required to meet wasteload allocations and requiring point source upgrades, and one that credits the discharger's wasteload allocation based on their implementation of successful nonpoint source reduction projects. By including the trading provision in the permit, nonpoint source management and control are linked directly to the Clean Water Act enforcement provisions of the NPDES permit.[14] If a discharger does not achieve the required level of nonpoint source control specified in the permit, its allocated load and permit level will automatically revert to the more stringent limits. For the plan to be effective, permit conditions must be enforced and violations must be subjected to the appropriate administrative or criminal procedure.

Technological Feasibility

Sufficient and reliable water quality data, and accurate modeling are essential to develop a basinwide water quality protection plan as well as a trading program. For Dillon Reservoir, a computer model developed as part of the Clean Lakes study indicated the maximum phosphorus loading that the basin could accommodate and still achieve the in-lake phosphorus standard. Further refinements to the Dillon Water Quality model will allow predictions concerning the phosphorus impacts of future basin development.

The Clean Lakes Study assumed that one pound of total phosphorus discharged from a point source would have the same water quality impact as one pound of total phosphorus discharged from a nonpoint source, and the same impact as discharges from different locations. This was substantiated in water quality model predictions that were within 5-10 percent of the observed levels for 1981 and 1982.[15]

Effective, low-cost nonpoint source control measures are also necessary for a trading program. In the Dillon watershed, the EPA pilot urban runoff facility demonstrated one potential type of inexpensive nonpoint source control. Several other options for nonpoint source control, including connecting subdivisions on failing septic systems to wastewater treatment facilities, are also appropriate in the Dillon area.

Administrative Framework

Regulations by the Colorado Water Quality Control Commission outline the general program structure for the Dillon trading program. The Commission, appointed by the Governor, assigns total phosphorus limits and credits, and assigns responsibilities for operating, maintaining and monitoring all nonpoint source controls for which credit is received. The Northwest Colorado Council of Governments (NWCCOG) serves as staff to the Summit Water Quality Committee, and took the lead overseeing development of the trading program.

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[14]Clean Water Act, Section 402.

[15]Kashmanian, Richard, et. al, 1987. *An Application of Point Source/Nonpoint Source Trading: A Case Study of Dillon Reservoir, Colorado.* U.S. EPA Office of Policy, Planning and Evaluation, Staff Paper, p12.

Point source regulation lies with the Water Quality Control Division of the Colorado Department of Health through its EPA-approved NPDES permitting program. The point/nonpoint source trading provisions are incorporated into the NPDES permit by including both point source discharges and nonpoint source controls in the permit.

In accordance with Clean Water Act requirements for state-managed NPDES programs, the Environmental Protection Agency, through its Region 8 office, reviews all permits for compliance with Dillon management regulations and water quality standards. EPA reviews and approves all trades recommended by the State that conform to regulations and are used to attain or maintain the in-lake phosphorus standard.[16]

Local governments share basinwide water quality responsibilities through the Summit Water Quality Committee, formed by intergovernmental agreement to provide a coordinated approach to protecting water quality. The Committee developed the administrative procedures for credit transactions that were approved by the Water Quality Control Division. Its present responsibilities include: extensive monitoring of water quality trends in the reservoir, tributary streams, and nonpoint source controls; identification of sites for nonpoint source control devices; distribution of phosphorus credits gained from the nonpoint source controls; and development of septic tank control programs.

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[16]Personal communication with Bruce Zander, EPA Region 8, July 25, 1991.

PROGRAM STATUS

The Dillon program became the first operating point/nonpoint source trading program in the nation after it received state and EPA approval in 1984. Local officials expected that the trading program would be a major component of the overall phosphorus control strategy for the basin due to the impact of rapid growth on point source phosphorus loads. The trading program was designed to accommodate new development in the region by bringing control of existing nonpoint sources of phosphorus under the umbrella of point source regulation.

However, several events in the late 1980s diminished the immediate need for implementing trades. In addition to an economic slump in the late 1980s that slowed basinwide development and corresponding increased levels of point and nonpoint phosphorus loadings, the POTWs in the basin achieved impressive phosphorus load reductions through minor plant alterations and improved operating efficiency of existing treatment technology.

Without resorting to additional, expensive treatment technology, the treatment plants were able to reduce their discharge substantially below projections. The four POTWs discharging into Dillon now boast some of the highest phosphorus removal efficiencies in the nation. For instance, the Snake River Plant, which has won several EPA awards for its phosphorus removal capabilities, now discharges as little as 20 pounds of phosphorus (at 0.02 mg/l) out of its annual allocation of 340 pounds.[17]

In contrast to the early 1980s, point source loading is now a relatively minor source of phosphorus to Dillon. Even with increased flows, combined POTW discharge, with an annual allocation of 1,510 pounds, totals less than 250 pounds out of the annual reservoir limit of 10,163 pounds.[18] Even at full buildout of the basin, treatment plants are not expected to reach their allocations.[19] Consequently, point/nonpoint source trading has played only a minor role in the overall basinwide phosphorus mitigation strategy. The limit on *nonpoint* phosphorus loading, implied by the total basinwide phosphorus load allowed, has proved to be the major constraint to future development.

Although total annual phosphorus loading was only 5,449 pounds in 1989[20] -- 54 percent of the total phosphorus allowed -- nonpoint source phosphorus poses the most important problem. Local officials are developing a phosphorus mitigation policy that will require new

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[17]Personal communication with Buck Wenger, Utility Manager, Snake River Sanitation District. July 17, 1991.

[18]From *1989 Annual Monitoring Report*, Table 9, as cited in *Summit Water Quality Committee 1990 Annual Report*. February 1991. Prepared by Lane Wyatt.

[19]See Supra note 18 and Supra note 17.

[20]Supra note 19, Table 11.

nonpoint sources to offset their phosphorus impact by controlling existing nonpoint sources, in addition to the stringent controls already required for new developments. For a program review in 1992, a new county committee has been formed to evaluate supplements to the current trading program along with new strategies to control nonpoint source phosphorus.[21]

To date, only one point/nonpoint source trade has been completed under the original regulations. Two additional nonpoint source control projects have been implemented by point sources, and are currently being monitored to determine their phosphorus removal capabilities. These will generate credits for the treatment plants or others to use in the future to offset new nonpoint source loads. The following discussion describes these projects.

Breckenridge Sanitation District[22]

In 1988, the Breckenridge Sanitation District, which operates the largest of the four POTWs in the basin, received 11 pounds of additional phosphorus credit for sewering of the Lake View Meadows subdivision. Prior to 1984, the subdivision had been serviced by individual septic systems, the largest collective source of nonpoint phosphorus entering Dillon reservoir.

Available data on septic system phosphorus yields indicated the potential for 22 pounds phosphorus removal if the homes were connected to the sewer system. Based on the 2:1 trading ratio, this generated 11 pounds credit to the Sanitation District, reflecting a total allotment in its revised NPDES permit of 675 pounds.

From an administrative perspective, the completed trade illustrated that the process outlined in regulation worked smoothly. However, the Sanitation District did not pursue the trade based on the economic incentives of nonpoint source control, as it currently uses only 15 percent of its phosphorus allocation. Instead, it applied for credits after the county responded to requests for sewer connections from a subdivision that had been experiencing septic system failures.

Because the sewer project was incorporated into a planned county road improvement project, the capital costs attributed to sewer construction were substantially below the county average. Of the total $5,600 assessed each lot in the subdivision (including undeveloped lots), only $700 was attributed to sewer costs. In contrast, the average cost for running sewer lines to residences located near existing trunk lines is $4,000 per residence, in addition to a $3,000

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[21]Personal communication with Lane Wyatt, Northwest Colorado Council of Governments, July 19, 1991; McKee, July 29, 1991; Wenger, August 8, 1991.

[22]Personal communication with Bill McKee, Senior Planner, Basin Management, Colorado Department of Health. July 16, 1991; Milt Thompson, Breckenridge District Manager. July 17, 1991; Rick Pocious, County Engineer, August 12, 1991.

tap fee.[23] Although the county financed the entire project through bonds, Breckenridge Sanitation District received credits based on the amount of phosphorus removed by converting existing homes from septic systems to sewer service.

Frisco Sanitation District[24]

Frisco is a small mountain community that experienced storm drainage problems. In order to counteract stormwater accumulation in two alleys behind Main Street, the Frisco district built a series of concrete vaults (manholes) that drain stormwater runoff and settle heavy sediment. The first project, built in 1985 to alleviate the drainage problems, also demonstrated phosphorus removal benefits: filtering water through perforated pipes removed 50-70 percent of phosphorus.

From this experience, the district built a second series of vaults to drain a different section of town and decrease phosphorus loading to the reservoir. The project qualified for federal funds administered through the Clean Water Act Section 319 nonpoint source management program, which provided $38,000 out of a total cost (including monitoring) of $63,000. The town of Frisco and the Frisco Sanitation District shared the non-Federal portion through a combination of cash and in-kind services.

However, like Breckenridge, Frisco did not need additional phosphorus credits: out of its current allocation of 341 pounds per year, it uses less than 50 pounds. On behalf of the town of Frisco, all credits obtained from the Frisco project will be applied to a planned town golf course in keeping with a proposed phosphorus mitigation policy that will require any projects that contribute new nonpoint source phosphorus to obtain equivalent nonpoint source phosphorus removals elsewhere.[25] In effect, the trade is an example of nonpoint/nonpoint source trading, under the umbrella of a point/nonpoint source trading program.

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[23]Lewis, William M., Jr. *Methods for Calculating the Value of a Pound of Phosphorus in the Lake Dillon Watershed for Purpose of Phosphorus Mitigation.* Prepared for the Summit Water Quality Committee, April 18, 1990. p.3. A residential unit on a septic system yields an estimated 1.4 pounds of phosphorus per year. Therefore an annualized capital cost per pound of phosphorus removed by connecting the home to a sewer is $465, not including the tap fee. Lewis reports a value of $5,000 per pound of phosphorus, which includes the tap fee in the total cost, and does not represent annualized costs.

[24]Personal communication with McKee, July 16, 1991; Butch Greene, Plant Manager, Frisco Sanitation District, July 16, 1991.

[25]The proposed phosphorus mitigation strategy will require phosphorus reductions equivalent to a proposed impact of a new project, essentially a 1:1 trading ratio. Therefore, controlling one pound of nonpoint source phosphorus results in a one pound credit to another nonpoint source. This should be distinguished from a 2:1 trading ratio where two pounds of nonpoint source phosphorus must be removed to generate one point source pound credit.

Phosphorus removal capabilities from the project will be determined by monitoring incoming and outgoing water. Based on initial results, the project is expected to generate 40-50 pounds phosphorus credit to the Sanitation District in 1994.[26] Assuming 50 pounds of phosphorus removal, the total annualized cost of this project is $10,253, or $205 per pound of phosphorus. However, the federal grant reduces the Sanitation District's cost substantially -- its $12,500 share of total costs results in an annual cost of $40 per pound.[27]

Snake River Wastewater Treatment Facility[28]

The county-owned Snake River treatment plant, which services the Keystone area, is also involved in a nonpoint source control project designed primarily to offset the impact of new nonpoint source contributions to the reservoir. As part of the overall management of Dillon reservoir, the Denver Water Board, owner and operator of the reservoir, plans to divert a stream with a high phosphorus concentration into Dillon reservoir. In keeping with a proposed phosphorus mitigation strategy for the reservoir, the Water Board has agreed to offset the anticipated 200 pound phosphorus impact of the stream diversion with equivalent phosphorus reductions elsewhere in the basin.

The Snake River project, the first nonpoint source control project identified to meet the Water Board's offset objective, will reduce the phosphorus loading from Soda Creek, which drains the Snake River district and has the highest phosphorus concentration of any stream entering Dillon reservoir. In order to reduce phosphorus loading from Soda Creek, the treatment plant built a discharge structure in April 1991 using the existing road causeway over the reservoir as a dam to intercept stream flow. When reservoir levels are low, the wall filters water entering the reservoir, removing up to 50 percent (75 pounds) of phosphorus under the best conditions. After modeling is completed, the Denver Water Board will receive half of the credits generated from this project.[29]

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[26]Again, in this case, the amount of credit received will equal the amount of phosphorus removed, thus cost calculations reflect a 1:1 ratio between credits received and pounds removed.

[27]For consistency with the initial economic study, calculations are based on a 10 percent discount rate and a ten year capital recovery period. See Supra note 9.

[28]Personal communication with McKee, July 16, 1991; Wenger, July 17 and August 8, 1991.

[29]See Supra notes 24 and 25. The total amount of nonpoint source phosphorus removed from this project will result in phosphorus credits shared equally between the Snake River Plant and the Denver Water Board.

Project costs for the detention pond totaled $106,000, including a $46,400 grant from Clean Water Act Section 201 funds administered through the State Water Quality Division.[30] The remaining costs were shared by the Snake River plant and the Denver Water Board. The Snake River project comes under the trading program umbrella because of regulations that require trades to be sponsored by a POTW. However, like the other treatment plants in the basin, Snake River uses only a fraction of its phosphorus allocation: 20 out of its allocated 340 pounds.

Assuming the project removes 75 pounds of phosphorus, total annualized capital costs would be $17,251, or $230 per pound.[31] However, costs to the treatment plant for its share of credits are substantially reduced by the federal grant and Denver Water Board contribution, resulting in an annual cost of $130 per pound.[32] These costs do not include operating and maintenance costs, which will be shared by the Snake River plant and the Denver Water Board.

[30]Under Section 201, the Construction Grants program (now phased out), up to 20% of a state's construction grants money for POTWs could be used for "any innovative and alternative approaches for the control of nonpoint sources of pollution" (201(g)(1)(B)). Until Congress appropriated Section 319 nonpoint source management program money in 1990, Colorado used part of its 201 allocation to fund nonpoint source projects.

[31]See Supra note 30.

[32]See Supra note 25.

CONCLUSION

Dillon Reservoir has frequently been cited as an example of the potential cost savings generated by a point/nonpoint source trading program. Indeed, the ease with which Dillon's completed trades occur illustrates that the administrative framework operates as designed.

To date, however, the program has not developed as envisioned largely due to the impressive load reductions achieved by the POTWs. By achieving some of the highest phosphorus removal capabilities in the nation, the treatment plants obviated the need for point source phosphorus credits to accommodate future growth. Although point/nonpoint source trading now plays only a minor role in overall basinwide phosphorus management, several valuable lessons emerge from the Dillon experience regarding the role of trading in basinwide water quality management. Particularly important is the realization that nonpoint/nonpoint source trading will be necessary in maintaining the water quality of Dillon Reservoir.

Maximum Basinwide Loads

Primarily, the Dillon experience illustrates the importance of a comprehensive basinwide management approach rather than focusing on point sources in isolation. By considering the relationship between point, nonpoint, and background sources of phosphorus to the reservoir, local officials determined acceptable maximum pollutant loadings to meet an in-lake standard. This basinwide planning approach represented a shift from the conventional regulatory approach which, for the most part, has been limited to point source control. As a result of Dillon's proactive planning, 1989 phosphorus loads to the reservoir totaled only 53 percent of the critical load.[33]

Several sections of the Clean Water Act address a comprehensive approach to water quality problems where point source control alone is insufficient to meet designated water quality standards. Section 302, water quality related effluent limitations, requires establishment of effluent limitations (including alternative effluent control strategies) for point sources that can reasonably be expected to contribute to the attainment or maintenance of water quality.[34] A trading program appears to be an acceptable alternative control strategy.

Additionally, Section 303, water quality standards and implementation plans, outlines the total maximum daily load (TMDL) process[35] as a mechanism for water quality-based control actions where technology-based controls alone are not adequate. A TMDL is the maximum amount of a pollutant that can enter a water body without violating water quality standards.

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[33]See Supra note 17.

[34]Clean Water Act, Section 302(a).

[35]Clean Water Act, Section 303(d); 40 CFR 130.

Recent guidance by EPA explains the role of TMDLs in evaluating the cumulative impact of all pollution sources, as well as available options for point and nonpoint source control.[36]

Although TMDLs can be difficult to establish where multiple sources impair water quality, this type of integrated basinwide management is essential to control the remaining water quality problems. The wasteload allocation experience at Dillon illustrates the multiple factors that must be considered when allocating the available load. Where point sources are able to achieve load reductions substantially below initial allocations, as at Dillon, reallocation may be necessary to maintain incentives for point/nonpoint source trading.

Within a comprehensive basinwide management strategy, however, alternative control measures, such as a trading program, can only be considered when all point source dischargers are, at a minimum, in compliance with technology-based requirements. Under the Clean Water Act, only point sources are subject to federally enforceable controls.[37] Therefore, a strategy that also relies on nonpoint source reduction to meet water quality standards must include assurances that such reductions will occur. At Dillon, this assurance is provided in the NPDES permit that defines the point source's obligation to build and maintain nonpoint source controls. Failure to do so would result in a more stringent point source discharge restriction.

Monitoring and Modeling

A water quality-based regulatory approach, above and beyond technology-based requirements, is only possible with adequate monitoring data and computer modeling capabilities. Water quality data and appropriate models must be available to evaluate relative impacts from point and nonpoint source loads along with the implications of alternative control strategies to meet a water quality standard.

At Dillon, monitoring data is used in conjunction with the Dillon Water Quality model to evaluate current control strategies and predict the impact of future development. As modeling capabilities become more sophisticated and monitoring data accumulates, the load allocation process can be tailored to address the water quality problem most effectively.

The availability of monitoring data and sufficient models will directly affect the amount of time required to develop and allocate total maximum daily loads and, if necessary, a trading program. In some cases, a TMDL may be more effective as a proactive planning tool, rather than as the primary method to improve water-quality limited water bodies, where independent regulation of nonpoint source control may be necessary.

The trading program at Dillon was designed to prevent *future* water quality deterioration in a rapidly expanding region, rather than to mitigate an existing problem. Local officials, faced

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[36]*Guidance for Water Quality-based Decisions: The TMDL Process.* April 1991. Office of Water Regulations and Standards, United States Environmental Protection Agency.

[37]Clean Water Act, Sections 301, 304.

with a potentially serious water quality problem, recognized the need to consider the total pollution load to the reservoir in order to maintain an acceptable level of water quality. The trading program is part of a larger basinwide phosphorus control strategy that also includes separate nonpoint source control requirements for new developments.

Estimating Cost-Savings Attributed to Trading

Point Sources. Using an economic rationale, point/nonpoint source trading is expected to occur when the marginal cost to control otherwise unregulated nonpoint sources is lower than equivalent reductions achieved at treatment plants through advanced treatment technology. The Dillon experience illustrated the sensitivities involved in the initial economic analysis of potential cost savings.

The economic analysis used to project cost savings attributed to the Dillon trading program considered the aggregate discharge limit for all point sources, rather than adherence to individual discharge limits. This analysis, which assumes a regulatory "bubble" applied to point source dischargers, yields the greatest economic efficiencies. as the lowest cost control combination would be evaluated across all dischargers; individual plants would be subject only to maintaining the aggregate discharge limit, not necessarily forced to reduce individual discharge levels beyond compliance with technology-based regulations. However, in practice this type of bubble approach could lead to several enforcement problems, specifically related to responsibility and accountability for violations, if individual permits did not reflect the requirement to adhere to individual facility wasteload allocations. The Dillon program does not use this bubble approach, which makes the initial reported cost savings difficult to interpret.

Additionally, although tertiary treatment had been installed at all the Dillon plants at the time of the study, projections of future loads were based on previous discharge levels without such technology. Consequently, projected load levels were inflated. The true conditions substantially altered the economic efficiencies underlying the original trading program.

The Dillon plants were able to further reduce phosphorus loads by increasing operating efficiency of their existing technologies. As a result, they achieved phosphorus removal capabilities even below those predicted for the advanced treatment alternative recommended in the study. As illustrated at Dillon, the possibility for low-cost capital improvements and improved operating efficiency to reduce discharge levels must be considered. When faced with a limit on allowable discharge in addition to a maximum effluent concentration, point source dischargers are more likely to look beyond mere permit compliance to find more efficient operating procedures. The appropriate cost comparisons should evaluate additional plant improvements needed if plants are operating at their highest efficiency, versus the cost of nonpoint source controls.

Nonpoint Sources. Effective, low-cost nonpoint source controls are essential to develop a successful trading program. However, calculating nonpoint source control costs and the potential cost savings attributed to a trading program is a difficult process, as actual nonpoint source control options vary considerably, both in effectiveness and cost.

In the original Dillon study, the costs for nonpoint source controls were based solely on cost efficiencies extrapolated from the type of urban runoff control facility considered most likely to be used for nonpoint source control. However, the nonpoint source control projects actually developed as part of the trading program included several different approaches and none yet utilize the type of runoff facility evaluated in the study. In Dillon, the most significant opportunity to recover nonpoint source phosphorus is to extend sewer service to residences serviced by septic systems, the single largest nonpoint source of phosphorus. Construction costs are assessed to homeowners in addition to a sewer tap fee. All estimates for nonpoint source control costs are site-specific, based on hydrogeographic conditions.

Trading Ratio. The choice of a trading ratio further affects the maximum load reduction and cost efficiencies that can be achieved through trading. At Dillon, the 2:1 trading ratio was chosen to offset the phosphorus impact associated with new developments, which increase phosphorus though additional loads to the treatment facility as well as the runoff associated with land use changes (even under stringent controls to reduce such runoff). Despite their apparent simplicity, as POTW treatment efficiencies improve and as new growth occurs there is a potential that the initially established trading ratios may need to be revised. In some cases, it may be necessary to reevaluate and even increase ratios to ensure that the trading ratio still fully mitigates runoff from new growth.

Treatment plants in the Dillon Reservoir improved their operating efficiency, enabling them to treat more influent per pound of phosphorus discharged. Thus, under improved efficiencies, a one pound credit represents a larger volume of influent -- enabling the sale of a greater number of sewer taps, and potentially, servicing a greater area of land -- than under initial efficiencies where a pound credit of phosphorus discharge represented a lesser volume of influent.

Under improved POTW treatment efficiencies, trades may not be necessary in order to sell taps and permit development so long as a plant's loading remains below its permit limit. As development continues and POTW phosphorus loadings approach the limit as a result of development, a plant operator will have to choose between trading or facility upgrades to enable the sale of more taps to permit more development.

The problem with existing trading ratios appears at the point that POTWs choose to trade *after* efficiency improvements and after limits are again being approached. The trading ratio, in this case 2:1, was established based on the original efficiency of the POTWs. For example, at the time the existing ratio was established under the old efficiency, a single 2:1 trade enabled a POTW to sell taps representing a specified acreage of development. Under this 2:1 trade, one pound of nonpoint source runoff reduction (at existing sources) would offset the one pound of additional point source discharge resulting from the development's sewer taps, and the other pound of nonpoint source reduction (at existing sources) offset the one pound of new nonpoint source runoff from the same development, following on-site control.

Under improved POTW treatment efficiency, a 2:1 trade would still permit a POTW to sell the number of taps whose influent would result in an increase of one pound of additional point source discharge, but the number of taps will have increased. Suppose that improved efficiencies enabled the plant to treat influent from twice as large an area as previous efficiencies allowed, and still discharge a single pound of phosphorus. A single 2:1 trade would now enable the POTW to sell taps for twice as much land. A development that is twice as large, however, will, in most cases have more nonpoint source runoff. The previous ratio was designed to mitigate one additional pound of nonpoint source loading, but it will not necessarily mitigate the runoff from development of twice as much area. In this scenario, the ratio may need to be increased to as much as 3:1 to fully mitigate the nutrient loading associated with the additional growth that is permitted as a result of plant improvements (assuming that twice as much area results in twice as much nonpoint source loading).

As illustrated in the example above, the initial trading ratio may not fully offset the nonpoint source runoff associated with the equivalent acreage the improved efficiency can now permit. The opposite argument would hold for improvements in controls of new nonpoint sources: the trading ratio could perhaps be revised downward (e.g., from 2:1 to 1.5:1 or 1:1) rather than upwards. Additionally, improvements in POTW treatment efficiencies may postpone or avert the need to trade, as was the case at Dillon Reservoir.

Federal Subsidies. Incentives to trade may be enhanced by the presence of federal support for nonpoint source control projects. Limited federal grant money is available for nonpoint source control projects through the Clean Water Act's Section 319 nonpoint source management programs. If a nonpoint source control project receives funding through this program, the costs to the point source participating in the trade will be reduced, therefore increasing the incentives to trade. The Construction Grants Program,[38] which provided funds for construction and upgrading of publicly owned treatment plants, has been replaced by the State Revolving Loan Fund, which increases the local share of upgrading treatment facilities.

Potential Impact of a Trading Program

In order for a trading program to successfully mitigate a nutrient problem, significant contributions of phosphorus must result from both point and nonpoint source dischargers. In Dillon today, for instance, point sources contribute only 2 percent of total phosphorus,[39] which acts as a constraint to the volume of existing nonpoint source phosphorus that can be controlled through trading -- there is not sufficient volume of point source phosphorus to "leverage" against existing nonpoint source loadings. Even under a hypothetical zero discharge limit for point sources, a functioning point/nonpoint source trading program in Dillon would only remove 400 pounds of nonpoint source phosphorus -- out of an allocation of approximately 2,000 pounds for point sources -- based on current point source discharge and a 2:1 trading ratio.

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[38]Clean Water Act, Section 201.

[39]See Supra note 17.

Although point/nonpoint source trading has not yet been necessary at Dillon, the lack of trading does not obviate the need for a trading program. Rather, it shows the careful planning and analysis necessary to develop a trading program as one component of an integrated basinwide management strategy.

Unless regulatory nonpoint source controls become required, a trading program provides one method to incorporate nonpoint source control into the regulatory reach of the Clean Water Act. If initial conditions are not correctly analyzed, however, the potential for trading to solve water quality problems could be greatly exaggerated. Nonpoint source control, independent of a trading program, may still be required to alleviate remaining site-specific water quality problems.

APPENDIX B

NUTRIENT TRADING IN THE TAR-PAMLICO RIVER BASIN

TABLE OF CONTENTS

INTRODUCTION

North Carolina designated the entire Tar-Pamlico River watershed as Nutrient Sensitive Waters (NSW) in 1989 after increased sediment and nutrient loads threatened the Pamlico River estuary's valuable fisheries. Consequently, the Division of Environmental Management (DEM), part of the Department of Environment, Health, and Natural Resources, proposed nutrient-reduction effluent limits for point source dischargers. The Tar-Pamlico Basin Association, a coalition of wastewater treatment plants in the river basin, and state and regional environmental groups proposed an alternative two-phased interim nutrient management strategy. The strategy was most recently revised in February of 1992.

The strategy includes point/nonpoint source nutrient trading, allowing the Association to fund less expensive nonpoint source controls, and thus avoid anticipated high compliance costs associated with achieving nutrient-reduction through major facility upgrades. Under the established rules, it is anticipated that trading will achieve equivalent or better water quality than would have been achieved under originally proposed effluent limits. Phase I of the strategy establishes the administrative and institutional framework for the implementation of the trading program. The state will hold the Association members jointly responsible for achieving an annual nutrient loading allowance for the entire Association, in lieu of individual plant effluent restrictions. Within the nutrient loading allowance, members may allocate individual discharge levels among themselves. The Association must offset nutrient discharges exceeding the total allowable load by funding nonpoint source reductions in the basin.

Association-funded nonpoint source reductions will be implemented through the existing North Carolina Agriculture Cost Share Program, which provides funds to farmers to implement nonpoint source controls known as Best Management Practices (BMPs). This arrangement restricts monies the program receives from the Association to nonpoint source controls within the Tar-Pamlico watershed. Association funds will supplement state cost share money already designated for the Tar-Pamlico Basin. There should be ample opportunity to trade nonpoint source reductions for any point source discharges above the allowable load because a significant portion of nitrogen and phosphorus loading results from nonpoint source runoff associated with agricultural practices that dominate the 5,400 square-mile watershed.

The Association has conducted engineering evaluations of its facilities and is in the process of implementing operational and minor capital improvements to reduce nutrient discharges, as required by Phase I of the strategy. This has allowed its members to avoid exceeding the loading allowance maximum for the first year, averting the need to conduct nutrient-reduction trading by funding nonpoint source controls. The agreement does, however, include a requirement for funding a minimum level of BMPs each year. Despite current loading below allowable levels, the inclusion of a trading scheme as part of the management strategy has initiated an effort to gain a better hydrologic understanding of the basin, and its pollution problems. The establishment of an administrative structure for a trading program will be particularly important to achieving water quality objectives in a cost-effective manner in the event that future nutrient discharge targets are reduced.

BACKGROUND

Nutrient Problem

The Tar-Pamlico River Basin encompasses a 5,400 square-mile watershed surrounding the Tar and Pamlico Rivers and their tributaries. The rivers run through portions of 17 counties before emptying into the Pamlico River Estuary and Pamlico Sound (see Map B-1). The Pamlico River Estuary's valuable fisheries are vulnerable to the algal blooms and low dissolved oxygen that result from excessive nutrient and sediment loading. In Tar-Pamlico's estuarine environment, nitrogen is considered to be the limiting nutrient, determining the existence and extent of algal blooms, although phosphorus also appears to contribute to localized water quality problems.

Point sources contributing to nutrient loadings in the basin include publicly-owned treatment works (POTWs), and industrial and mining operations discharging into the Tar and Pamlico Rivers and their tributaries. In addition, a substantial portion of total nutrients is estimated to result from agricultural nonpoint sources.

Existing Controls

Prior to the Environmental Management Commission's (EMC) approval of the Nutrient Sensitive Waters Implementation Strategy (described in the following sections), no major *nitrogen* control measures had been adopted by the state for the Tar-Pamlico River Basin. Despite the lack of regulatory nitrogen control measures, a voluntary program -- the North Carolina Agricultural Cost Share Program -- has provided assistance to farmers installing best management practices (BMPs) to control levels of nitrogen and phosphorus in agricultural runoff.

The state did institute a major *phosphorus* control measure in 1988 -- a phosphate ban -- that resulted in significant reductions in loadings to the basin.[2] Additional reductions are anticipated when Texasgulf Industries completes renovations in 1992 that are expected reduce the plant's current loadings by 90 percent. Agriculture and forested lands are now the primary nonpoint sources of phosphorus, and are estimated to contribute 60 percent of the total loading.[3]

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[1] *Tar-Pamlico River Basin Nutrient Sensitive Waters Designation and Nutrient Management Strategy*. April 1989. Department of Natural Resources and Community Development, Division of Environmental Management, Water Quality Section, p. 18.

[2] Ibid, p. 18.

[3] Ibid, p. 18.

Nutrient Sensitive Waters Designation

In 1989, increasing eutrophication problems and outbreaks of fish diseases prompted EMC to formally designate the entire Tar-Pamlico watershed as "Nutrient Sensitive Waters" (NSW). This designation requires the identification of nutrient sources, establishment of nutrient-reduction goals, and development and implementation of a nutrient management strategy.[4]

A nutrient budget prepared by the state for the entire basin showed that the majority of nutrient loading results from nonpoint source runoff associated with the agricultural practices that dominate the basin. Specific point sources found to contribute substantially to nitrogen and phosphorus loading are POTWs with permitted flows exceeding 0.5 million gallons per day, and a large Texasgulf Industries phosphate mining operation near the terminus of the Pamlico River.

North Carolina has not established water quality standards for phosphorus or nitrogen, but instead employs chlorophyll *a*, a plant pigment used by algae to convert sunlight energy into food energy, as a direct measure of algae growth and an indicator of eutrophication. The state has established water quality standards for NSW designated waters to address isolated eutrophication problems.

The basin's designation as NSW and the results of the nutrient budget, prompted the Division of Environmental Management (DEM) to propose a year-round phosphorus effluent limit and a seasonally varying nitrogen limit for new and expanding wastewater treatment plants to mitigate the growing nutrient problem. The effluent limits proposed by the DEM were: 2mg/l for phosphorus year round; 4mg/l for nitrogen in summer; and 8mg/l for nitrogen in winter.[5] At that time, both phosphorus and nitrogen effluent levels in the basin were higher than the proposed limits. Total phosphorus effluent concentrations ranged from 0.7 to 3.35 mg/l, with a basinwide average of 2.25 mg/l. Total point source nitrogen concentrations ranged from 5.4 to 22.95 mg/l, with a basinwide average of 14.38 mg/l.[6] It was anticipated that these limits would result in the desired water quality improvements.

Several dischargers, anticipating needed expansions in the future, expressed concern over the potentially high costs of achieving the specified limits proposed by the DEM. A preliminary estimate indicated that facilities in the basin would spend between $50 and $100 million

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[4]The state's NSW designation applies to waters that are experiencing or are subject to excessive vegetative growth that impairs the best usage of the water.

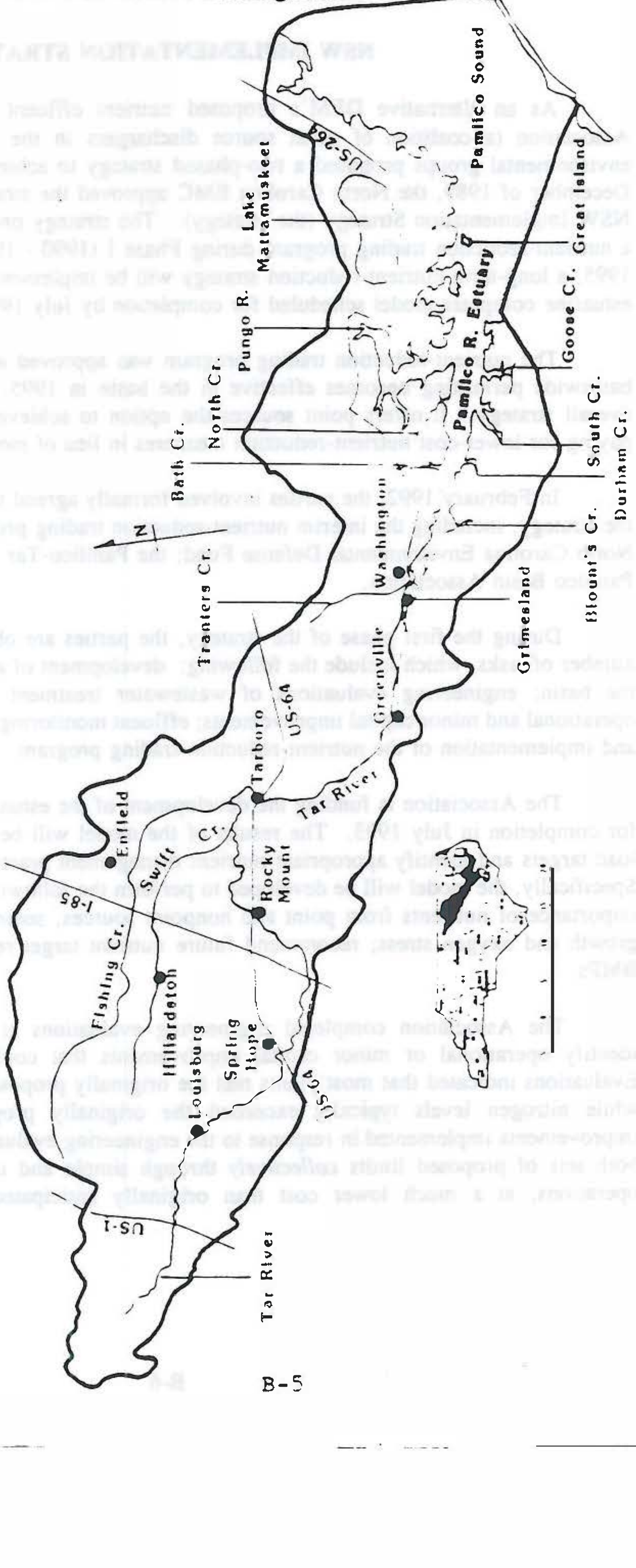
[5]*Tar Pamlico River Basin Nutrient Sensitive Waters Designation and Nutrient Management Strategy*, North Carolina Department of Natural Resources and Community Development, Division of Environmental Management. April 1989 (Report 89-07).

[6] Ibid.

improving plants to meet the state-proposed effluent limitations.[7] These high cost estimates reflect the fact that some treatment facilities do not have biological treatment capabilities, and would face expensive upgrades to meet effluent limitations.

[7] Personal communication, Malcolm Green, General Manager, Greenville Utilities Commission, and Chair, Tar-Pamlico Basin Association, July 31, 1991.

Map B-1: Tar-Pamlico Drainage Basin



NSW IMPLEMENTATION STRATEGY

As an alternative DEM's proposed nutrient effluent limits, the Tar-Pamlico Basin Association (a coalition of point source dischargers in the basin), and state and regional environmental groups proposed a two-phased strategy to achieve nutrient-reduction goals. In December of 1989, the North Carolina EMC approved the strategy as the formal Tar-Pamlico NSW Implementation Strategy (the strategy). The strategy provides for, among other things, a nutrient-reduction trading program during Phase I (1990 - 1994). In Phase II, beginning in 1995, a long-term nutrient-reduction strategy will be implemented based upon the results of an estuarine computer model scheduled for completion by July 1993.

The nutrient-reduction trading program was approved as both an interim strategy until basinwide permitting becomes effective in the basin in 1995, and as an integral part of the overall strategy. It offers point sources the option to achieve the desired reduction goal by paying for lower-cost nutrient-reduction measures in lieu of more costly capital improvements.

In February 1992, the parties involved formally agreed to the terms of the first phase of the strategy, including the interim nutrient-reduction trading program. They are: the DEC; the North Carolina Environmental Defense Fund; the Pamlico-Tar River Foundation; and the Tar-Pamlico Basin Association.

During the first phase of the strategy, the parties are obligated to a fulfill their role in number of tasks, which include the following: development of an estuarine computer model for the basin; engineering evaluations of wastewater treatment plants and implementation of operational and minor capital improvements; effluent monitoring of wastewater treatment plants; and implementation of the nutrient-reduction trading program.

The Association is funding the development of the estuarine computer model scheduled for completion in July 1993. The results of the model will be used to establish total nutrient load targets and identify appropriate nutrient management practices in Phase II of the strategy. Specifically, the model will be developed to perform the following functions: assess the relative importance of nutrients from point and nonpoint sources, sediments, and atmosphere to algal growth and oxygen stress; recommend future nutrient target reductions; and track and target BMPs.

The Association completed engineering evaluations at individual member plants to identify operational or minor capital improvements that could reduce nutrient discharges. Evaluations indicated that most plants met the originally proposed phosphorus limit of 2 mg/l, while nitrogen levels typically exceeded the originally proposed limits. However, the improvements implemented in response to the engineering evaluations allowed plants to achieve both sets of proposed limits *collectively* through simple and inexpensive changes to current operations, at a much lower cost than originally anticipated. Because only two larger

Association member plants have nitrogen removal capability, they will likely face the bulk of nitrogen removal burden required under the adopted strategy.[8]

Association members are responsible for monitoring their phosphorus and nutrient loadings and submitting a composite annual report to DEM every March 1 detailing data results for the previous calendar year. The March 1, 1992 report included monitoring data for the period January 1 - December 31, 1991. These annual reports will be used to determine the level of compliance with the strategy.

The interim nutrient-reduction trading program's administrative framework is in place and annual loading allowances for the twelve-member Association have been set for the calendar years 1991 - 1994.[9] If the nutrient discharges of Association member facilities exceed the loading allowance, they must contribute to the nonpoint source reduction fund. The Association has not yet initiated trading -- funding lower cost nonpoint source controls to offset discharges above an allowable load -- because the Association's loading has not exceeded its allowance as specified by the strategy. The agreement does, however, include a requirement for funding a minimum level of BMPs each year. The ability of the Association to achieve a nutrient loading level below their specified allowance in the first year of the NSW Strategy (1991) was primarily a consequence of operational improvements and minor capital investments that members agreed to implement in response to engineering evaluations. The Association's 1991 nutrient load was approximately 13 percent below their loading allowance for that year.[10]

Existing non-Association members that expand their operations are subject to the effluent limitations originally proposed by DEM. The Tarboro plant, a non-Association member, recently expanded and its new permit reflects these limits. Non-Association members do have the option to participate in the trading program, and may obtain nutrient-reduction credits, but at a higher cost per nutrient credit than Association members. New dischargers are subject to the most stringent effluent limitations and do not have the option to participate in the trading program.

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[8]*Nutrient Removal Study*, March 1991. Tar-Pamlico Basin Association, Inc. p.5-1.

[9]National Spinning, an industrial discharger, is a member of the Association. However, the facility's discharges are not incorporated in the calculation of the Association's loading of total nutrients

[10]Personal Communication with Beth McGee, North Carolina Department of Environment, Health, and Natural Resources, Division of Environmental Management, March 23, 1992.

NUTRIENT TRADING PROGRAM DETAILS

Nutrient Reduction Goal

The nutrient reduction goal of the NSW Strategy reflects the nutrient reduction level that would have presumably been achieved through the originally proposed effluent limits -- facilities expanding their flow capacity to 0.5 million gallons per day or greater would have been subject to effluent limits for nitrogen and phosphorus. The originally proposed effluent limits were calculated based on concentration limits and projected flows for three facilities planning to expand before 1995, and would have resulted in a total nutrient reduction of 200,000 kilograms.[11] Thus, the Association's nutrient reduction goal for 1994 (the last year of the NSW Strategy Phase I) was set at 200,000 kilograms.

Allowable Nutrient Loading

It was determined that the Association's total nutrient load would reach 625,000 kg/yr by 1994 in the absence of nutrient loading restrictions or effluent limits.[12] To achieve the Association's nutrient reduction goal of 200,000 kg/yr, a declining schedule of total load allowances for the calendar years 1991-1994 is incorporated in the NSW Strategy, culminating with a maximum load allowance of 425,000 kg in 1994 -- 200,000 kg below the baseline estimation. The annual loading allowance schedule for the Association is as follows: 525,000 kg/yr in 1991; 500,000 kg/yr in 1992; 475,000 kg/yr in 1993; and 425,000 kg/yr in 1994.

Association members include twelve POTWs, which are considered a single unit for nutrient reduction accounting purposes.[13] There will be no new members admitted to the Association during Phase I (1991 - 1994) because annual load allowances were calculated based on the projected flow and nutrient load of the facilities that were members when the strategy was

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[11] *Tar-Pamlico NSW Implementation Strategy*, December 14, 1989. State of North Carolina Department of Environment, Health, and Natural Resources, Division of Environmental Management, in July 1, 1991 memo from David Harding. Also, personal communication with Steve Levitas, Environmental Defense Fund. June 28, 1991; Doug Rader, Environmental Defense Fund. July 1, 1991; Steve Tedder, North Carolina Division of Environmental Management. July 2, 1991.

[12] Based on a projected 1994 flow of 30.555 MGD.

[13] The twelve POTW member facilities include: Belhaven, Bunn, Enfield, Franklin Water and Sewer Authority, Greenville, Louisburg, Oxford, Pine Tops, Rocky Mount, Spring Hope, Warrenton, and Washington. National Spinning is also a member of the Association. While it may contribute to nonpoint source nutrient reduction fund, its nutrient discharges are not incorporated in the Association's annual loading calculation.

approved. Association membership may be reopened in Phase II to other nutrient dischargers.[14]

The Association's total nutrient load did not exceed its allowance in 1991, averting the need to obtain nutrient reduction credits through the trading program. Operational improvements and minor capital investments that members agreed to implement in response to engineering evaluations resulted in a total 1991 nutrient load approximately 13 percent below their allowance.[15] However, the Association's nutrient load allowance will gradually decrease over the next three years of Phase I, as it approaches the 200,000 kg/yr reduction target. As the Association's nutrient load approaches and exceeds its allowance, trading to obtain nutrient reduction credits and offset discharges above the allowance should become an increasingly cost-effective means for the Association to maintain compliance.

Trading Specifications

The trading program provides the Association the opportunity to achieve its nutrient reduction goal by paying for lower cost nonpoint source nutrient reduction control measures as an alternative to costly plant upgrades. Within the Tar-Pamlico Basin, agricultural best management practices (BMPs) provide low-cost methods to reduce nutrient loading, and typically include such controls as grassed waterways and livestock manure treatment lagoons.

If the Association's total nutrient load should exceed its load allowance in any remaining years of Phase I, it must offset the excess discharge by obtaining nutrient reduction credits through monetary contributions to the state Agricultural Cost Share Program for BMPs in the Tar-Pamlico Basin. Nonpoint source credit is available to the Association at a rate of $56 per kilogram of nutrient per year, and to non-Association members at a rate of $62 per kilogram of nutrient per year -- their permitted effluent limits will be adjusted accordingly.[16] The BMP cost equivalent per kilogram of nutrient reduction per year was derived from nonpoint source control experiences in the Chowan River Basin. The cost includes a safety factor or 3:1 for cropland BMPs and 2:1 for animal BMPs.

Nutrient reduction credits for BMPs have a useful life of ten years unless otherwise specified by the Department of Soil and Water Conservation under the trading program. The assignment of a useful life to credits assumes that BMPs, funded through the cost share program in exchange for nutrient reduction credits, will effectively control nonpoint source nutrient loadings for ten years. A monetary contribution to reducing nonpoint source nutrient loading is therefore recognized in the year the contribution is made, as well as the following nine years. The implication is that at a credits expiration of life, it will have to be re-purchased or renewed.

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[14] Tar-Pamlico NSW Implementation Strategy, Revised February 13, 1992.

[15] Personal communication with Beth McGee, North Carolina Department of Environment, Health, and Natural Resources, Division of Environmental Management, March 23, 1992.

[16] Tar-Pamlico NSW Implementation Strategy, Revised February 13, 1992.

The assignment of a ten year useful life to credits is based on the assumption that the trading program will continue beyond Phase I.

BMP Payments

To ensure the availability of funds for agricultural BMP implementation through the nutrient-reduction trading program, the Association will make a minimum payment to the Agricultural Cost Share Program each year. Minimum payments during the Phase I period will total $500,000. In the event that the Association's annual payment for excess nutrient loading amounts to less than the scheduled minimum payment, the Association will supplement the annual excess loading payment to account for the difference. The Association will receive credit for minimum payments and excess loading payments made in prior years to account for the ten year useful life of nutrient reduction credits.

The Association's annual payment to the nonpoint source nutrient reduction fund will be the greater of: (1) the scheduled minimum payment; or (2) the excess loading payment. The calculation for determining the Association's excess loading payment, which takes into account prior minimum and excess loading payments that were made to the fund in exchange for credits whose life has not expired, is displayed below.

Excess Loading Payment = [Actual Loading (kg/yr) - Allowable Loading (kg/yr) x $56 (kg/yr)] - [Prior Payments (minimum and excess loading)]

Association's Allocation of Costs and Loading Allowance

Basin Association members have determined operating rules and financial obligations among the themselves. Program cost allocations to date have been a function of individual members' permitted flows, as a percentage of the Association's aggregate permitted flow. Because the Association was able to meet their loading allocation in 1991 (525,000 kg) through operational improvements and minor capital investments, it was not necessary to allocate the loading allowance among member facilities, nor was the Association required to make an excess loading payment for that year. The Association estimated that its total nutrient loading level would have exceeded the 1991 allowance by approximately 38 percent (200,000 kg) if minor operational and capital improvements had not been made. Instead, it managed to reduce nutrient loading to 13 percent below the allowance.[17]

As the Association's total nutrient load approaches its declining annual allowances in Phase I, allocation of the allowance and/or costs to offset discharge levels exceeding the allowance will be determined in the same manner as are program and membership costs presently -- based on members' permitted level as a percentage of the Association's aggregate permitted level.

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[17] Personal communication with Beth McGee, North Carolina Department of Environment, Health, and Natural Resources, Division of Environmental Management, March 23, 1992.

Non-Association Members

Existing non-Association member facilities that expand their design flows to 0.5 million gallons per day or greater are subject to nutrient effluent limits rather than constraints on their total nutrient discharge levels. They are subject to the effluent limits originally proposed by the DEM for expanding facilities -- 2 mg/l total phosphorus, and 4 mg/l (summer) and 8 mg/l (winter) total nitrogen. These facilities may also participate in the nutrient-reduction trading program, subjecting themselves to less stringent limitations by contributing to the nutrient-reduction fund. Their effluent limits will be adjusted based upon contributions to the cost share fund, where 1 kilogram of reduction credit is available to them at a rate of $62/kg/yr. A one-time up-front payment to the fund is required, and calculated as follows:

BMP Payment($) = *New Design Flow (MGD) x Excess Nutrients (mg/l) x $62/kg/yr x Conversion Factor.*

where:

Excess Nutrients = *(Total Phosphorus Limit - 2 mg/l) + (Total Nitrogen Limit - 6 mg/l)*

Conversion Factor = *1382*

New facilities will be subject to effluent permit limitations *similar* to those originally proposed by the DEM. New facilities with design flows of .05 million gallons per day or greater are limited to 2 mg/l total phosphorus. New facilities with design flows of 0.1 million gallons per day or greater are limited to 2 mg/l total phosphorus, and 4 mg/l (summer) and 8 mg/l (winter) total nitrogen. New dischargers cannot participate in the nutrient-reduction trading program.

NSW STRATEGY ADMINISTRATIVE FRAMEWORK

The success of the NSW Implementation Strategy, and the nutrient reduction trading program in particular, will require cooperation between several state agencies as well as the Basin Association. The Division of Soil and Water Conservation (DSWC), part of the Department of Environment, Health and Natural Resources (DEHNR), is the state's lead agency for agricultural nonpoint source pollution under the Clean Water Act Section 319, and oversees the existing Agricultural Cost Share Program. Under the cost share program, funds are allocated to local Soil and Water Conservation Districts which enter into voluntary contracts with farmers to implement state-authorized BMPs. The program provides funding, instruction, and technical assistance to farmers in this effort. Through the existing cost share program, the Division of Soil and Water Conservation (DSWC) will administer funds generated by the nutrient-reduction trading program, allocating and targeting them within the Tar-Pamlico Basin. The DSWC will prioritize funding to BMPs that have the highest potential and efficiency for nutrient removal.[18]

Rather than establish a competing program, contributions from the trading program will augment existing nonpoint source controls in the watershed. Consistent with the existing cost share program, these funds will cover 75% of the cost of BMPs. Both the State DSWC and local Soil and Water Conservation Districts will have important roles in BMP selection, installation, evaluation, and financial management under the cost share program. The Association has already provided $150,000 to the DSWC for two additional staff positions. These employees will begin tracking, targeting, administering and implementing BMPs.

The Division of Environmental Management (DEM) maintains responsibility for National Pollutant Discharge Elimination System (NPDES) permits and appropriate nutrient levels. The DEM serves as staff to the Environmental Management Commission (EMC), a 17 member governing board appointed by the governor. In addition to NPDES permitting, DEM's responsibilities with respect to the Tar-Pamlico nutrient-reduction trading program include:

- final decision-making authority as to the adequacy of nutrient tradeoff and allocations;
- compliance monitoring;
- tracking of nutrient reduction progress;
- monitoring surface water quality;
- assisting DSWC in choosing small watersheds to target for BMP implementation;
- determining funding levels contributed to the BMP fund and the status of BMP control; and,

[18] Tar-Pamlico NSW Implementation Strategy, Revised February 13, 1992.

- requiring individual point sources to remove nutrients where a localized water quality problem exists.

The Association is responsible for meeting its annual nutrient loading allowance through reduced plant discharges or offsetting excess discharges with BMP funding. To date, the Association has contributed $400,000 for the development of a basinwide nutrient computer model which will serve as the basis for developing Phase II of the strategy, and $150,000 for additional staff positions at DSWC to establish a tracking system for existing and installed BMPs.

The approved NSW Strategy also provides for the creation of an ad-hoc advisory committee to address nonpoint source and related water quality issues within the Tar-Pamlico Basin. The Secretary of the DEHNR will appoint the committee, which will include representatives from municipal dischargers, counties, Soil and Water Conservation Districts, environmental groups, the DEM and DSWC, the state Agricultural Task Force, and other state agencies.

Enforcement and Compliance[19]

Because Association dischargers are considered one unit, the nutrient reduction-trading program will not be successful should the collective group fail to meet the annual loading allowance or offset excess loadings through sufficient BMP funding. Should the terms of the Phase I agreement be violated, all existing facilities with design flows of 0.1 million gallons per day or greater (which includes all Association facilities) would be subject to the same effluent limits as new facilities -- total phosphorus of 2 mg/l and total nitrogen of 4 mg/l (summer) and 8 mg/l (winter) -- within three years from the date of EMC action following the strategy's failure. These limits would be potentially more stringent than the constraints imposed on most facilities under the NSW Strategy. The Association, therefore, faces strong incentives for compliance and self-enforcement.

New dischargers will be restricted by an additional requirement in the event that agreement terms are violated. All new dischargers will be required to evaluate non-discharge alternatives as their primary option, and implement a non-discharge system unless they can demonstrate that it is technically or economically infeasible. If implementation of a non-discharge system is not feasible, new facilities will then be subject to the same effluent limits as those stipulated in the strategy. New facilities with design flows of .05 million gallons per day or greater will be limited to 2 mg/l total phosphorus. New facilities with design flows of 0.1 million gallons per day or greater will be limited to 2 mg/l total phosphorus, and 4 mg/l (summer) and 8 mg/l (winter) total nitrogen.

The Association is not involved in the implementation of nonpoint source controls beyond the point of providing nutrient reduction funds to the cost share program. The Association has no responsibility or authority to ensure that BMPs funded through trading are either implemented

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[19] Tar-Pamlico NSW Implementation Strategy, Revised February 13, 1992.

correctly or maintained. Furthermore, it does not have any input as to specific locations for BMP implementation within the basin. The DSWC is responsible for targeting and implementing BMPs, and it relies heavily on local Soil and Water Conservation District officials to make inspections of BMP projects, and work with farmers to assure compliance.

This arrangement relieves the Association from the risk of *noncompliance* if the BMPs are not successful in achieving nutrient load targets. If there is a localized nutrient water quality problem, however, individual members of the Association are at risk of the DEM instituting more stringent effluent limits on them, regardless of their participation in the Association and monetary contributions to the BMP fund.

CONCLUSION

The primary achievements of the Tar-Pamlico nutrient reduction strategy thus far are the initiation of the estuarine computer model's development from which nutrient reduction goals can be refined, the design of a trading program that will facilitate the most efficient means of reducing nutrients to attain established goals, and initial nutrient loading reductions through operational and minor capital improvements to POTWs.

The estuarine computer model will establish a meaningful baseline from which nutrient loading goals will be established. The results of the model will serve as the basis for modifying the nutrient reduction strategy as factors and conditions change in the future.

The institutional framework to support point/nonpoint source nutrient reduction trades is in place. Under the trading program, Association members are recognized as a single unit and are subject to an agreed upon annual nutrient loading allowance, rather than the effluent limits that govern non-Association members individually. If the Association exceeds its loading allowance, it may offset its excesses by funding nonpoint source nutrient reduction controls.

The terms and allowances of the trading program will apply during an interim period while the computer model is completed. However, as the nutrient reduction strategy evolves into its second phase, point/nonpoint source trading is expected to remain an important component.

Engineering evaluations of Association member facilities, required under the terms of the strategy, revealed that plants could reduce nutrient loadings through operational and minor capital improvements, at a substantially lower cost than originally estimated. Association members implemented most of the recommended improvements, and further benefitted by joining together to collectively meet the nutrient loading allowance cap. The Association estimated that its total nutrient loadings would have exceeded the 1991 allowance by approximately 38 percent if operational and minor capital improvements were not made. As a result of the improvements, however, the Association's loadings were 13 percent below their 1991 allowance.[20]

In addition, the establishment of an administrative structure for a trading program will be particularly important in achieving water quality objectives in a timely fashion, in the event that stringent nutrient discharge targets are established as a result of the nutrient model.

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[20] Personal communication with Malcolm Green, General Manager, Greenville Utilities Commission, and Chair, Tar-Pamlico Basin Association, March 18, 1992.

Prospects for Success

Overall, the nutrient reduction strategy has already achieved some degree of effectiveness, and shows potential for future improvement of the water quality in the Tar-Pamlico Basin.

The ability of the Association to reduce nutrient loadings below their 1991 allowance (through minor operational and capital improvements) does not explicitly imply that trading will not occur during the first phase of the nutrient reduction strategy. The Association's nutrient load allowance will gradually decline over the next three years of Phase I, culminating in a nutrient reduction target of 200,000 kg/yr. If the Association's load approaches, or exceeds its allowance, trading to obtain nutrient reduction credits or offset discharges above the allowance will be the most cost-effective method of maintaining compliance with the terms of the nutrient reduction strategy agreements.

However, the trading program raises some questions with regard to the implementation, enforcement and targeting of nonpoint source controls, including the implementation of BMPs through the North Carolina Agricultural Cost Share Program, enforcement and reliability of BMPs, and targeting BMPs for funding. The discussion below identifies the potential drawbacks and possible mitigation strategies.

Implementation of BMPs through the Agricultural Cost Share Program[21]

A potential problem with the cost share approach is that farmers will most likely participate only to the degree that private returns from a conservation investment exceed private costs. However, profitability is not the only criteria that will determine farmer participation in the voluntary program -- compliance with other regulations will factor into their decision.

Cost share funds cover 75 percent of the *average* cost of BMPs -- based on statewide averages, not individual projects. As a result, some BMPs for some farmers may prove to be profitable, while others may be more costly to farmers than anticipated. In adverse economic conditions, costly BMPs could be abandoned. Insulating water quality improvement from economic cycles will be more difficult when attainment is dependent on potentially costly voluntary nonpoint source controls.

Enforcement and Reliability of BMPs

Under the framework of the cost share program, the DSWC relies heavily on local Soil and Water Conservation Districts to work with farmers to ensure that BMPs are implemented correctly and maintained. Even if implemented and maintained correctly, the effectiveness of

[21] *North Carolina Agriculture Cost Share Program for Nonpoint Source Pollution Control*, May 1987. North Carolina Department of Natural Resources and Community Development, Division of Soil and Water Conservation. North Carolina Administrative Code Title 15, Chapter 6, Section 6E.

nonpoint source nutrient controls is more difficult to measure and monitor than that of point source nutrient controls. These factors incorporate a degree of uncertainty about the benefits derived from BMPs

The uncertainty associated with funding BMPs poses a risk to Association members. With no recourse to enforce BMPs, and no guarantee that they will result in the projected water quality improvement, Association members are at risk of the DEM instituting and enforcing more stringent effluent limits. If this risk is factored into the Association's decision as to how they can meet the loading allowance, they may choose to fund the expansion of an existing member facility. Although this option may cost more initially, the Association would have control of the facility's removal capability, and thus greater certainty that water quality standards would be achieved.

Targeting BMPs for Funding

While the DEM can *assist* the DSWC in choosing small watersheds to target for implementation of BMPs funded through the trading program, it does not have explicit *authority* to specify BMP locations (nor does the Association), making it difficult to ensure improvement of local nutrient levels within the large Tar-Pamlico Basin.

Just as the DEM takes the lead in regulatory enforcement of point sources, the DSWC is responsible for regulatory compliance issues relating not nonpoint source controls. The DSWC's responsibilities under the cost share program, and thus the Tar-Pamlico nutrient reduction strategy include targeting, implementing, and evaluating BMPs. Implicit in these responsibilities is the management of the BMP fund reserved for BMPs in the Tar-Pamlico River Basin. The DSWC relies heavily on local Soil and Water Conservation District officials to make inspections of BMP projects, and work with farmers to assure compliance.

If local water quality problems arise within the basin, individual point sources may be subject to effluent limits that are more constraining than their current effluent limits, or allocation of the loading allowance as an Association member. DEM maintains the authority to impose effluent limits on individual point sources if the local situation warrants such action. The Association's lack of authority to target BMPs and the possibility of stricter effluent limits on individual point sources present another uncertainty risk to Association members and facilities interested in trading independently in that there is no guarantee they will not be subject to increasing constraints on nutrient discharges.

Three program modifications could help alleviate this problem. First, the DEM, in conjunction with cost share program managers, could develop a list of potential nonpoint source reduction sites and prioritize them according to the severity of the nutrient problem in local waters near the site. The DSWC would then be obligated to implement BMPs funded with Association monies at locations where local nutrient problems are either severe, or would otherwise not be corrected. Second, to help implement the priority list, the program could develop incentives for the dischargers and the cost share program to fund priority sites. And third, local Water and Soil Conservation District officials could be required to perform annual spot checks on all BMPs implemented with funds from the Association, rather than on 5 percent, which is the standard procedure under the existing cost share program. These modifications, however, do not fully resolve the potential that point source dischargers may incur stricter permit requirements if anticipated benefits from BMPs are not fully realized.

Lessons from Tar-Pamlico

The DEM, point source dischargers, and environmental groups will be evaluating the trading program in the Tar-Pamlico Basin as a trial for future statewide application in North Carolina. The Neuse River Basin, a neighboring watershed, will begin basinwide permitting in 1993 using only traditional technology-based effluent standards and end-of-pipe controls and nonpoint source programs. Experiences in the two basins should provide a good comparison of the benefits and drawbacks of the trading and traditional approach to nutrient reduction. Even if water quality conditions in the Tar-Pamlico Basin do not lead to trading in the near future, the Tar-Pamlico experience to date holds several lessons for other basins in North Carolina and elsewhere that may be considering point/nonpoint source trading.

- An unusual coalition of traditional adversaries came together to develop Tar-Pamlico's nutrient trading program as a creative approach to overcoming water quality problems. Support from interested parties, particularly the regulated community, has traditionally been an important element in successful pollution control programs.

- The engineering evaluation of the dischargers' facilities showed that the basin could achieve significant nutrient reductions through simple and relatively inexpensive plant modifications. This is an important condition of the trading program because it provides the regulator and the regulated with better information about what types of reductions are available at what cost. It also establishes an accurate marginal cost basis for trades, providing a starting point from which to develop appropriate nutrient reduction targets and reduction credit fees.

- Cooperation between the Association of point sources discharges and the state thus far has benefitted all parties. The terms of the nutrient reduction strategy exempted Association members from increasingly stringent effluent limits in Phase I (1991-1994). The imposition of these limits would have required expensive capital cost improvements. In return for this exemption, the Association agreed to evaluate engineering practices and make minor improvements as recommended by nutrient reduction specialists, fund the development of the estuarine computer model, fund two additional staff positions at the DSWC, and contribute minimum payments to the BMP fund. The Association's contributions directly benefit the state. These benefits are already being realized -- Association members reduced their loadings significantly due to operational and minor capital improvements, funding for positions at the DSWC has enabled them to begin tracking and targeting BMPs, and the Association's funding of the estuarine computer model has relieved the state of this burden. The state will realize future benefits when BMPs funded by the

Association in exchange for nutrient reduction credits (excess loading or minimum payments) will generate further nutrient reductions in the basin.

- Cooperation among state agencies has also facilitated the development of an effective nutrient management strategy. The DEM and DSWC, both divisions of the Department of Environment, Health and Natural Resources, have complementary responsibilities in the trading program. The DEM is responsible for matters pertaining to the maintenance of water quality and regulatory oversight of sources contributing to water quality degradation. Although the DEM may assist the DSWC in targeting BMPs it does not have the final decision-making authority in this determination. However, the DEM does have final decision-making authority as to the adequacy of nutrient tradeoff and allocations.

APPENDIX C

WATER BODY SYSTEM 305(b) DATA: WATERBODIES FOR WHICH POINT/NONPOINT SOURCE NUTRIENT TRADING APPEARS APPLICABLE NOW

WaterBody System Report
List of WaterBodies

OBS	WBID	WBNAME	WBCOUNT	WBTYPE	WBSIZE	WBUNIT
1	AZ15020010-006	Chevelon Creek, Chevelon Ck. W. Chevelon Ck.	Coconino	RPR	50.0	M
2	AZ15020010-011	Black Canyon Creek, Pierce Wash-B	Navajo	RRRR	2.2	M
3	AZ15040004-023	San Francisco River, San Francisco R.-Border	Greenlee	RER	9.0	M
4	AZ15060103-005	Pinal Creek, Pinal Creek-Salt River	Gila	RRR	17.6	M
5	AZ15060103-005DF113	Miami Wash, Miami Wash Bloody Tank Wash	Gila	RRR	2.7	M
6	AZ15060103-005DF113DF111	Bloody Tanks Wash, Bloody Tanks W. Miami Wash	Gila	RRR	7.6	M
7	AZ15060202-010	Dry Beaver Creek, Jack Canyon Beaver Ck.	Yavapai	RRR	13.0	M
8	AZ15060202-011	Dry Beaver Creek, Rattlesnake Jack Canyon	Yavapai	RPR	3.3	M
9	AZ15060202-015	Dry Beaver Creek, Dry Beaver Ck. Rattlesnake	Yavapai	RRR	8.9	M
10	AZ15060202-021	Dry Creek, Dry Creek Oak Creek	Coconino	RRR	10.3	M
11	AZ15060202-025DF116	Diller Creek, Diller Ck Verde River	Yavapai	RRR	5.0	M
12	AZ15060202-050	Granite Creek, W Verde River	Yavapai	RPR	5.5	M
13	AZ15060203-022	East Verde River, East Verde River-Verde R.	Gila	RPR	41.5	M
14	AZ15070201-014	Gila River, Painted Rock-4th July	Maricopa	REN	3.3	M
15	CT0000-E	LONG ISLAND SOUND		E	492.5	S
16	CT3000-E	THAMES RIVER ESTUARY		E	14.1	S
17	CT3300	FRENCH RIVER		R	6.0	M
18	CT3700	QUINEBAUG RIVER		R	40.0	M
19	CT4303	STILL RIVER		R	9.0	M
20	CT4315	PEQUABUCK RIVER		R	13.0	M
21	CT4500	HOCKANUM RIVER		R	17.0	M
22	CT5200	QUINNIPIAC RIVER		R	25.0	M
23	CT5200-E	NEW HAVEN HARBOR		E	26.1	S
24	CT6000	HOUSATONIC RIVER		R	71.0	M
25	CT6000-00-5+-L1	LILLINONAH,LAKE SOUTHBURY, BRIDGEWATER	LITCHFIELD	L	1900.0	A
26	CT6000-00-5+-L2	ZOAR, LAKE NEWTOWN MONROE	LITCHFIELD	L	975.0	A
27	CT6000-00-5+-L4	HOUSATONIC,LAKE SHELTON	FAIRFIELD	L	328.2	A
28	CT6600	STILL RIVER		R	21.0	M
29	CT7001-E	BLACKROCK HARBOR		E	0.8	S
30	CT7002-E	BRIDGEPORT HARBOR		E	10.8	S
31	CT7300-E	NORWALK HARBOR		E	4.0	S
32	CT7405-E	STAMFORD HARBOR		E	1.4	S
33	CT7409-E	GREENWICH HARBOR		E	0.2	S
34	DCPMS10E	MIDDLE POTOMAC DC		E	1.3	S
35	DE060-002	BEAVERDAM CREEK	SUSSEX	R	7.1	M
36	DE060-005	INGRAM BRANCH	SUSSEX	R	5.9	M
37	FL 03070204030	AMELIA RIVER		E	3.5	S
38	FL 03070204031	AMELIA ISLAND		E	5.1	S
39	FL 03070205009	AMELIA ISLAND		E	5.1	S
40	FL 03070205903	MILLS CREEK		R	7.4	M
41	FL 03080103004	LAKE GEORGE		L	42.5	S
42	FL 03080101010	LAKE WOODRUFF		L	2.4	S
43	FL 03080101022	LAKE MONROE		L	6.4	S
44	FL 03080101023	LAKE MONROE		L	7.8	S
45	FL 03080101051	LAKE HARNEY		L	6.8	S
46	FL 03080101034	ECONLOCKHATCHEE RIVER		R	12.3	M
47	FL 03080101035	LITTLE ECONLOCKHATCHEE RIVER		R	15.5	M
48	FL 03080101907	GEE CREEK		R	4.4	M
49	FL 03080102019	LAKE GRIFFIN		L	13.1	S
50	FL 03080102020	LAKE GRIFFIN		L	0.8	S
51	FL 03000102021	LAKE GRIFFIN		L	0.5	S
52	FL 03080102026	HAINES CREEK		R	6.2	M
53	FL 03080102028	LAKE EUSTIS		L	1.2	S
54	FL 03080102029	LAKE EUSTIS		L	0.5	S
55	FL 03080102032	LAKE DORA		L	0.6	S

WaterBody System Report
List of WaterBodies

OBS	WBID	WBNAME	WBCOUN	WBTYPE	WBSIZE	WBUNIT
56	FL 03080102033	APOPKA-BEAUCLAIR CANAL		R	7.6	M
57	FL 03080102034	LAKE APOPKA		L	50.8	S
58	FL 03080103003	ST JOHNS RIVER		E	12.8	S
59	FL 03080103008	ST JOHNS RIVER		E	3.8	S
60	FL 03080103012	RIBAULT RIVER		R	5.5	M
61	FL 03080103014	ST JOHNS RIVER		E	4.3	S
62	FL 03080103015	ST JOHNS RIVER		E	2.1	S
63	FL 03080103017	ST JOHNS RIVER		E	3.6	S
64	FL 03080103018	ST JOHNS RIVER		E	2.9	S
65	FL 03080103022	ST JOHNS RIVER		E	21.8	S
66	FL 03080103066	CRESCENT LAKE		L	0.7	S
67	FL 03080103908	FISHING CREEK		R	3.6	M
68	FL 03080103909	CEDAR RIVER (OFF ORTEGA RIVER)		R	9.1	M
69	FL 03080103910	BUTCHER PEN CREEK		R	1.4	M
70	FL 03080103912	MILLS BRANCH		R	6.1	M
71	FL 03080201003	MATANZAS RIVER (ICWW)		E	2.5	S
72	FL 03080201015	PONCE DE LEON INLET		E	1.9	S
73	FL 03080201016	ICWW (HALIFAX RIVER)		E	49.1	S
74	FL 03080202002	INDIAN RIVER		E	73.2	S
75	FL 03080202004	INDIAN RIVER		E	44.5	S
76	FL 03080202908	INDIAN RIVER		E	62.3	S
77	FL 03080202909	INDIAN/BANANA RIVER/SYKES CREEK		E	58.5	S
78	FL 03080202911	INDIAN RIVER		E	34.8	S
79	FL 03080202914	CRANE CREEK		R	3.0	M
80	FL 03080203004	SOUTH INDIAN RIVER		E	7.4	S
81	FL 03090101016	LAKE HATCHINEHA		L	1.9	S
82	FL 03090101020	CYPRESS LAKE		L	4.9	S
83	FL 03090101021	CYPRESS LAKE		L	1.1	S
84	FL 03090101022	CYPRESS LAKE		L	0.8	S
85	FL 03090101026	LAKE TOHOPEKALIGA		L	10.8	S
86	FL 03090101027	LAKE TOHOPEKALIGA		L	6.6	S
87	FL 03090101033	SHINGLE CREEK		R	21.7	M
88	FL 03090101036	REEDY CREEK		R	1.7	M
89	FL 03090101911	LAKE RUSSELL		L	1.2	S
90	FL 03090102001	TAYLOR CREEK		R	21.3	M
91	FL 03090202906	N FORK, NEW RIVER, BELOW S-33		R	6.7	M
92	FL 03090202921	HILLSBORO CANAL/L-14,15,39		R	53.0	M
93	FL 03090202922	N NEW R CAN/L-18,19,20,35,38		R	67.0	M
94	FL 03090202959	ST LUCIE RIVER		E	6.2	S
95	FL 03090202963	PLANTATION CAN, C-12, AB S-33		R	8.6	M
96	FL 03090204905	NAPLES BAY		E	1.5	S
97	FL 03090205003	CALOOSAHATCHEE RIVER		E	10.2	S
98	FL 03090205004	CALOOSAHATCHEE RIVER		E	10.0	S
99	FL 03090205006	CALOOSAHATCHEE RIVER		E	3.1	S
100	FL 03090205007	CALOOSAHATCHEE RIVER		E	3.5	S
101	FL 03090205901	DEEP LAGOON		R	2.4	M
102	FL 03100101005	PEACE RIVER		R	1.5	M
103	FL 03100101006	PEACE RIVER		R	9.3	M
104	FL 03100101010	PEACE RIVER		R	18.2	M
105	FL 03100101020	PEACE RIVER		R	2.7	M
106	FL 03100101021	PEACE RIVER		R	6.9	M
107	FL 03100101022	PEACE RIVER		R	11.9	M
108	FL 03100101024	PEACE RIVER		R	3.9	M
109	FL 03100101025	PEACE RIVER		R	7.2	M
110	FL 03100101026	PEACE RIVER		R	[illegible]	M

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OBS	WBID	WBNAME	WBCOUNT	WBTYPE	WBSIZE	WBUNIT
111	FL 03100101027	BOWLEGS CREEK		R	9.3	M
112	FL 03100101031	PEACE RIVER		R	16.4	M
113	FL 03100101032	PEACE CREEK DRAINAGE CANAL #1		R	27.5	M
114	FL 03100101033	SADDIE CREEK		R	4.2	M
115	FL 03100101034	LAKE HANCOCK		L	6.9	S
116	FL 03100101036	PAYNE CREEK		R	2.2	M
117	FL 03100101045	PEACE RIVER		E	7.4	S
118	FL 03100101049	PEACE RIVER		E	1.3	S
119	FL 03100101050	PEACE RIVER		E	1.4	S
120	FL 03100101916	BANANA LAKE		L	0.8	S
121	FL 03100101918	LAKE PARKER		L	3.6	S
122	FL 03100103001	CHARLOTTE HARBOR		E	23.6	S
123	FL 03100103007	CHARLOTTE HARBOR		E	14.3	S
124	FL 03100103011	CHARLOTTE HARBOR		E	8.4	S
125	FL 03100103018	SANIBEL ISLAND		E	19.6	S
126	FL 03100201007	LITTLE SARASOTA BAY		E	3.5	S
127	FL 03100201008	PHILLIPPI CREEK		R	13.3	M
128	FL 03100201009	SARASOTA BAY		E	19.4	S
129	FL 03100201903	LEMON BAY(EXTENDED)		E	8.1	S
130	FL 03100201910	WHITTAKER BAYOU		E	0.1	S
131	FL 03100204001	ALAFIA RIVER		R	13.2	M
132	FL 03100204003	ALAFIA RIVER		R	4.0	M
133	FL 03100204005	ALAFIA RIVER, SOUTH PRONG		R	6.5	M
134	FL 03100204006	ALAFIA RIVER, NORTH PRONG		R	6.1	M
135	FL 03100205003	FLINT CREEK		R	0.8	M
136	FL 03100205005	LAKE THONOTOSASSA		L	2.5	S
137	FL 03100205006	LAKE THONOTOSASSA		L	1.6	S
138	FL 03100205007	BAKER CREEK		R	7.5	M
139	FL 03100205009	HILLSBOROUGH RIVER		R	2.6	M
140	FL 03100205010	BLACKWATER CREEK		R	7.1	M
141	FL 03100205013	ITCHEPACKASASSA CREEK		R	9.7	M
142	FL 03100206004	HILLSBOROUGH BAY		E	5.3	S
143	FL 03100206006	HILLSBOROUGH BAY		E	3.6	S
144	FL 03100206007	HILLSBOROUGH BAY		E	8.7	S
145	FL 03100206009	HILLSBOROUGH BAY		E	4.2	S
146	FL 03100206009.50	MCKAY BAY		E	2.5	S
147	FL 03100206010	HILLSBOROUGH BAY		E	20.9	S
148	FL 03100206012	OLD TAMPA BAY		E	19.9	S
149	FL 03100206013	SWEETWATER CREEK		R	8.5	M
150	FL 03100206014	OLD TAMPA BAY		E	5.3	S
151	FL 03100206018	OLD TAMPA BAY		E	56.0	S
152	FL 03100206912	CROSS BAYOU CANAL		R	3.8	M
153	FL 03100207902	CROSS BAYOU CANAL		R	2.9	M
154	FL 03110102014	FENHOLLOWAY RIVER		R	12.8	M
155	FL 03110102015	FENHOLLOWAY RIVER		R	16.5	M
156	FL 03110201002	SUWANNEE RIVER		R	23.7	M
157	FL 03110201032	ROARING CREEK		R	6.8	M
158	FL 03110201901	SWIFT CREEK		R	10.9	M
159	FL 03110201902	HUNTER CREEK		R	2.8	M
160	FL 03110206013	NEW RIVER		R	17.6	M
161	FL 03120003010	LAKE TALQUIN		L	2.4	S
162	FL 03120003014	OCHLOCKONEE RIVER		R	1.6	M
163	FL 03120003020	LITTLE RIVER		R	9.4	M
164	FL 03120003023	ATTAPULGUS CREEK		R	4.1	[illegible]
165	FL 03140203014	ALLIGATOR CREEK		R	14.3	[illegible]

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OBS	WBID	WBNAME	WBCOUNTY	WBTYPE	WBSIZE	WBUNIT
166	IA 01-MEN-0010	MISSISSIPPI R	LOUISA	R	87.93	M
167	IA 01-MEN-0030	MISSISSIPPI R	DUBUQUE	R	43.63	M
168	IA 01-MEN-0040	MISSISSIPPI R	CLAYTON	R	41.05	M
169	IA 01-UIA-0100	UPPER IOWA R	ALLAMAKEE	R	14.07	M
170	IA 01-WPS-0010	WAPSIPINICON R	CLINTON	R	67.82	M
171	IA 02-CED-0010	CEDAR R	LOUISA	R	25.33	M
172	IA 02-CED-0020	CEDAR R	MUSCATINE	R	44.69	M
173	IA 02-CED-0030	CEDAR R	LINN	R	48.64	M
174	IA 02-CED-0040	CEDAR R	BLACK HAWK	R	22.93	M
175	IA 02-CED-0050-L	CEDAR FALLS IMPOUNDMENT	BLACK HAWK	R	1.53	M
176	IA 02-CED-0110	CEDAR R	FLOYD	R	48.83	M
177	IA 02-CED-0370	BLACK HAWK CR	BLACK HAWK	R	13.90	M
178	IA 02-IOW-0010	IOWA R	LOUISA	R	25.21	M
179	IA 02-IOW-0020	IOWA R	LOUISA	R	18.37	M
180	IA 02-IOW-0030	IOWA R		R	19.71	M
181	IA 02-IOW-0050	IOWA R	JOHNSON	R	34.17	M
182	IA 02-IOW-0060	IOWA R	TAMA	R	44.15	M
183	IA 02-IOW-0070	IOWA R	MARSHALL	R	48.43	M
184	IA 02-IOW-0080	IOWA R	FRANKLIN	R	29.22	M
185	IA 02-SHL-0020	SHELL ROCK R	FLOYD	R	37.11	M
186	IA 03-SKN-0010	MISSISSIPPI R	LEE	R	34.24	M
187	IA 03-SKU-0010	SKUNK R		R	32.44	M
188	IA 03-SSK-0020	SOUTH SKUNK R	JASPER	R	33.68	M
189	IA 03-SSK-0030	SOUTH SKUNK R	STORY	R	20.40	M
190	IA 04-EDM-0010	DES MOINES R, EAST FK	HUMBOLDT	R	42.29	M
191	IA 04-UDM-0030	DES MOINES R	BOONE	R	43.17	M
192	IA 04-UDM-0040	DES MOINES R	WEBSTER	R	24.52	M
193	IA 04-UDM-0060	DES MOINES R	WEBSTER	R	12.28	M
194	IA 04-UDM-0070	DES MOINES	HUMBOLDT	R	3.44	M
195	IA 04-UDM-0110	BEAVER CR	POLK	R	20.55	M
196	IA 04-UDM-0190	BOONE R	HAMILTON	R	25.14	M
197	IA 06-BSR-0010	BIG SIOUX R	WOODBURY	R	54.19	M
198	IA 06-BSR-0020	BIG SIOUX R	SIOUX	R	37.60	M
199	IA 06-FLO-0010	FLOYD R	WOODBURY	R	19.42	M
200	IA 06-FLO-0020	FLOYD R	PLYMOUTH	R	22.50	M
201	IA 06-LSR-0010	LITTLE SIOUX R	HARRISON	R	15.56	M
202	IA 06-LSR-0020	LITTLE SIOUX R	MONONA	R	63.62	M
203	IA 06-LSR-0030	LITTLE SIOUX R	CHEROKEE	R	54.21	M
204	IA 06-MEN-0010	MISSOURI R	FREMONT	R	39.43	M
205	IA 06-MEN-0020	MISSOURI R	MILLS	R	36.92	M
206	IA-04-LDM-0010	DES MOINES R	LEE	R	68.33	M
207	IA-04-LDM-0020	DES MOINES R	WAPELLO	R	54.12	M
208	IA-04-LDM-0030-L	RED ROCK RESERVOIR	MARION	IH	10400.00	A
209	IA-04-LDM-0040	DES MOINES R	MARION	R	24.17	M
210	IA-04-LDM-0230	SOUTH R	WARREN	R	19.68	M
211	IA-04-LDM-0300	NORTH R	POLK	R	28.64	M
212	IA-04-RAC-0010	RACCOON R	POLK	R	20.63	M
213	IA-04-RAC-0040	RACCOON R, NORTH	GREENE	R	54.88	M
214	IA-04-RAC-0050	RACCOON R, NORTH	SAC	R	19.08	M
215	IA-05-NOD-0010	NODAWAY R	PAGE	R	4.11	M
216	IA-05-NOD-0020	NODAWAY R	PAGE	R	19.28	M
217	IA-05-NSH-0010	NISHNABOTNA R	FREMONT	R	5.51	M
218	IA-05-NSH-0020	NISHNABOTNA R, EAST	FREMONT	R	54.29	M
219	IA-05-NSH-0030	NISHNABOTNA R, EAST	CASS	R	36.64	M
220	IA-05-THO-0010	THOMPSON R	DECATUR	R	18.93	M

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OBS	WBID	WBNAME	WBCOUNT	WBTYPE	WBSIZE	WBUNIT
221	IA 05-RHO-00858-L	Mt. Ayr Old Reservoir	RINGGOLD	L	12.0	A
222	ILBEA01	Muddy Cr.		R	4.9	M
223	ILBED01-D	Dogwood Cr.		R	4.8	M
224	ILBEJC01	Cottonwood Cr.		R	17.5	M
225	ILBEH01-B	Kickapoo Cr.		R	11.1	M
226	ILBEH01-D	Cassel Cr.		R	8.7	M
227	ILBER001	Hackett Branch		R	19.8	M
228	ILBEHC01	Hayes Branch		R	13.2	M
229	ILBER001	Spoil Bank Trib.		R	10.2	M
230	ILBER01	Scattering Fk.		R	14.1	M
231	ILBE01-A	Embarras R.		R	7.9	M
232	ILBE07-A	Embarras R.		R	13.8	M
233	ILBE07-B	Embarras R.		R	16.5	M
234	ILBE07-C	Embarras R.		R	3.7	M
235	ILBE07-D	Embarras R.		R	3.2	M
236	ILBE14-A	Embarras R.		R	5.9	M
237	ILBH01	Mill Cr.		R	32.2	M
238	ILBH02	Sugar Cr.		R	28.5	M
239	ILBPJC06-A	Saline Br.		R	10.3	M
240	ILBPJ03-E	Salt Fk. Vermilion R.		R	12.9	M
241	ILBP01-A	Vermilion R.		R	8.7	M
242	ILBP01-B	Grape Cr.		R	6.7	M
243	ILB06-A	Wabash R.		R	7.9	M
244	ILB06-E	Wabash R.		R	16.9	M
245	ILB06-F	Wabash R.		R	8.1	M
246	ILCD01-B	Seminary Cr.		R	1.1	M
247	ILDA04-B	Macoupin Cr.		R	30.9	M
248	ILDB01-B	Otter Cr.		R	18.4	M
249	ILDD04-A	Mauvaise Terre R.		R	31.2	M
250	ILDGJ01-A	Troublesome Cr.		R	11.4	M
251	ILDGJ01-B	Killjordan Cr.		R	6.6	M
252	ILDGJ01-D	Troublesome Creek		R	3.8	M
253	ILDGL01-E	E.Fk.La Moine R.		R	3.1	M
254	ILDG04-D	La Moine R.		R	7.1	M
255	ILDG04-F	Prairie Cr.		R	7.6	M
256	ILDJB18	Big Cr.		R	27.2	M
257	ILDJH01	East Cr.		R	8.0	M
258	ILDJ06-C	W. Fk. Spoon R.		R	17.2	M
259	ILDKF11	Prairie Cr.		R	16.3	M
260	ILDK12-D	Indian Cr.		R	7.2	M
261	ILDL01-A	Kickapoo Cr.		R	18.2	M
262	ILDQ03-A	Big Bureau Cr.		R	45.8	M
263	ILDQ03-B	Big Bureau Cr.		R	11.7	M
264	ILDR01	Little Vermilion R.		R	22.0	M
265	ILDS06	Vermilion R.		R	22.1	M
266	ILDS07-A	Vermilion R.		R	35.0	M
267	ILDS07-C	Vermilion R.		R	3.5	M
268	ILDS07-D	Vermilion R.		R	5.4	M
269	ILDTZS01	Flint Cr.		R	14.0	M
270	ILDTZS02	Tyler Cr.		R	17.7	M
271	ILDT22-B	Fox R.		R	9.7	M
272	ILDT22-C	Fox R.		R	15.2	M
273	ILDT22-D	Fox R.		R	6.1	M
274	ILDT38-B	Fox R.		R	5.6	M
275	ILDT38-C	Fox R.		R	5.0	M

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OBS	WBID	WBNAME	WBCOUN	WBTYPE	WBSIZE	WBUNIT
276	ILDZZP03	Farm Cr.		R	19.2	M
277	ILD03-A	Illinois R.		R	1.8	M
278	ILD03-B	Illinois R.		R	8.3	M
279	ILD03-C	Illinois R.		R	3.9	M
280	ILD03-D	Illinois R.		R	13.9	M
281	ILD05-A	Illinois R.		R	10.4	M
282	ILD05-B	Illinois R.		R	2.1	M
283	ILD05-C	Illinois R.		R	1.8	M
284	ILD09-A	Illinois R.		R	10.5	M
285	ILD09-B	Illinois R.		R	0.5	M
286	ILD09-C	Illinois R.		R	0.4	M
287	ILD09-D	Illinois R.		R	3.4	M
288	ILD09-E	Illinois R.		R	3.1	M
289	ILD09-F	Illinois R.		R	3.3	M
290	ILD10-A	Illinois R.		R	3.9	M
291	ILD10-B	Illinois R.		R	5.6	M
292	ILD16-A	Illinois R.		R	8.6	M
293	ILD16-B	Illinois R.		R	16.4	M
294	ILD16-C	Illinois R.		R	1.2	M
295	ILD20-A	Illinois R.		R	10.7	M
296	ILD20-B	Illinois R.		R	3.7	M
297	ILD23-A	Illinois R.		R	21.0	M
298	ILD23-B	Illinois R.		R	2.0	M
299	ILD23-C	Illinois R.		R	0.9	M
300	ILD30-A	Illinois R.		R	0.7	M
301	ILD30-B	Illinois R.		R	0.4	M
302	ILD30-C	Illinois R.		R	4.0	M
303	ILD30-D	Illinois R.		R	10.2	M
304	ILD31-A	Illinois R.		R	9.5	M
305	ILD31-B	Illinois R.		R	2.8	M
306	ILD31-C	Illinois R.		R	3.9	M
307	ILD31-D	Illinois R.		R	10.3	M
308	ILEOA01	Sugar Cr.		R	6.2	M
309	ILE09-A	Sangamon R.		R	3.7	M
310	ILGBAA01	Rock Run		R	9.8	M
311	ILGBE01-A	Lily Cache Cr.		R	14.5	M
312	ILGBE01-B	Lily Cache Cr.		R	5.0	M
313	ILGBK05-A	W. Br. DuPage R.		R	8.8	M
314	ILGBK05-B	W. Br. DuPage R.		R	6.6	M
315	ILGBK05-C	W. Br. DuPage R.		R	5.0	M
316	ILGBK05-D	W. Br. DuPage R.		R	3.0	M
317	ILGBK05-E	W. Br. DuPage R.		R	4.0	M
318	ILGBK05-F	W. Br. DuPage R.		R	3.6	M
319	ILGBK05-G	W. Br. DuPage R.		R	2.7	M
320	ILGBL10-A	E. Br. DuPage R.		R	4.9	M
321	ILGBL10-B	E. Br. DuPage R.		R	5.9	M
322	ILGBL10-C	E. Br. DuPage R.		R	3.1	M
323	ILGBL10-D	E. Br. DuPage R.		R	4.8	M
324	ILGBL10-E	E. Br. DuPage R.		R	6.4	M
325	ILGBL10-F	DuPage R.		R	3.1	M
326	ILGBL10-G	DuPage R.		R	2.9	M
327	ILGBL10-H	DuPage R.		R	3.6	M
328	ILGBL10-I	DuPage R.		R	4.4	M
329	ILGB11-A	DuPage R.		R	5.5	M
330	ILGB11-B	DuPage R.		R	[illegible]	M

WaterBody System Report
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OBS	WBID	WBNAME	WBCOUN	WBTYPE	WBSIZE	WBUNIT
331	ILGG02-B	Hickory Cr.		R	6.0	M
332	ILGJ01	Sawmill Cr.		R	7.4	M
333	ILGK03	Flag Cr.		R	8.8	M
334	ILGLA01-A	Addison Cr.		R	6.9	M
335	ILGLA01-B	Addison Cr.		R	5.2	M
336	ILGL09-A	Salt Cr.		R	6.1	M
337	ILGL09-B	Salt Cr.		R	9.0	M
338	ILGL09-C	Salt Cr.		R	10.9	M
339	ILGO01	Willow Cr.		R	9.7	M
340	ILGU02	Indian Cr.		R	14.0	M
341	ILGV01	Bull Cr.		R	7.4	M
342	ILGW02	Mill Cr.		R	12.7	M
343	ILG01-A	DesPlaines R.		R	3.8	M
344	ILG01-B	DesPlaines R.		R	3.0	M
345	ILG01-C	DesPlaines R.		R	8.0	M
346	ILG11-A	DesPlaines R.		R	4.9	M
347	ILG11-B	DesPlaines R.		R	6.8	M
348	ILG11-C	DesPlaines R.		R	8.0	M
349	ILG11-D	DesPlaines R.		R	6.3	M
350	ILG12-A	DesPlaines R.		R	8.0	M
351	ILG12-B	DesPlaines R.		R	3.0	M
352	ILG23	DesPlaines R.		R	3.9	M
353	ILG30-A	DesPlaines R.		R	9.3	M
354	ILG30-C	DesPlaines R.		R	4.1	M
355	ILG30-D	DesPlaines R.		R	7.8	M
356	ILG30-E	DesPlaines R.		R	2.6	M
357	ILG30-F	DesPlaines R.		R	8.9	M
358	ILG30-G	DesPlaines R.		R	3.4	M
359	ILG30-H	DesPlaines R.		R	3.8	M
360	ILG30-I	DesPlaines R.		R	5.0	M
361	ILHBD04-A	Deer Cr.		R	17.5	M
362	ILHBD04-B	Thorn Cr.		R	11.6	M
363	ILHBD04-C	Thorn Cr.		R	8.0	M
364	ILHB42-B	L. Calumet R.		R	8.9	M
365	ILHCC05	N. Fk. N. Br. Chic. R.		R	17.7	M
366	ILHCCC04-B	Mid Fk. N. Br. Chic. R.		R	25.2	M
367	ILHCC07	N. Br. Chicago R.		R	10.2	M
368	ILH01-A	L. Calumet R.		R	6.6	M
369	ILH01-B	Calumet R.		R	6.6	M
370	ILH01-C	Calumet-Sag Channel		R	8.8	M
371	ILH01-D	Calumet-Sag Channel		R	6.6	M
372	ILI01-A	Mississippi R.		R	5.7	M
373	ILI01-B	Mississippi R.		R	12.6	M
374	ILI01-C	Mississippi R.		R	15.2	M
375	ILI01-D	Mississippi R.		R	10.0	M
376	ILI01-E	Mississippi R.		R	1.5	M
377	ILI02	Mississippi R.		R	13.8	M
378	ILI84-A	Mississippi R.		R	2.7	M
379	ILI84-B	Mississippi R.		R	6.0	M
380	ILI84-C	Mississippi R.		R	21.8	M
381	ILI84-D	Mississippi R.		R	1.0	M
382	ILI84-E	Mississippi R.		R	32.6	M
383	ILJHAC02	Harding Ditch		R	9.8	M
384	ILJHA01-A	Canal #1		R	[illegible]	M
385	ILJHA01-B	Prairie Du Pont Cr.		R	12.5	M

WaterBody System Report
List of WaterBodies

OBS	WBID	WBNAME	WBCOUNTY	WBTYPE	WBSIZE	WBUNIT
386	ILJNA01-A	Canteen Cr.		R	6.7	M
387	ILJN02-B	Cahokia Canal		R	8.1	M
388	ILJQA01-A	Indian Cr.		R	19.1	M
389	ILJR02-A	Wood R.		R	2.4	M
390	ILJR02-B	E. Fk. Wood R.		R	0.5	M
391	ILJ83-A	Mississippi R.		R	11.3	M
392	ILJ83-B	Mississippi R.		R	11.5	M
393	ILJ83-C	Mississippi R.		R	3.3	M
394	ILJ83-D	Mississippi R.		R	0.9	M
395	ILJ83-E	Mississippi R.		R	9.7	M
396	ILJ83-F	Chain of Rocks		R	8.7	M
397	ILJ83-G	Mississippi R.		R	2.8	M
398	ILJ83-H	Mississippi R.		R	10.5	M
399	ILJ83-I	Mississippi R.		R	12.2	M
400	ILJ83-J	Mississippi R.		R	9.7	M
401	ILJ83-K	Mississippi R.		R	3.0	M
402	ILJ83-L	Mississippi R.		R	19.2	M
403	ILJ83-M	Mississippi R.		R	12.8	M
404	ILK02-A	Mississippi R.		R	12.3	M
405	ILK04-A	Mississippi R.		R	20.1	M
406	ILLD001-A	Cedar Cr.		R	5.0	M
407	ILLDE01-B	Cedar Cr.		R	31.7	M
408	IL103-D	Mississippi R.		R	14.3	M
409	ILNDB01-A	Piles Fk.		R	5.6	M
410	ILND01-A	Crab Orchard Cr.		R	4.1	M
411	ILND01-B	Crab Orchard Cr.		R	3.2	M
412	ILND04-B	Crab Orchard Cr.		R	5.5	M
413	ILNJ07-A	Casey Fk.		R	6.4	M
414	ILOC04-A	Richland Cr.-South		R	3.9	M
415	ILOC04-B	Richland Cr.-South		R	2.7	M
416	ILOC04-C	Richland Cr.-South		R	1.8	M
417	ILOC04-D	Richland Cr.-South		R	6.0	M
418	ILODL02-E	Richland Cr.-South		R	2.7	M
419	ILODL02-F	Richland Cr.-South		R	1.5	M
420	ILODL02-G	Richland Cr.-South		R	4.3	M
421	ILOH01-A	Sugar Cr.		R	3.9	M
422	ILOIB01-E	Sewer Cr.		R	1.5	M
423	ILOJ08-C	Town Cr.		R	1.2	M
424	ILOJ08-E	Crooked Cr.		R	4.2	M
425	ILOJ08-F	Crooked Cr.		R	4.0	M
426	ILOJ08-G	Crooked Cr.		R	11.6	M
427	ILOJ08-J	Crooked Cr.		R	3.6	M
428	ILO13-F	Kaskaskia R.		R	7.0	M
429	ILO15-A	Kaskaskia R.		R	10.6	M
430	ILPQE06-B	Hokelar Cr.		R	10.8	M
431	ILROU	DEPUE	BUREAU	L	524.0	A
432	ILRGA	BRUCE	DU PAGE	L	14.6	A
433	ILRGG	CHURCHILL LAGOON	DU PAGE	L	21.0	A
434	ILRHA	WOLF	COOK	L	419.0	A
435	ILRNB 1	REND-1	FRANKLIN	L	18900.0	A
436	ILRNB 2	REND-2	FRANKLIN	L	18900.0	A
437	ILRTJ	LONG	LAKE	L	335.0	A
438	ILRTP	SLOCUM	LAKE	L	215.0	A
439	ILRTR	MARIE	LAKE	L	516.0	A
440	ILRIZH	HOOSIER	LAKE	L	100.3	A

WaterBody System Report
List of WaterBodies

OBS	WBID	WBNAME	WBCOUN	WBTYPE	WBSIZE	WBUNIT
441	ILSOZE	POWERTON	TAZEWELL	I	1426.00	A
442	ILVID	DEEP	LAKE	L	225.50	A
443	KY5100102-008	SOUTH FORK LICKING RIVER MAINSTEM	HARRISON	R	14.00	M
444	KY5100102-020	BIG BRUSHY CREEK BASIN	NICHOLAS	R	23.50	M
445	KY5100205-038101	HERRINGTON LAKE	GARRARD	L	2940.00	A
446	KY5130101-003101	LAUREL RIVER LAKE	LAUREL	L	6060.00	A
447	KY5130101-006101	LONDON CITY RESERVOIR	LAUREL	L	159.00	A
448	KY5130205-008	LITTLE RIVER MAINSTEM	TRIGG	R	40.70	M
449	KY5130205-009	NORTH FORK LITTLE RIVER BASIN	CHRISTIAN	R	31.50	M
450	KY5130205-010	SOUTH FORK LITTLE RIVER BASIN	CHRISTIAN	R	25.40	M
451	KY5140102-005	SALT RIVER MAINSTEM	BULLITT	R	13.80	M
452	KY5140102-015	SALT RIVER MAINSTEM	BULLITT	R	30.70	M
453	KY5140102-024	SALT RIVER MAINSTEM	SPENCER	R	4.10	M
454	KY6040006-006	CLARKS RIVER MAINSTEM	MARSHALL	R	25.90	M
455	MA21-04	SOUTH BRANCH HOOSIC RIVER		R	7.10	M
456	MA21-04A	HOUSATONIC RIVER		R	10.30	M
457	MA21-05	HOUSATONIC RIVER		R	45.10	M
458	MA33-07	SOUTH RIVER		R	1.90	M
459	MA36-12	SEVEN MILE RIVER		R	2.40	M
460	MA36-22	CHICOPEE RIVER		R	2.70	M
461	MA51-03	BLACKSTONE RIVER		R	9.00	M
462	MA62-01	TAUNTON RIVER		R	19.60	M
463	MA62-06	SALISBURY PLAIN AND MATFIELD RIVERS		R	7.60	M
464	MA62-15	RUMFORD RIVER		R	7.10	M
465	MA62-23	MUDDY COVE BROOK		R	0.80	M
466	MA62-26	NEMASKET RIVER		R	5.40	M
467	MA71-03	MYSTIC RIVER		E	2.00	S
468	MA72-03	CHARLES RIVER		R	3.10	M
469	MA73-01	NEPONSET RIVER		R	13.70	M
470	MA81-10	NASHUA RIVER		R	3.70	M
471	MA82A-11	RIVER MEADOW BROOK		R	6.10	M
472	MA82B-02	ASSABET RIVER		R	3.50	M
473	MA82B-04	ASSABET RIVER		R	7.90	M
474	MA82B-05	ASSABET RIVER		R	8.60	M
475	MA82B-06	ASSABET RIVER		R	3.20	M
476	MA84B-01	WOLF SWAMP AND HILL BROOK		R	3.90	M
477	MA93-05	GOLDTHWAIT BROOK		R	3.30	M
478	MA93-06	NORTH RIVER		E	2.70	S
479	MA93-08	BASS RIVER		E	1.30	S
480	MA93-10	FOREST RIVER		E	0.50	S
481	MA94-01	COHASSET HARBOR		E	0.83	S
482	MD-02130103-E-11	Isle of Wight Bay	WORCESTER	E	6.80	S
483	MD-02130105-R-11	Newport Bay (non-tidal)	WORCESTER	R	10.50	M
484	MD-02130207-E-11	Big Annemessex River (tidal)	SOMERSET	E	11.30	S
485	MD-02130304-L-21	Johnson Pond	WICOMICO	L	304.00	A
486	MD-02130403	Lower Choptank River	DORCHESTER	R	19.00	M
487	MD-02130403-E-11	Lower Choptank River (tidal)	DORCHESTER	E	126.90	S
488	MD-02130502-E-11	Miles River (tidal)	TALBOT	E	11.40	S
489	MD-02130505-E-11	Lower Chester River (tidal)	QUEEN ANNES	E	64.20	S
490	MD-02130701-E-11	Bush River (tidal)	HARFORD	E	12.00	S
491	MD-02130801-E-11	Gunpowder River (tidal)	BALTIMORE	E	21.20	S
492	MD-02130805-L-11	Loch Raven Reservoir	BALTIMORE	L	2400.00	A
493	MD-02130903-E-11	Baltimore Harbor	BALTIMORE CITY	E	51.90	S
494	MD-02131002-E-11	Severn River (tidal)	ANNE ARUNDEL	E	10.90	S
495	MD-02131004-E-11	West River (tidal)	ANNE ARUNDEL	E	5.70	S

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OBS	WBID	WBNAME	WBCOUN	WBTYPE	WBSIZE	WBUNIT
496	MD-02131005-E-11	Other West Chesapeake Drainage	CALVERT	E	0.50	S
497	MD-02131101	Patuxent Mainstem Mouth to Ferry Landing	CALVERT	R	39.00	M
498	MD-02131101-E-11	Patuxent Mainstem Mouth to Ferry Lndg (tidal)	CALVERT	E	47.70	S
499	MD-02131102	Patuxent Mainstem Ferry Landing to Rt. 214	ANNE ARUNDEL	R	18.00	M
500	MD-02131103	Western Branch	PRINCE GEORGES	R	16.00	M
501	MD-02131105-R-11	Little Patuxent River	HOWARD	R	58.90	M
502	MD-02139998-E-11	Lower Chesapeake Bay	ST MARYS	E	779.70	S
503	MD-02140101-E-11	Potomac - Smith Point to Mouth (tidal)	ST MARYS	E	317.00	S
504	MD-02140103-E-11	St. Mary's River (tidal)	ST MARYS	E	15.60	S
505	MD-02140104-E-11	Breton Bay	ST MARYS	E	4.80	S
506	MD-02140111-E-11	Mattawoman Creek (tidal)	CHARLES	E	8.60	S
507	MD-02140201	Potomac/Marshall Hall to Chain Bridge	PRINCE GEORGES	R	20.00	M
508	MD-02140303-R-11	Upper Monocacy River	FREDERICK	R	146.00	M
509	MD-02140304-R-11	Double Pipe Creek	CARROLL	R	77.10	M
510	MD-02140504-R-11	Conococheague Creek	WASHINGTON	R	40.10	M
511	ME 00123L	FISH R, 1K TRIBS	AROOSTOOK	L	7145.00	A
512	MN07010202004				.	
513	MN07010204002				.	
514	MN07010204004				.	
515	MN07010205001				.	
516	MN07020006001				.	
517	MN07040001004				.	
518	MN07040001011				.	
519	MN07040002017				.	
520	MN07040002018				.	
521	MN07040002019				.	
522	MN07040002021				.	
523	MN07040003017				.	
524	MN07080201023				.	
525	MN09020104004				.	
526	MN09020107002				.	
527	MN10170203035				.	
528	MN10170203034				.	
529	MSE002	BACK BAY OF BILOXI (AT POPPS FERRY)	HARRISON	E	2.00	S
530	MSE006	TIDEWATER BAYOU	JACKSON	E	0.25	S
531	MSR001	BAKERS CREEK	HINDS	R	23.20	M
532	MSR002	BIG BLACK RIVER	MADISON	R	45.80	M
533	MSR003	BIG BLACK RIVER	WARREN	R	45.80	M
534	MSR011	BAHALA CREEK		R	15.40	M
535	MSR012	BOGUE CHITTO RIVER		R	28.80	M
536	MSR013	BOGUE CHITTO RIVER		R	20.40	M
537	MSR016	PEARL RIVER	RANKIN	R	17.70	M
538	MSR017	PEARL RIVER	HINDS	R	45.70	M
539	MSR021	PEARL RIVER	MADISON	R	19.10	M
540	MSR025	PELAHATCHIE CREEK	RANKIN	R	4.50	M
541	MSR027	YOCKANOOKANY RIVER		R	50.20	M
542	MSR040	LEAF RIVER		R	27.10	M
543	MSR051	OKATIBBEE CREEK	LAUDERDALE	R	12.60	M
544	MSR054	OKATOMA CREEK	COVINGTON	R	27.70	M
545	MSR064	TALLAHALA CREEK		R	30.60	M
546	MSR068	COLDWATER RIVER		R	56.70	M
547	MSR070	DEER CREEK	WASHINGTON	R	108.50	M
548	MSR071	LEAD BAYOU	BOLIVAR	R	5.50	M
549	MSR074	BIG SUNFLOWER RIVER		R	7.50	M
550	MSR075	BIG SUNFLOWER RIVER		R	7.20	M

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OBS	WBID	WBNAME	WBCOUN	WBTYPE	WBSIZE	WBUNIT
551	MSR078	WHITE OAK BAYOU	TUNICA	R	19.00	M
552	MSR082	YAZOO RIVER		R	132.70	M
553	MSR088	MACKEYS CREEK		R	8.00	M
554	MSR089	MCKINLEY CREEK	MONROE	R	5.00	M
555	MSR102	JOHN CREEK	LEE	R	10.50	M
556	MSR103	BRIDGE CREEK	ALCORN	R	11.00	M
557	MSR104	ELAM CREEK	ALCORN	R	3.00	M
558	MSR108	MISSISSIPPI RIVER	WARREN	R	30.90	M
559	MSR109	MISSISSIPPI RIVER	DE SOTO	R	6.20	M
560	MSR110	MISSISSIPPI RIVER	TUNICA	R	43.10	M
561	MSR247	TANGIPAHOA RIVER		R	31.20	M
562	MSR272	TALLAHALA CREEK		R	26.40	M
563	MSR349	RIVERDALE CR		R	8.90	M
564	MSR459	MONCOHIAN CREEK		R	38.80	M
565	MSR467	ESCATAWPA RIVER	JACKSON	R	18.00	M
566	MSR476	OLD LITTLE TALLAHATCHIE RIVER		R	14.40	M
567	MSR479	HAIRSTON BENDWAY		R	5.50	M
568	MSR484	MISSISSIPPI RIVER		R	111.60	M
569	MSR498	LEAF RIVER		R	9.70	M
570	MSR499	LEAF RIVER		R	8.50	M
571	MSR512	YOCONA RIVER		R	10.50	M
572	MSR515	TRIBUTARY OF WHITE OAK BAYOU		R	0.25	M
573	MSR519	BIG SUNFLOWER RIVER		R	74.70	M
574	MSTR02	BERNARD BAYOU	HARRISON	R	16.40	M
575	MSTR07	ESCATAWPA RIVER	JACKSON	R	5.90	M
576	MSTR08	ESCATAWPA RIVER	JACKSON	R	2.90	M
577	MSTR09	ESCATAWPA RIVER	JACKSON	R	5.90	M
578	MSTR22	EDWARDS BAYOU	HANCOCK	R	2.00	M
579	MT41I006	PRICKLY PEAR CREEK DRAINAGE	LEWIS AND CLARK	R	205.00	M
580	MT41I007	MISSOURI RIVER DRAINAGE LAKES	LEWIS AND CLARK	L	10200.20	A
581	MT41S004	BIG SPRING CREEK DRAINAGE	FERGUS	R	174.80	M
582	MT42B005	UPPER TONGUE RIVER DRAINAGE LAKES	ROSEBUD	L	3500.10	A
583	MT76H001	BITTERROOT RIVER MAINSTEM	MISSOULA	R	84.00	M
584	MT76LJ008	ASHLEY CREEK DRAINAGE	FLATHEAD	R	101.55	M
585	MT76LJ013	WHITEFISH RIVER DRAINAGE	FLATHEAD	R	26.40	M
586	MT76L002	LOWER FLATHEAD RIVER TRIBUTARIES	SANDERS	R	594.70	M
587	MT76N001	MAINSTEM CLARK FORK (FLATHEAD - BLACKFOOT)	SANDERS	R	123.20	M
588	NC30208	ROANOKE 06		R	314.00	M
589	NC30301	TAR-PAMLICO 01		R	444.90	M
590	NC30307	TAR-PAMLICO 07		R	313.90	M
591	NC30402	NEUSE 02		R	575.60	M
592	NC30407	NEUSE 07		R	599.90	M
593	NC30501	WHITE OAK 01		R	98.40	M
594	NC30602	CAPE FEAR 02		R	468.60	M
595	NC30606	CAPE FEAR 06		R	57.50	M
596	NC30607	CAPE FEAR 07		R	295.40	M
597	NC30608	CAPE FEAR 08		R	176.80	M
598	NC30622	CAPE FEAR 22		R	365.60	M
599	NC30704	YADKIN 04		R	469.00	M
600	NC30707	YADKIN 07		R	175.00	M
601	NC30758	LUMBER 58		R	198.00	M
602	NC30805	BROAD 05		R	144.60	M
603	NC30831	CATAWBA 31		R	1761.70	M
604	NC30834	CATAWBA 34		R	249.30	M
605	NC30835	CATAWBA 35		R	509.70	M

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OBS	WBID	WBNAME	WBCOUN	WBTYPE	WBSIZE	WBUNIT
606	NC30837	CATAWBA 37		R	81.90	M
607	NC40506	FRENCH BROAD 06		R	711.80	M
608	NC40501	HIWASSEE 01		R	334.00	M
609	NC50701	NEW 01		R	409.90	M
610	ND-09020201-006-L	DEVILS LAKE	RAMSEY	LCN	49585.00	A
611	ND-09020204-003-S	SHEYENNE RIVER	CASS	R	11.50	M
612	ND-09020301-001-S	RED RIVER	GRAND FORKS	R	48.00	M
613	ND-10110101-001-L	POWERS LAKE	BURKE	LCN	950.60	A
614	ND-10130102-006-L	LAKE OAHE		LCI	175.78	S
615	NJ-02030103-010R	PASSAIC RIVER UPPER		R	54.00	M
616	NJ-02030103-050R	ROCKAWAY RIVER		R	61.00	M
617	NJ-02030103-140R	SADDLE RIVER		R	16.00	M
618	NJ-02030103-150R	PASSAIC RIVER LOWER		R	14.00	M
619	NJ-02030103-180R	HACKENSACK RIVER LOWER		R	44.00	M
620	NJ-02030104-020R	ELIZABETH RIVER		R	11.00	M
621	NJ-02030104-050R	RAHWAY RIVER		R	24.00	M
622	NJ-02030105-080R	RARITAN RIVER UPPER		R	8.00	M
623	NJ-02030105-100R	MILLSTONE RIVER UPPER		R	20.00	M
624	NJ-02030105-120R	RARITAN RIVER MIDDLE		R	12.00	M
625	NJ-0205105-050R	LAMINGTON RIVER		R	27.00	M
626	NJ-02040105-050R	PAULINSKILL RIVER LOWER		R	46.00	M
627	NJ-02040105-150R	MUSCONETCONG RIVER UPPER		R	45.00	M
628	NJ-02040105-240R	ASSUNPINK CREEK LOWER		R	5.50	M
629	NJ-02040202-010R	NORTH BRANCH PENNSAUKEN CREEK		R	10.00	M
630	NJ-02040202-040R	NORTH BRANCH RANCOCAS CREEK LOWER		R	18.00	M
631	NJ-02040202-100R	PENNSAUKEN CREEK MAINSTEM AND SO BRANCH		R	14.00	M
632	NJ-02040202-110R	COOPER RIVER		R	21.00	M
633	NJ-02040202-120R	BIG TIMBER CREEK		R	24.00	M
634	NJ-02040202-150R	RACCOON CREEK		R	17.00	M
635	NJ-02040301-010R	MANASQUAN RIVER		R	30.00	M
636	NJ-02040302-030R	GREAT EGG HARBOR RIVER UPPER		R	18.00	M
637	OH66 3	BLANCHARD (EAGLE CREEK TO OTTAWA CREEK)	HANCOCK	R	12.50	M
638	OH72 11.8			R	4.50	M
639	PA-00181-003.3-000.0	BUCK RUN (UNT) LITTLE BUCK RUN		R	.	M
640	PA-00374-000.9-000.0	RED CLAY CREEK		R	.	M
641	PA-00391-006.2-000.0	WEST BRANCH RED CLAY CREEK		R	.	M
642	PA-00462-014.4-000.0	MIDDLE BRANCH WHITE CLAY CREEK		R	.	M
643	PA-00604-005.0-000.0	EAST BRANCH CHESTER CREEK		R	.	M
644	PA-00621-006.0-002.0	RIDLEY CREEK		R	.	M
645	PA-00833-075.1-065.6	SCHUYLKILL RIVER		R	.	M
646	PA-01017-020.6-001.8	PERKIOMEN CREEK		R	.	M
647	PA-01024-015.9-000.2	SKIPPACK CREEK		R	.	M
648	PA-01181-005.4-000.1	WOTAN CREEK		R	.	M
649	PA-01309-000.2-000.0	SHARP CREEK		R	.	M
650	PA-01655-020.2-000.4	MANATAWNY CREEK		R	.	M
651	PA-01846-036.0-000.0	TULPEHOCKEN CREEK		R	.	M
652	PA-01918-002.0-000.2	Jackson Creek		R	.	M
653	PA-02658-008.0-002.1	LITTLE NESHAMINY CREEK		R	.	M
654	PA-02776-003.3-000.3	COOKS RUN		R	.	M
655	PA-02776-003.5-000.0	COOKS RUN (COUNTRY CLUB RUN)		R	.	M
656	PA-02868-004.3-000.3	WEST BRANCH NESHAMINY CREEK		R	.	M
657	PA-03110-007.6-000.0	TOHICKON CREEK		R	.	M
658	PA-03110-019.8-011.0	LAKE NOCKAMIXON		L	.	
659	PA-03110-025.0-019.8	TOHICKON CREEK		R	.	
660	PA-03345-006.0-000.0	SAUCON CREEK (SOUTH BRANCH)		R	.	M

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List of WaterBodies

OBS	WBID	WBNAME	WBCOUN	WBTYPE	WBSIZE	WBUNIT
661	PA-07070-016.0-000.0	EAST BRANCH OCTORARO CREEK		R		W
662	PA-07548-025.0-000.0	CONESTOGA CREEK		R		W
663	PA-07548-065.5-050.9	CONESTOGA RIVER		R		W
664	PA-07597-027.7-000.0	Mill Creek		R		W
665	PA-07795-001.9-001.3	UNT. CONESTOGA RIVER		R		W
666	PA-07815-004.3-000.0	E BR CONESTOGA RIVER		R		W
667	PA-09691-016.5-000.0	Quittapahilla Creek		R		W
668	PA-10194-016.0-004.5	Conodoguinet Creek		R		W
669	PA-13809-019.7-000.0	YELLOW CREEK		R		W
670	PA-26504-006.6-000.0	Plum Creek		R		W
671	PA-31820-004.6-000.0	BEL AIRE LAKE		L		
672	PA-33953-012.2-000.0	BEAVER RIVER		R		W
673	PA-34025-040.5-005.2	CONNOQUENESSING CREEK		R		W
674	PA-35482-033.2-000.0	SHENANGO RIVER		R		W
675	PA-36873-004.6-003.6	Brush Run		R		W
676	PA-36938-000.8-000.0	UNT Brush Run		R		W
677	PA-37373-002.7-001.2	Thompson Run		R		W
678	PA-37702-007.6-000.2	JACKS RUN		R		W
679	PA-42685-001.0-000.0	UNT Buffalo Creek		R		W
680	PA-49224-101.2-092.6	CLARION RIVER		R		W
681	PA-52942-007.6-005.1	CONNEAUTTEE CREEK		R		W
682	PA-58849-008.1-000.0	ALLOWAY CREEK (UNIT)		R		W
683	PA-59041-018.5-012.0	ROCK CREEK		R		W
684	PREC0116	QUEBRADA DE LAS LAJAS		R	6.30	W
685	PREC0138	QUEBRADA AGUAS CLARAS		R	4.80	W
686	PREE0064	RIO LA PLATA		C/E	9.60	W
687	PREE0125	RIO SABANA		C/E	0.90	W
688	PREE0166	CANO DE SANTIAGO		C/E	7.20	W
689	PREK0168	CANO DE SANTIAGO		R	6.00	W
690	PREL0082	LAGO CIDRA		L	260.00	A
691	PRER0101	RIO CANOVANAS		R	32.60	W
692	PRER0105	RIO CANOVANILLAS		R	27.90	W
693	PRER0164	RIO INGENIO		R	32.60	W
694	RI0001002	BRANCH R AND TRIBS	PROVIDENCE CO.	R	41.85	W
695	RI0004009	TEN MILE R	PROVIDENCE CO.	R	7.50	W
696	RI0006017	MAIN STEM AND TRIBS	PROVIDENCE/KENT CO.'S	R	25.50	W
697	RI0007019	SEEKONK R	PROVIDENCE CO.	R	5.00	W
698	RI0007020	PROVIDENCE R	PROVIDENCE CO.	EST	6.60	S
699	RI0007025	GREENWICH BAY AND COVES	KENT CO.	EST	4.30	S
700	RI0007032	MOUNT HOPE BAY	NEWPORT & BRISTOL	E	9.30	S
701	SD-POCASSE	LK POCASSE	CAMPBELL	L	1000.00	A
702	TN05130105029	ROCKCASTLE CREEK	FENTRESS	R	4.40	W
703	TN05130204016	HARPETH RIVER	WILLIAMSON	R	51.70	W
704	TN06010102001	SOUTH HOLSTON RIVER	SULLIVAN	R	7.30	W
705	TN06010102006	BOONE RESERVOIR	SULLIVAN	L	4400.00	A
706	TN06010103008	WATAUGA RIVER	WASHINGTON	R	10.80	W
707	TN06010104MOSSYCR	MOSSY CREEK	JEFFERSON	R	2.80	W
708	TN06010106001	PIGEON RIVER	COCKE	R	12.10	W
709	TN06010107007	LITTLE PIGEON RIVER	SEVIER	R	10.70	W
710	TN06010107010	WEST PRONG LITTLE PIGEON RIVER	SEVIER	R	6.90	W
711	TN06010107014	WEST PRONG LITTLE PIGEON RIVER	SEVIER	R	9.50	W
712	TN06010107029	DOUGLAS RESERVOIR	JEFFERSON	L	30400.00	A
713	TN06010107036	FRENCH BROAD RIVER	JEFFERSON	R	14.60	W
714	TN06010107038	DUPLIN CREEK	SEVIER	R	10.20	W
715	TN06010108SINKINGCR	SINKING CREEK	GREENE	R	13.40	W

WaterBody System Report
List of WaterBodies

OBS	WBID	WBNAME	WBCOUN	WBTYPE	WBSIZE	WBUNIT
716	TN06010108001	NOLICHUCKY RIVER	COCKE	R	22.40	M
717	TN06010201CANEYCR	CANEY CREEK	ROANE	R	5.50	M
718	TN06010201FIRSTCREEK	FIRST CREEK	KNOX	R	4.60	M
719	TN06010201SECONDCR	SECOND CREEK	KNOX	R	4.40	M
720	TN06010201SINKINGCREEK	SINKING CREEK	KNOX	R	1.50	M
721	TN06010201THIRDCR	THIRD CREEK	KNOX	R	6.90	M
722	TN06010201TUCKEYCR	TUCKEY CREEK	KNOX	R	5.00	M
723	TN06010201020	FORT LOUDON RESERVOIR	KNOX	L	14600.00	A
724	TN06010201025	TENNESSEE RIVER	KNOX	R	11.90	M
725	TN06010201026	LITTLE RIVER	BLOUNT	R	10.80	M
726	TN06010201035	TENNESSEE RIVER	KNOX	R	15.50	M
727	TN06010205BIGCR	BIG CREEK	CAMPBELL	R	5.00	M
728	TN06010206008	RUSSELL CREEK	CLAIBORNE	R	6.00	M
729	TN06010207EASTFORKPOPLARC	EAST FORK POPLAR CREEK	ROANE	R	15.00	M
730	TN06010207011	BEAVER CREEK	KNOX	R	29.90	M
731	TN06010207014	BULLRUN CREEK	ANDERSON	R	35.10	M
732	TN06010207016	HINDS CREEK INCL BUFFALO CREEK	ANDERSON	R	26.40	M
733	TN06010208013	OBED RIVER INCL OTTER CREEK	MORGAN	R	24.70	M
734	TN06020001002	TENNESSEE RIVER	HAMILTON	R	9.20	M
735	TN06020001007	S CHICKAMAUGA CR INCL W CHICKAMAUGA CR	HAMILTON	R	10.70	M
736	TN06020001048	RICHLAND CREEK	RHEA	R	3.10	M
737	TN06030003053	ROCK CREEK	FRANKLIN	R	8.10	M
738	TN06040005023	WEST SANDY CREEK INCL HOLLY FORK BRANCH	HENRY	R	23.40	M
739	TN08010202002	OBION RIVER	DYER	R	20.70	M
740	TN08010203CLEARCREEK	CLEAR CREEK	CARROLL	R	9.60	M
741	TN08010203006	S F OBION R FROM [illegible] CR TO BEAVER CR	WEAKLEY	R	25.20	M
742	TN08010203010	BEAVER CREEK	CARROLL	R	17.50	M
743	TN08010205001	SOUTH FORK FORKED DEER RIVER	DYER	R	19.40	M
744	TN08010205010	SOUTH FORK FORKED DEER RIVER	HAYWOOD	R	14.00	M
745	TN08010205012	S. F. FORKED DEER R.	MADISON	R	22.70	M
746	TN08010208031	SUGAR CR	HAYWOOD	R	8.50	M
747	TN08010209001	LOOSAHATCHIE RIVER	SHELBY	R	5.40	M
748	TN08010209002	LOOSAHATCHIE RIVER	SHELBY	R	19.00	M
749	TX0701	Taylor Bayou above Tidal	JEFFERSON	R	33.00	M
750	TX0805	Upper Trinity /Lower West Fork Trinity River	HENDERSON	R	155.00	M
751	TX1005	Houston Ship Channel/San Jacinto River	HARRIS	R	12.00	M
752	TX1006	Houston Ship Channel	HARRIS	R	6.00	M
753	VAT02060010-01E	CHINCOTEAGUE WATERSHED	ACCOMACK	E	42.88	S
754	VAT02070011-01E	LITTLE WICOMICO RIVER	NORTHUMBERLAND	E	2.46	S
755	VAT02070011-03E	COAN RIVER	NORTHUMBERLAND	E	5.18	S
756	VAT02070011-05E	YEOCOMICO RIVER	NORTHUMBERLAND	E	5.42	S
757	VAT02070011-06E	GARDNER & BONUM CREEKS	WESTMORELAND	E	0.71	S
758	VAT02070011-07E	NOMINI BAY AND LOWER MACHODOC CREEK	WESTMORELAND	E	12.39	S
759	VAT02070011-08E	MATTOX CREEK	WESTMORELAND	E	1.09	S
760	VAT02070011-09E	MONROE CREEK & BAY	WESTMORELAND	E	1.51	S
761	VAT02080104-02E	CARTER CREEK	LANCASTER	E	1.27	S
762	VAT02080104-03E	URBANNA CREEK	MIDDLESEX	E	0.46	S
763	VAT02080104-04E	RAPPAHANNOCK RIVER - MULBERRY POINT	ESSEX	E	44.30	S
764	VAT02080104-05R	TOTUSKEY CREEK	RICHMOND CITY	R	46.70	M
765	VAT02080104-06R	HOSKINS CREEK	ESSEX	R	27.90	M
766	VAT02080105-01E	MATTAPONI RIVER - WEST POINT	KING AND QUEEN	E	2.84	S
767	VAT02080106-01E	PAMUNKEY RIVER - WEST POINT	KING WILLIAM	E	3.00	S
768	VAT02080106-01R	PAMUNKEY RIVER	KING WILLIAM	R	106.50	M
769	VAT02080108-04E	BACK RIVER	HAMPTON CITY	E	10.03	S
770	VAT02080108-05R	BRICK KILN CREEK	HAMPTON CITY	R	11.30	M

WaterBody System Report
List of WaterBodies

OBS	WBID	WBNAME	WBCOUNT	WBTYPE	WBSIZE	WBUNIT
771	VAT02080108-07E	BACK RIVER	HAMPTON CITY	E	10.03	S
772	VAT02080108-16E	LYNNHAVEN RIVER	VIRGINIA BEACH CITY	E	5.44	S
773	VAT02080108-17E	BROAD AND LINKHORN BAYS	VIRGINIA BEACH CITY	E	3.33	S
774	VAT02080109-01E	HOLDENS CREEK - SANDY BOTTOM BRANCH	ACCOMACK	E	0.22	S
775	VAT02080109-02E	POCOMOKE SOUND - SAXIS ISLAND	ACCOMACK	E	17.51	S
776	VAT02080109-03E	ONANCOCK CREEK WATERSHED	ACCOMACK	E	2.39	S
777	VAT02080109-05E	PUNGOTEAGUE CREEK	ACCOMACK	E	3.43	S
778	VAT02080109-06E	NANDUA CREEK	ACCOMACK	E	4.02	S
779	VAT02080109-07E	OCCOHANNOCK CREEK	ACCOMACK	E	2.88	S
780	VAT02080109-08E	NASSAWADOX AND HUNGARS CREEKS	NORTHAMPTON	E	6.36	S
781	VAT02080109-09E	CHERRYSTONE INLET/CAPE CHARLES HARBOR	NORTHAMPTON	E	4.52	S
782	VAT02080110-01E	ASSAWOMAN ISLAND	ACCOMACK	E	7.86	S
783	VAT02080110-02E	PARKER CREEK & METOMPKIN BAY	ACCOMACK	E	5.20	S
784	VAT02080110-04E	HOG ISLAND BAY & MOCKHORN ISLAND	NORTHAMPTON	E	163.00	S
785	VAT02080206-03E	PAGAN RIVER	ISLE OF WIGHT	E	2.64	S
786	VAT02080206-08E	JAMES RIVER - JAMESTOWN ISLAND	JAMES CITY	E	43.11	S
787	VAT02080208-01E	JAMES RIVER - HAMPTON ROADS	NEWPORT NEWS CITY	E	40.51	S
788	VAT02080208-03E	ELIZABETH RIVER - CRANEY ISLAND	NORFOLK CITY	E	11.43	S
789	VAT02080208-05E	ELIZABETH RIVER - LAMBERTS POINT	NORFOLK CITY	E	2.46	S
790	VAT02080208-06E	EASTERN BRANCH OF ELIZABETH RIVER	NORFOLK CITY	E	1.04	S
791	VAT02080208-08E	SOUTHERN BRANCH OF ELIZABETH RIVER - BERKELY	NORFOLK CITY	E	0.25	S
792	VAT02080208-09E	SOUTHERN BRANCH OF ELIZABETH RIVER - NAVAL YD	CHESAPEAKE CITY	E	0.67	S
793	VAT02080208-10E	SOUTHERN BRANCH OF ELIZABETH RIVER - G.BRIDGE	CHESAPEAKE CITY	E	1.19	S
794	VAT02080208-13E	NANSEMOND RIVER	SUFFOLK CITY	E	9.62	S
795	VAT03010201-01R	NOTTOWAY RIVER (SOUTHAMPTON)	SOUTHAMPTON	R	420.00	M
796	VAT03010202-01R	BLACKWATER RIVER - BELOW FRANKLIN	SOUTHAMPTON	R	58.00	M
797	VAT03010202-02R	BLACKWATER RIVER - DUNDEE	SOUTHAMPTON	R	203.00	M
798	VAT03010204-01R	TARRARA CREEK	SOUTHAMPTON	R	59.10	M
799	VAT03010205-01E	LAKE TECUMSEH & RED WING LAKE (DAM NECK AREA)	VIRGINIA BEACH CITY	E	0.28	S
800	VAT03010205-03R	NORTH LANDING RIVER	CHESAPEAKE CITY	R	68.50	M
801	VAT03010205-05R	NORTHWEST RIVER	CHESAPEAKE CITY	R	20.20	M
802	VI001	CHRISTIANSTED HARBOR		E	0.64	S
803	VI036	LINDBERG BAY		E	0.50	S
804	VT01-03	Walloomsac River		R	104.70	M
805	VT01-04	Batten Kill Main Stem		R	20.00	M
806	VT03-01	Lower Otter Creek		R	29.70	M
807	VT03-05	Upper Main Stem Otter Ck.		R	14.00	M
808	VT04-01L01	OTTER CREEK SECTION - LAKE CHAMPLAIN		L	4423.00	A
809	VT05-01L01	MISSISQUOI BAY - LAKE CHAMPLAIN		L	7998.00	A
810	VT05-04L01	NORTHEAST ARM - LAKE CHAMPLAIN		L	58184.00	A
811	VT05-04L02	ISLE LA MOTTE - LAKE CHAMPLAIN		L	26202.00	A
812	VT05-07	St. Albans Bay Drainage		R	23.00	M
813	VT05-07L01	ST. ALBANS BAY - LAKE CHAMPLAIN		L	2498.00	A
814	VT05-09L01	MALLETTS BAY - LAKE CHAMPLAIN		L	13388.00	A
815	VT05-10L01	BURLINGTON BAY - LAKE CHAMPLAIN		L	2532.00	A
816	VT05-10L02	MAIN SECTION - LAKE CHAMPLAIN		L	42010.00	A
817	VT05-11	Shelburne Bay Direct Drainage		R	35.00	M
818	VT05-11L01	SHELBURNE BAY - LAKE CHAMPLAIN		L	2249.00	A
819	VT08-01	Lower Winooski River		R	20.00	M
820	VT08-05	Upper Mid-Winooski		R	15.00	M
821	VT08-16	Stevens Branch - Winooski River		R	28.70	M
822	VT09-06	Third Branch - White River		R	95.00	M
823	VT10-01	Lower Ottauquechee River		R	16.50	M
824	VT10-05	Upper Ottauquechee River		R	11.50	M
825	VT10-11	Lower Black River		R	8.00	M

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OBS	WBID	WBNAME	WBCOUNTY	WBTYPE	WBSIZE	WBUNIT
826	VT10-14	Upper Black River		R	22.00	M
827	VT11-01	Lower Williams River		R	10.50	M
828	VT12-05	North Branch Deerfield		R	36.00	M
829	VT15-08	East Branch Passumpsic		R	38.60	M
830	VT17-01L01	LAKE MEMPHREMAGOG		L	5847.00	A
831	WA-01-0080	OUTER BELLINGHAM BAY	WHATCOM	EA	58.34	S
832	WA-01-0800	OUTER BELLINGHAM BAY	WHATCOM	EA	58.34	S
833	WA-01-3110	WHATCOM CREEK	WHATCOM	RA	3.00	M
834	WA-08-1018	KELSEY CREEK	KING	RAA	4.60	M
835	WA-08-9340	UNION LAKE	KING	LL	580.00	A
836	WA-09-1010	DUWAMISH WATERWAY AND R.	KING	EB	1.01	S
837	WA-09-1020	GREEN R.	KING	RA	31.30	M
838	WA-09-9260	SAWYER LAKE	KING	LL	302.00	A
839	WA-10-1010	PUYALLUP R.	PIERCE	R	1.00	M
840	WA-10-1011	HYLEBOS CREEK	PIERCE	R	5.90	M
841	WA-10-1020	PUYALLUP R.	PIERCE	RA	9.40	M
842	WA-22-4045	WILDCAT CREEK	GRAYS HARBOR	R	9.20	M
843	WA-28-1020	SALMON CR.	CLARK	R	26.40	M
844	WA-34-1020	PALOUSE R., S.F.	PALOUSE	RA	23.30	M
845	WA-37-1040	YAKIMA R.	YAKIMA	RA	12.50	M
846	WA-39-1037	CRYSTAL CREEK	KITTITAS	R	3.00	M
847	WA-39-1110	SELAH DITCH	KITTITAS	RA	0.98	M
848	WA-54-1020	SPOKANE R.	SPOKANE/STEVENS	RA	17.40	M
849	WA-59-1010	COLVILLE R.	STEVENS	RA	52.90	M
850	WI-LC-17-262	North Fork Eau Claire River Watershed	EAU CLAIRE	R	159.00	M
851	WI-LC-19-262	Lower Yellow River Watershed	CHIPPEWA	R	236.50	M
852	WI-LC-2063500-262	Red Cedar River	DUNN	R	111.00	M
853	WI-LC-23-262	Trimbelle River and Isabelle Creek Watershed	PIERCE	R	125.00	M
854	WI-LK-01-080	West Twin River Watershed	MANITOWOC	R	102.00	M
855	WI-LK-02-080	East Twin River Watershed	MANITOWOC	R	98.90	M
856	WI-LK-03-080	Kewaunee River Watershed	KEWAUNEE	R	87.20	M
857	WI-UF-07-111	Big Green Lake Watershed	GREEN LAKE	R	49.30	M
858	WI-UW-04-171	Hemlock Creek Watershed	WOOD	R	82.00	M
859	WI-UW-11-171	Mill Creek Watershed	PORTAGE	R	105.00	M
860	WI-UW-1179900A-171	Wisconsin River Mainstem Northern sub basin	LINCOLN	R	133.40	M
861	WI-UW-1179900B-171	Wisconsin River Mainstem Central sub basin	PORTAGE	R	64.00	M
862	WI-UW-1179900C-171	Wisconsin River Mainstem Southern Subbasin	ADAMS	R	62.20	M
863	WI-UW-14-171	Little Eau Pleine River Watershed	PORTAGE	R	197.20	M
864	WI-UW-17-171	Lower Big Eau Pleine River Watershed	MARATHON	R	94.00	M
865	WI-UW-18-171	Upper Big Eau Pleine River Watershed	MARATHON	R	171.00	M
866	WVKNL-22-(1)	HURRICANE W S WS	PUTNAM	L	12.00	A
867	WVKNL-30-A-(1)	RIDENOUR LK	KANAWHA	L	27.00	A
868	WVKNL-81-(1)	BLUESTONE LK	SUMMERS	L	2040.00	A
869	WVK-30	ARMOUR CK	PUTNAM	R	3.70	M
870	WVK-40	TYLER CK	KANAWHA	R	3.42	M
871	WVK-41	[illegible] CK	KANAWHA	R	4.71	M
872	WVK-43	ELK RV	KANAWHA	R	177.00	M
873	WVK-49	CAMPBELLS CK	KANAWHA	R	18.50	M
874	WVK-49-A	DRY BR/CAMPBELLS CK	KANAWHA	R	1.33	M
875	WVK-81	NEW RV	FAYETTE	R	87.00	M
876	WVK-82	GAULEY RV	FAYETTE	R	106.00	M
877	WVKE-23	BIG SANDY CK	KANAWHA	R	24.40	M
878	WVKE-37-B	LAUREL FK./LAUREL CK	CLAY	R	2.47	M
879	WVKG-23	[illegible]	NICHOLAS	R	2.25	M
880	WVKG-26	[illegible] CK	NICHOLAS	R	27.02	M

WaterBody System Report
List of WaterBodies

OBS	WBID	WBNAME	WBCOUN	WBTYPE	WBSIZE	WBUNIT
881	WVKG-34	CHERRY RV	NICHOLAS	R	10.45	M
882	WVKG-5-B	BELLS CK	FAYETTE	R	8.17	M
883	WVKN-10-A	HOUSE BR	FAYETTE	R	3.60	M
884	WVKN-21	ARBUCKLE CK	FAYETTE	R	6.20	M
885	WVKN-22	DUNLOUP CK	FAYETTE	R	15.80	M
886	WVKN-46	GREENBRIER RV	SUMMERS	R	146.00	M
887	WVKN-48	BLUESTONE RV	SUMMERS	R	62.00	M
888	WVKN-51	INDIAN CK	SUMMERS	R	34.00	M
889	WVKN-60	EAST RV	MERCER	R	18.40	M
890	WVKN-60-B	PIGEON CK	MERCER	R	3.70	M
891	WVKN-60-K	GRASSY BR	MERCER	R	1.60	M
892	WVKNB-12	BRUSH CK	MERCER	R	23.30	M
893	WVKNB-12-B	LAUREL CK/BRUSH CK	MERCER	R	8.80	M
894	WVKNB-12-G	DAVES FK/BRUSH CK	MERCER	R	3.80	M
895	WVKNB-12-J	SOUTH FK/BRUSH CK	MERCER	R	7.00	M
896	WVKNB-12-J-1	GREEN VALLEY/SO FK/BRUSH CK	MERCER	R	2.00	M
897	WVKNB-12-K	NORTH FK/BRUSH CK	MERCER	R	5.40	M
898	WVKNB-22	BLACKLICK CK	MERCER	R	7.80	M
899	WVKNB-28	WIDEMOUTH CK	MERCER	R	6.60	M
900	WVKNB-28-B	RIGHTHAND FK/WIDEMOUTH CK	MERCER	R	7.80	M
901	WVKNB-28-C	LEFT HAND FK/WIDEMOUTH CK	MERCER	R	5.60	M
902	WVKNB-3-C-1	JUMPING BR	SUMMERS	R	5.50	M
903	WVKNB-30	CRANE CK	MERCER	R	6.80	M
904	WVKNB-31	LORTON LICK CK	MERCER	R	5.00	M
905	WVKNB-36	BRUSH FK	MERCER	R	6.80	M
906	WVKNG-25	HOWARD CK	GREENBRIER	R	22.70	M
907	WVKP-5	ROCKY FK	KANAWHA	R	6.08	M
908	WVKP-5-A	FISHER BR	KANAWHA	R	3.53	M
909	WVLK	LITTLE KANAWHA RV	WOOD	R	169.00	M
910	WVLKH-9	SOUTH FK/HUGHES RV	RITCHIE	R	55.50	M
911	WVM	MONONGAHELA RV	PRESTON	R	37.50	M
912	WVM-23	BUFFALO CK	MARION	R	30.20	M
913	WVM-27	TYGART RV	MARION	R	130.20	M
914	WVMC-12-B-5	CHERRY RN	PRESTON	R	3.80	M
915	WVMC-33	BUFFALO CK	PRESTON	R	9.10	M
916	WVMY-2	SHORT CK	PRESTON	R	6.19	M
917	WVO-20	KANAWHA RV	MASON	R	97.00	M
918	WVO-3-B	GRAPEVINE BR	CABELL	R	3.40	M
919	WVO-32	MILL CK	JACKSON	R	29.36	M
920	WVO-32-L-7-E	SHAMBLEN BR	JACKSON	R	1.14	M
921	WVO-4	GUYANDOTTE RV	CABELL	R	168.00	M
922	WVO-91	HARRISON RN	BROOKE	R	1.00	M
923	WVOG-2	MUD RV	CABELL	R	79.00	M
924	WVOG-3-A	LEFT FK/DAVIS CK	CABELL	R	2.50	M
925	WVOG-49-E-7	BARKER FK/GARRETT FK	LOGAN	R	1.52	M
926	WVOGM-6	FUDGES CK	CABELL	R	6.65	M
927	WVP	POTOMAC RV	JEFFERSON	R	115.00	M
928	WVP-3	ELKS RN	JEFFERSON	R	6.29	M
929	WVP-13	CACAPON RV	MORGAN	R	110.00	M
930	WVP-19	LITTLE CACAPON RV	HAMPSHIRE	R	28.96	M
931	WVP-20	NORTH BR/POTOMAC RV	HAMPSHIRE	R	75.75	M
932	WVP-21	SOUTH BR/POTOMAC RV	HAMPSHIRE	R	85.00	M
933	WVPC-23-A-1	TROUT POND RN	HARDY	R	2.89	M
934	WVPSB-21	SOUTH FK/SOUTH BR POTOMAC	HARDY	R	75.99	M
935	WVPSB-25-A	JOHNSON RN	GRANT	R	4.20	M

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WaterBody System Report
List of WaterBodies

OBS	WBID	WBNAME	WBCOUN	WBTYPE	WBSIZE	WBUNIT
936	WVPSB-25-C-2	SPRING RN/SO MILL CK	GRANT	R	2.70	M
937	WVPSB-26-D-2	STAR RN/SO FK/LUNICE CK	GRANT	R	2.39	M
938	WVPSB-28-A-1	BIG RN/JORDAN RN	GRANT	R	1.71	M
939	WVPSB-33	REEDS CK	PENDLETON	R	2.60	M
940	WVS	SHENANDOAH RV	JEFFERSON	R	19.45	M
941	WVS-1	FLOWING SPRINGS RN	JEFFERSON	R	6.63	M
942	WVS-2	CATTAIL RN	JEFFERSON	R	3.66	M
943	WVS-4	EVITTS RN	JEFFERSON	R	10.30	M

APPENDIX D

WATER BODY SYSTEM 305(b) DATA: WATERBODIES FOR WHICH POINT/NONPOINT SOURCE NUTRIENT TRADING APPEARS APPLICABLE IN THE FUTURE

WaterBody System Report
List of WaterBodies

OBS	WBID	WBNAME	WBCOUN	WBTYPE	WBSIZE	WBUNIT
1	MN07020006003	N/A	N/A	N/A	N/A	N/A
2	MSE001	BACK BAY OF BILOXI (AT OCEAN SPRINGS)	JACKSON	E	6.00	S
3	MSL009	CRYSTAL LAKE	RANKIN	L	200.00	A
4	TN06020001038	DECATUR CREEK	MEIGS	R	7.90	M
5	TN06020002005	CANDIES CREEK	BRADLEY	R	30.20	M
6	TN08010208012	HATCHIE RIVER	HAYWOOD	H	26.80	M
7	TN08010208016	HATCHIE RIVER	HARDEMAN	R	13.90	M
8	VT03-03	Mid-Main Stem Otter Creek	N/A	H	34.10	M
9	VT13-01	Upper Southern Connecticut River	WINDSOR	H	20.50	M
10	VT13-02	Upper Mid Southern Connecticut River	WINDSOR	H	21.50	M
11	VT13-03	Mid-Southern Connecticut River	WINDHAM	H	24.00	M
12	VT13-04	Vernon Impoundment	WINDHAM	R	7.50	M
13	WA-08-9350	WASHINGTON LAKE	KING	LL	22138.00	A
14	WA-28-9090	VANCOUVER LAKE	CLARK	L	2858.00	A
15	WA-41-9250	MOSES LAKE	GRANT	LL	6800.00	A
16	WVPC-24	LOST RV	HARDY	R	26.03	M
17	WYBR16010101-059-2	WOODRUFF NARROWS RES	LINCOLN	L	1409.00	A