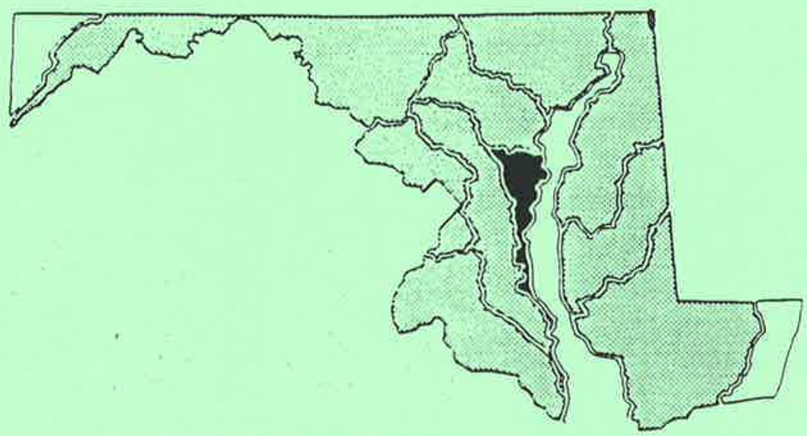
TRIBUTARY STRATEGY FOR NUTRIENT REDUCTION IN MARYLAND'S LOWER WESTERN SHORE WATERSHED



May, 1995

Maryland Department of the Environmment
Maryland Department of Natural Resources
Maryland Department of Agriculture
Maryland Office of State Planning
Maryland Governor's Office
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PREFACE

In 1983, the states of Maryland, Pennsylvania, and Virginia, the District of Columbia, the Chesapeake Bay Commission, and the U.S. Environmental Protection Agency joined in a partnership to restore the Chesapeake Bay. Leaders of these jurisdictions recognized that the Bay's problems could not be solved by any one of them acting alone. In 1987, they signed the Bay Agreement to remedy the most pervasive pollution problem by working cooperatively toward a 40% reduction in nutrients entering the Bay by the year 2000. In 1992, they acknowledged that the Bay was in decline because of changes in the watershed as a whole, and likewise, that the Bay's restoration is dependent upon a watershed-wide solution. The Bay Agreement was therefore amended to require tributary-specific plans for nutrient reduction in the Bay's major tributaries.

Significant progress has been made toward the nutrient reduction goal, but much remains to be done. This is especially true given that the nutrient reduction goal results in a nutrient load cap which we are not to exceed. Each of the aforementioned jurisdictions is currently developing "Tributary Strategies" that describe the ways in which nutrient pollution loads can be reduced by 40% in the many sub-watersheds that drain into the Bay. This coordinated watershed-by-watershed approach brings the Bay clean-up closer to home for the many citizens and local governments that must participate for the restoration to be successful. The benefits of these Strategies will be realized not only in the Bay itself, but also in the local streams and rivers and in the groundwater that directly affect our health and quality of life.

This document is a Strategy or an approach to achieve the 40% nutrient reduction goal for the Lower Western Shore watershed. It represents a collective effort over the past year among all levels of government, and extensive input by various interest groups and citizens. The local governments, in particular, have spent considerable time and effort and provided numerous comments on the draft Strategies. The Strategy shows how the goal may be achieved through specific programs and practices, called "nutrient reduction options." In implementing the Strategy over the coming years, new information on methods to reduce nutrient pollution will undoubtedly come to light, available funding will change, more detailed data on watershed conditions and needs will become available, and priorities will shift. This Strategy is meant to be flexible in order to incorporate these changes so that the goal can be met in the most efficient and practical manner. Locally-based "Tributary Implementation Teams" will be established to facilitate the continued participation of local governments, interest groups, and citizens in deciding how best to refine and implement the Strategies to meet our shared goals.

Three public meetings were held in 1993 and 1994 to discuss the development of this Strategy. The draft Strategy produced in spring 1994 has since been revised in response to public comment. Among the more frequently heard recommendations were a greater focus on education, improvement of existing regulations, and emphasis on cost-effective options and on practices with benefits in addition to nutrient reduction. Other revisions to the Strategy were due to data corrections, practical implementation considerations, and as a result of changes in or new state laws or policies adopted during the drafting of the Strategy.

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The Problem

The Chesapeake Bay is the nation's largest estuary and one of its most valuable and treasured natural resources. It is home to a rich diversity of over 2,700 plant and animal species, and serves as a major commercial and recreational resource for the people of Maryland. Unfortunately, water quality and living resources in this great Bay have declined markedly over the last several decades. Bay waters have become murky from pollution, unable to support the underwater grasses that serve as critical habitat for Bay life. This, combined with other stresses, has dramatically reduced fish, shellfish, waterfowl, and other wildlife populations, degraded our drinking water supplies, and diminished recreational opportunities, thereby reducing our ability to earn a living and to enjoy the Bay.

In the late 1970s, scientists began an extensive study of the Chesapeake Bay to determine the reasons for its decline. Three major problems were identified:

- excess **nutrients** from wastewater, agricultural land, and developed land;
- **sediment** runoff from farms, construction sites, and other lands; and
- possibly elevated levels of **toxic** chemicals.

All three problems are being addressed in the Chesapeake Bay restoration. This Tributary Strategy focuses on the largest problem, the reduction of excess nutrients—nitrogen and phosphorus—entering the Bay.

Restoration Commitments

To address the Bay's problems, a watershed-wide restoration effort began in the early 1980s.

- **In 1983**, the Bay jurisdictions (Maryland, Virginia, Pennsylvania, and the District of Columbia), the Chesapeake Bay Commission (representing the legislative bodies of Maryland, Pennsylvania, and Virginia), and the federal government made a joint commitment to restore the Bay's water quality and living resources and established the Chesapeake Bay Program.

- **In 1987,** the Bay Agreement was signed by the parties above (called the Chesapeake Bay Executive Council). A major element of the Agreement was the commitment to reduce nutrients entering the Bay by 40% by the year 2000. Bay scientists have determined that this step will increase oxygen in the deep waters of the Bay by about 20%, resulting in more "livable" habitat for the Bay's living resources. Equally important, scientific forecasts show that the Bay will get significantly worse if nothing is done.

- **In 1992,** amendments to the Agreement reaffirmed the 40% goal and highlighted the importance of the Bay's tributaries. As a result, the Bay Program is "moving upstream," renewing the focus on the rivers of the Chesapeake. These rivers carry nutrients and sediment to the Bay. If we can reduce the amount of nutrients entering the rivers, we will reduce the pollution flow to the Bay. This will not only help the Bay, but will bring cleaner water and more living resources to the rivers and streams of Maryland.

- **In 1993 and 1994,** development of the Strategies or plans to reduce the pollution entering the rivers were initiated and these plans are the main focus of this document.

- **In 1997,** the Strategies will be reevaluated for progress to determine if mid-course corrections are necessary.

Significant progress has been made as a result of the Bay restoration effort. Since 1985, the baseline year for measuring the reductions, Maryland has reduced nitrogen entering its tidal waters from controllable sources by 23% and phosphorus by 38%. But more remains to be done. To gain the full benefits of our work so far, and to continue our progress toward our goal, we in Maryland must bring the commitment of the Bay Agreement to our own neighborhood rivers and streams.

What is a Tributary Strategy?

A Tributary Strategy is a comprehensive approach to reducing nutrient pollution in a watershed. It is developed by the state, local governments, and citizens living and working in the watershed. To achieve the 40% nutrient reduction for the state, Maryland's Chesapeake Bay watershed has been divided into ten major tributary watersheds, of which the Lower Western Shore is one. Each of these tributaries has a specific nutrient reduction goal which, when summed across all the tributaries, will allow Maryland to achieve its overall reduction goal. This regional focus allows the state and local governments to work with the public to build a locally-based framework to protect and restore the rivers and streams of the Lower Western Shore watershed.

The Lower Western Shore Tributary Strategy is a collaborative effort by state and local government staff, a workgroup from the agricultural community in the Lower Western Shore watershed, and participants in public meetings. It includes a number of "options"—practices and programs that reduce nutrient pollution—that together will achieve the 40% nutrient reduction goal.

The Strategy is a combination of existing regulatory programs and comprehensive voluntary programs. It includes some options we know will reduce nutrients, but don't know by how much. The Strategy is a plan for achieving the 40% nutrient reduction goal that will undoubtedly be fine-tuned and improved as it is implemented between now and the year 2000. The Strategy will reflect public, local, state, and federal government concerns, availability of resources, and the emergence of new technologies. A critical part of the Tributary Strategy, other than the plan itself, is the process that is being established for making it work, a process that relies upon the participation of all those who have a role in its success.

The Tributary Strategies present a unique opportunity to change the way we manage resources. The Strategies focus on our watersheds, rather than the traditional jurisdictions of county or state boundaries. This innovative approach is an opportunity for citizens to have critical input into how natural resources are managed in their own watershed. By providing a framework for a comprehensive approach to watershed management, the Tributary Strategies provide an opportunity to integrate nutrient reduction efforts, habitat restoration, growth management and planning, preservation of agricultural lands, protection of drinking water reservoirs and aquifers, and other initiatives to promote a healthy environment and livable communities.

Living Resources in the Tributary Strategies

The Tributary Strategies are part of the larger effort to restore the Bay's living resources that includes habitat restoration, toxics reduction, removal of blockages to fish spawning areas, and improved fisheries management. The ultimate purpose of the Tributary Strategies is to restore the water quality necessary for the Bay's living resources. The 40% reduction goal was reaffirmed by the Bay scientists after determining that meeting this goal would improve the dissolved oxygen and water clarity needed to support fish communities and Bay grasses in the mainstem of the Bay. The Strategies recognize that improvements in the mainstem of the Bay depend on nutrient reductions in the tributaries and thereby extend this goal to improve water quality and habitat to the tributaries as well.

Many of the options included in the Strategies have additional purposes other than nutrient reduction. Forested buffers and nonstructural shore erosion controls, for example, create wildlife and aquatic habitat as well as reduce nutrients. Implementing these and other options, such as forest and wetland conservation, will provide additional benefits to living resources through the protection and creation of habitat. Options that create and restore habitat may be particularly cost-effective components of the Strategy when all of their benefits are considered. The Strategies aim to incorporate these considerations in setting implementation priorities.

As we begin to implement and track the progress of the Strategies, living resources will indicate improvements in environmental quality. The Chesapeake Bay Program has already set quantitative targets for the restoration of Bay grasses, a primary indicator of improving water quality. Other indicators are being developed for areas further upstream such as an "index of biotic integrity" which combines information on different fish species to indicate the overall health of the ecosystem.

The Tributary Strategy Process

Public meetings to discuss the draft Lower Western Shore Tributary Strategy were held in 1993 and 1994. During these meetings, interested citizens commented on the process of developing the Strategy, what options should be included in it, and how these options could be implemented. The public raised strong support for education targeted to homeowners and voluntary efforts, improved enforcement of existing regulations, options that are cost-effective and site-specific in design and implementation, and practices that have environmental benefits in addition to nutrient reductions. Public comments on the draft Strategy are helping ensure that the Strategy for the watershed is workable, fair, cost-effective, and recognizes the environmental priorities of its citizens and local governments.

Developing and implementing this Strategy is an evolving process. The Strategy, revised in response to public comments, data fine-tuning, and other technical and practical implementation considerations, is part of Maryland's commitment to meet its 40% nutrient reduction goal. Tributary Implementation Teams will be formed in each of Maryland's ten tributaries to assist with refining and implementing the Strategies (see "Implementation"). A progress review of the Strategy will be undertaken in 1997.

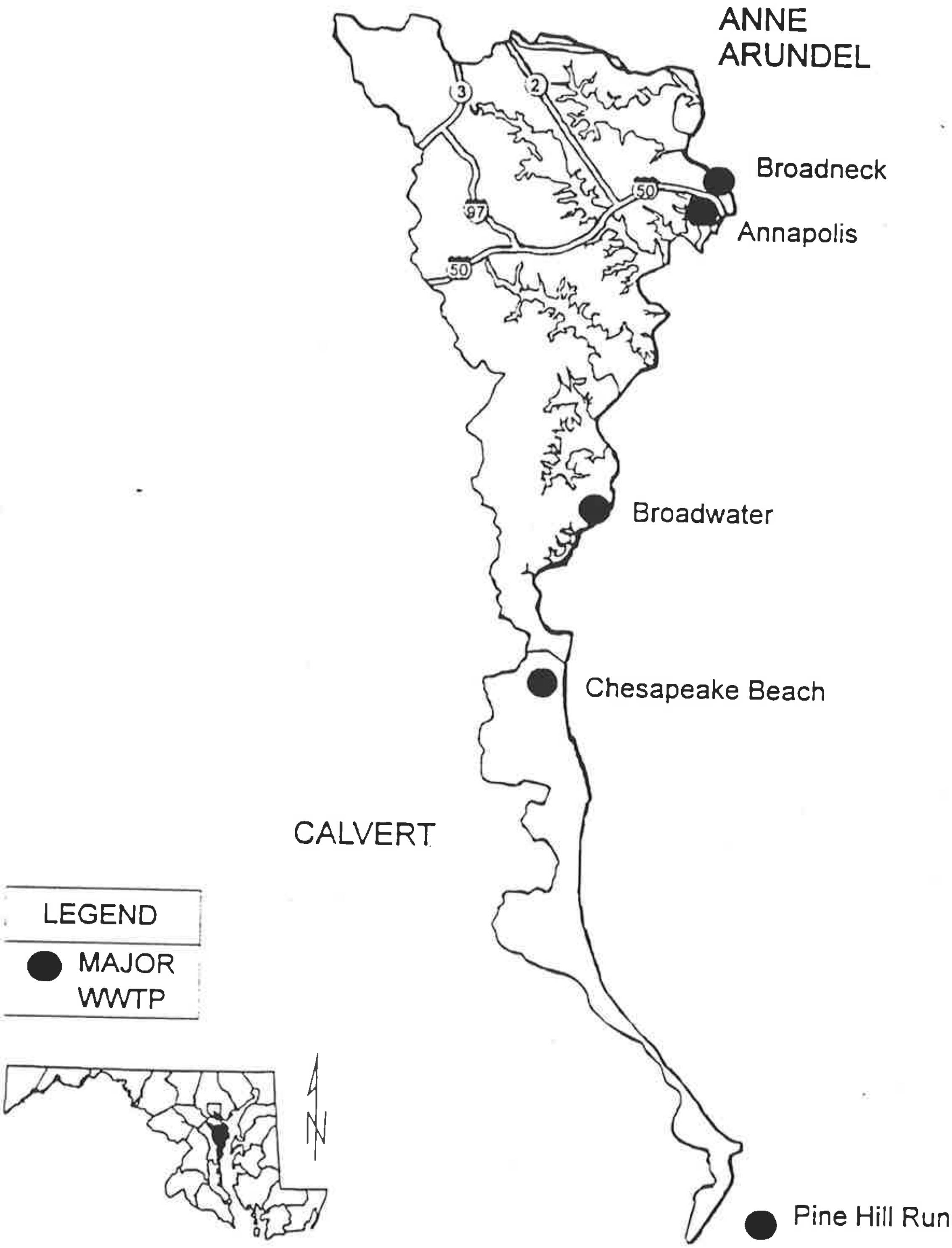
To maintain the progress that has been made and to continue to protect the Bay beyond the year 2000, all of the signatories to the Chesapeake Bay Agreement agreed that once the 40% reduction has been achieved, nutrient pollution to the Bay should not be allowed to increase. This "cap" on nutrient loads means that future growth and development must be managed in a way that does not cause additional nutrient pollution. Meeting this challenge will require ongoing collaboration between state and local governments and the people who live in the Lower Western Shore watershed.

The Lower Western Shore Watershed

The Lower Western Shore watershed covers about 270 square miles, extending from south of the Baltimore Beltway in a narrow band along the western shore of the Bay to the mouth of the Patuxent River. The upper part of the watershed encompasses the area between Annapolis and Baltimore and has experienced major population growth and changes in land use in recent years. The watershed includes the Magothy, Severn, South, Rhode and West rivers, as well as numerous smaller streams. It includes parts of Anne Arundel and Calvert counties (see Figure 1).

The Lower Western Shore provides spawning grounds for one species of river herring and yellow and white perch. The freshwater streams in the watershed support about 13 species of fish, and over 40 species of fish can be found in the low salinity tidal portions of the rivers. The brackish, saltier nearshore Bay is home to nearly 70 kinds of estuarine and marine fish, including striped bass, flounder, and bluefish.

Figure 1. Lower Western Shore Watershed



Map prepared by the Maryland Office of Planning,
modified by the Maryland Department of the Environment

Despite this diversity, populations of several important fish species—such as white and yellow perch, and river herring—are at low levels. Populations of pollution tolerant fish such as menhaden and gizzard shad are increasing. In 1991, no bay grasses were identified in the annual aerial survey of the watershed. The Bay Program has set an initial restoration target of 1,408 acres of bay grasses needed to provide habitat for living resources in the rivers and nearshore Bay of the Lower Western Shore.

In most of the Lower Western Shore watershed, dissolved oxygen levels become very low in the warmer months, creating poor habitat conditions for fish, shellfish, and benthic animals. Nitrogen, phosphorus, and algae concentrations throughout the watershed are too high, impacting habitat quality and limiting the ability of submerged aquatic vegetation to grow and survive. Nitrogen levels in the South, Severn, and Rhode rivers appear to be improving. Phosphorus levels in the South, Severn, and West rivers also seem to be improving. Algal levels are not changing significantly in any tributaries of the Lower Western Shore watershed.

Nutrient Loads and Goals

From the Lower Western Shore basin, 1.7 million pounds of nitrogen and 0.26 million pounds of phosphorus enter tidal waters each year from all sources (see Table 1). To restore important habitats and improve water quality in the rivers and the Bay, state and local governments have pledged to work toward a 40% reduction in the "controllable" part of this load, that is, the pollution part caused by man's activities which include point sources (wastewater treatment plants) and nonpoint sources (polluted runoff and groundwater from agricultural and developed land). This translates to a reduction goal of 0.5 million pounds of nitrogen and 0.1 million pounds of phosphorus which, when subtracted from the 1985 base load, results in the loading cap shown in Table 1. To achieve this loading cap, pollution will have to be reduced from all sources: wastewater treatment plants, agriculture, and developed lands.

Reductions due to air pollution controls are not counted towards the attainment of the 40% reduction goal. Atmospheric loads, however, are included in the nonpoint source (NPS) load estimates. Only deposition directly to water surfaces (a relatively small load) is not considered in these estimates.

Table 1. Nitrogen and Phosphorus 1985 Base Loads, Controllable Loads, Reduction Goals and Loading Caps for the Lower Western Shore Watershed

Loading Source	Nitrogen Load (million lbs/yr) 1985 Base	Nitrogen Load (million lbs/yr) Controllable	Phosphorus Load (million lbs/yr) 1985 Base	Phosphorus Load (million lbs/yr) Controllable
Point Sources	0.7	0.7	0.18	0.18
Total Nonpoint Sources (NPS)	1.0	0.6	0.07	0.06
Agricultural Land NPS	0.2	0.2	0.02	0.02
Developed Land NPS	0.6	0.4	0.05	0.04
Undeveloped Land NPS	0.2	0.0	0.00	0.00
Direct Atmospheric	0.1	0.0	0.00	0.00
Total Load	1.7	1.2	0.26	0.24
40% Reduction Goal	-0.5	(40% of Controllable)	-0.10	(40% of Controllable)
Loading Cap	1.2		0.16	

Notes:

1) Due to rounding errors, some numbers in the table may not equal the totals shown.
2) 1985 base load is the estimated amount of nutrients entering tidal waters in 1985.
3) Controllable load is the 1985 base load minus the load if the watershed were totally forested and with no point sources. This can be thought of as the "pollution load" due to man's activities in the watershed.
4) 40% Reduction Goal = 40% of Controllable Load. The 40% reduction goal applies to the total controllable loads. Load reductions from each source will depend on the final strategy that is selected and implemented.
5) Loading Cap = 1985 Base - 40% Reduction Goal
6) Point source load is the load delivered to tidal waters from municipal point sources > 1000 gal/day plus major industrial and military discharges.
7) Undeveloped land nonpoint source (NPS) load is from forest and wetland areas and is not considered a controllable or "pollution load".
8) Direct atmospheric is the load from the atmosphere to water surface only, atmospheric load to land is included in the three land use categories.

How the Strategy was Assembled

To assemble the Strategy, nutrient reduction options were prioritized as described below until the 40% goal was achieved. Achieving equity among categories of options was an important consideration throughout this process (see the attached glossary for a complete list and brief descriptions of the options). The first three options below were included in every Tributary Strategy:

- All wastewater treatment plants (WWTPs) with a design flow equal to or greater than 0.5 million gallons per day (MGD) will be expected to implement chemical phosphorus removal and install biological nutrient removal (BNR) or equivalent technology for nitrogen removal. While the technology will be designed to operate seasonally, every effort will be made to operate the BNR process for as much of the year as feasible in order to remove more nitrogen.

- All existing regulatory programs with nonpoint source control benefits (e.g., erosion and sediment control, stormwater management, and implementation of the Forest Conservation Act) will be fully implemented and enforced.

- All other options currently being implemented will continue to be implemented at current funding levels.

If the combination of the above options did not reach the 40% goal, then the following options were included, as needed, above and beyond the first three options to achieve the 40% goal:

- A target of at least 10% of the maximum feasible coverage was set for educational programs promoting septic system pumping, urban/suburban nutrient management, and domestic animal waste control.

- Increased implementation of the remaining options at "realistic" levels based on cost-effectiveness and past implementation levels. (Cost-effectiveness is the lowest cost per pound for the nutrient not yet reduced by 40%.)

If the combination of the options listed above still fell short of the 40% goal, then:

- Remaining options were included at the maximum feasible level, in order of cost-effectiveness.

Strategy Description

Over the past year, state and local government staff and concerned citizens have worked together to develop a menu of "nutrient reduction options." These include both regulatory and voluntary (e.g., incentive and educational) programs encompassing existing programs, new directions for state and local governments, and nongovernmental activities. Many of these options have important benefits, such as habitat creation or runoff control, in addition to nutrient reduction. The following sections describe what is necessary to achieve an overall 40% nutrient reduction in the four major categories of options: wastewater treatment plants, developed land, agricultural land, and resource protection and watershed planning. The potential for further expanding the selected options, or adding new ones, is also discussed. Several options could contribute more significantly to nutrient reduction if existing obstacles to implementation (such as need for public education, lack of eligibility for funding, etc.) are addressed.

Wastewater Treatment Plants

The Strategy calls for the implementation of biological nutrient removal (BNR) of nitrogen and chemical phosphorus removal (CPR) at all wastewater treatment plants that currently have a design flow equal to or greater than 0.5 MGD. If smaller WWTPs are expanded to above 0.5 MGD in the future, the expectation is that BNR and/or CPR will be implemented at the time of expansion.

The implementation of BNR at each of these WWTPs has been and will continue to be achieved through the adoption of a BNR Agreement between the Maryland Department of the Environment (MDE) and the jurisdiction controlling the plant. The Agreement calls for the controlling jurisdiction to design and construct facilities so as to achieve a seasonal (April-October) total nitrogen concentration of 8 mg/l and operate the BNR process for as much of the year as possible in order to maximize nitrogen removal. After a trial period of operation, permit language will be drafted based upon the plant's performance during this period. The duration of the trial period as well as the conditions that will be included in the plant's discharge permit have not yet been determined. For most of the major plants statewide, phosphorus removal is a discharge permit requirement.

Based on our limited experience with the performance of BNR at existing WWTPs, MDE believes that a plant designed to meet a seasonal total nitrogen (TN) limit of 8 mg/l will actually yield an annual average TN concentration of 8 mg/l if the BNR process is operated year-round. In the warmer months of the year (April-October), TN concentrations should range from 4 mg/l to 8 mg/l, while in the colder months of the year (November-March), TN concentrations should range from 9 mg/l to 13 mg/l. If the BNR process is only in effect during the design period of April through October, the average annual TN concentration should be about 10 mg/l.

Annual BNR with CPR was selected as the point source nutrient reduction option because it was determined to be the most cost-effective method of removing nitrogen and phosphorus from wastewater. If future evaluations of nutrient reduction progress show that the goals in the watershed will not be met with the existing Strategy, options that may be considered as part of the revised Strategy will be upgrading of major WWTPs with advanced nutrient removal (limit of technology) and/or implementation of BNR and CPR at some of the minor WWTPs (less than 0.5 MGD).

Two of the five major WWTPs in the Lower Western Shore basin are currently removing nitrogen. The Chesapeake Beach plant has been operating with BNR of nitrogen since 1991 and currently has a seasonal nitrogen limit of 10 mg/l. Construction to modify the Broadneck WWTP for BNR of nitrogen has just been completed. MDE has scheduled the two major WWTPs without nitrogen removal to be upgraded with BNR of nitrogen by the year 2000. The Annapolis plant is currently experimenting with a new ring lace media technology which increases bacterial growth, thereby increasing the rate of denitrification. The plant is planned for full-scale upgrade within the next year.

The Pine Hill Run wastewater treatment plant is located in St. Marys County, south of the Patuxent River mouth. This plant is included in the Lower Western Shore rather than the Lower Potomac because it discharges directly to the Bay. The feasibility of options for retrofitting the Pine Hill Run wastewater treatment plant with BNR and/or upgrading the plant are currently under study. Anne Arundel County has also signed an agreement with MDE to upgrade the Broadwater WWTP.

Three of the five major WWTPs also have some level of phosphorus removal. The Broadneck plant has BNR of phosphorus. The Annapolis plant, which has a year round phosphorus limit of 2 mg/l, achieves phosphorus removal through a combination of BNR of phosphorus and the addition of ferrous sulfate at county pumping stations. The Chesapeake Beach plant, which has a seasonal phosphorus limit of 2 mg/l applicable from April through October, utilizes BNR of phosphorus rather than chemical addition. The plant does, however, have chemical addition facilities as a backup.

One result of the wastewater treatment process is a by-product known as sludge. The sludge that remains after organic material is broken down contains valuable plant nutrients. Some sludge is incinerated or landfilled, but the best way to dispose of sludge is to "recycle" it as plant fertilizer. Many farmers therefore allow sludge application on their crop or pasture land to save on chemical fertilizer costs. MDE requires nutrient management plans to be in place before sludge application, facilitating development of nutrient management plans and assuring that only necessary amounts of nitrogen are added to the land.

Developed Land

For all newly developed land, the Strategy calls for the full implementation of existing state and local regulatory programs for erosion and sediment control and stormwater management. Granting of waivers should be minimized. In addition, state requirements for both programs are being revised and strengthened. Erosion and sediment control standards and specifications have been revised and were implemented in the summer of 1994. State stormwater management program requirements are currently being revised to improve stormwater quality control by introducing alternatives for development site design and promoting the use of marshes, wet ponds, and extended detention or retention facilities.

Nonregulatory programs for urban lands that contribute to nutrient reductions include retrofitting previously developed land with stormwater control measures and converting existing dry ponds to more effective stormwater management practices. Stormwater retrofits apply to land that was developed without stormwater controls. This option is expensive because land available for stormwater facilities is often scarce, but controls are necessary to achieve water quality and stream protection benefits in urban areas. Several such projects are planned in this basin. Additional projects will be identified as part of more detailed watershed water quality management planning by local governments.

Educational efforts will also be enhanced in a number of areas affecting pollution control on developed land. Nutrient management efforts for private homes, businesses, roadways, and public land need to be increased. Outreach and education efforts will be strengthened and improved; educational materials will be developed and published to provide landowners with specific guidance for types of vegetation, landscaping methods, and organic waste and fertilizer management to minimize environmental impacts. Operation and maintenance of septic systems can also be improved through the use of low-flow plumbing fixtures, reduction in the use of garbage disposals, and regular pumping to remove accumulated solids. Not only will these measures improve the nutrient removal capabilities of septic systems, but they will also prolong the life of these systems and save on expensive repair and replacement costs.

Agricultural Land

Agriculture is the smallest land use in the Lower Western Shore, yet the implementation of agricultural best management practices (BMPs) will make an important contribution to nutrient reductions in this tributary. The Lower Western Shore agricultural workgroup identified a list of applicable BMPs for this tributary. The group pointed out that there are BMPs that many farmers implement on their own, including conservation tillage and nutrient management. The nutrient reductions that are associated with these are unknown but need to be acknowledged. The draft Strategy calls for the expansion of BMP implementation to maximum feasible levels.

Implementation of nutrient management plans, cover crops, conservation tillage, Soil Conservation and Water Quality Plans (SCWQPs), and treatment of lands with high erosion potential will contribute significantly to nutrient reduction in the Lower Western Shore. Nutrient management plans will need to be increased from the current level of less than 1% to 86% of applicable acres. Much of this will be achieved through the assistance of certified private consultants. In addition, cover crops will need to be planted on 50% of the cropland acres available for timely planting of cover crops. Conservation tillage in the Lower Western Shore will need to be accelerated from the current level of 46% to 81% of cropland. Existing educational programs can be used to achieve this goal. SCWQPs are currently on 42% of the agricultural land in the Lower Western Shore and this percentage should increase to 80%. Treatment of lands with high erosion potential will need to occur on 80% of the applicable cropland acres.

While most of the nutrient reductions from agricultural lands will be achieved through the five practices described above, others will also be important. New animal waste management systems will reduce pollution. Implementing horse pasture management for reducing nutrient pollution from horse operations in suburban to rural areas is also recommended and will require additional resources.

Resource Protection and Watershed Planning

Resource protection options include a range of practices designed to protect forests, wetlands, and other natural areas. These ecosystems generate fewer nutrients than any other land use, and some, such as forests and wetlands, actually function as nutrient filters. Many of these options—such as forested buffers and nonstructural shore erosion control—help restore habitat for fish and wildlife, and the food webs they depend on. The implementation targets for each practice included in the Strategy are the minimum needed to achieve the 40% nutrient reduction goal. Additional implementation above these targets would help to restore the biological diversity and abundance of our streams, rivers, and the Bay.

Among the resource protection options, a priority will be planting streamside forested buffers and protecting existing buffers on agricultural and developed lands. The Departments of Natural Resources and Agriculture, together with other interested groups, have begun working to identify and address existing obstacles to planting forested and grassed buffers, and other stream protection measures. Recommendations include promoting flexible, site-specific solutions; providing incentives to private landowners to protect riparian areas; and providing additional resources for technical assistance.

The Strategy recognizes the benefits of the Forest Conservation Act, which is estimated to reduce forest loss by at least 20% between now and the year 2000. Under the Strategy, tree planting will be increased and a broader coverage of forest harvesting best management practices will be achieved through logger training, enforcement, standardized permit procedures, and monitoring. These steps will promote full implementation of existing regulatory requirements, such as erosion and sediment control, and greater coverage of additional voluntary measures that may be appropriate at a given site. The Strategy also recommends an increase in structural and nonstructural (vegetative) shore erosion controls, which prevent sediment and associated nutrients from entering the Bay.

In spring 1994, Maryland passed legislation requiring the installation of marine sewage pumpouts at all marinas with 50 or more slips and all new or expanding marinas over ten slips. Federal funding under the Clean Vessel Act will allow the state to expand its grant program to marinas to cover the full cost of installing these new pumpouts. State and federal law prohibit the discharge of raw sewage into the Bay, and legislation passed in 1994 will allow state enforcement of this provision. The Strategy calls for pumpout use by all boats with holding tanks. The state will be focusing its efforts on educational programs for boaters to encourage pumpout use.

Many resource protection and watershed planning options help reduce nutrient pollution, but have benefits that are difficult to quantify. Calvert County, for example, is developing a wetland watershed plan to improve wetlands protection and facilitate mitigation efforts. Other programs that prevent nutrient pollution include the Critical Area Law, which has been estimated to reduce nutrients from critical areas by 20-30%; the 1992 Economic Growth, Resource Protection and Planning Act, which requires the State and local governments to protect sensitive areas and concentrate growth; and local planning and zoning ordinances to protect streams, shorelines, and wetlands. Because we lack nutrient reduction estimates for these programs, they are considered to be "unquantified options" that contribute to maintaining the cap on nutrient loads. Anne Arundel and Calvert counties are participating in a demonstration project in the Patuxent watershed to improve estimates of the impacts of many land management practices on water quality. The results of this project, which is analyzing practices and programs such as clustering, stream buffer protection, and the Forest Conservation Act, will assist planning efforts in the Lower Western Shore watershed as well.

Strategy Recommendations

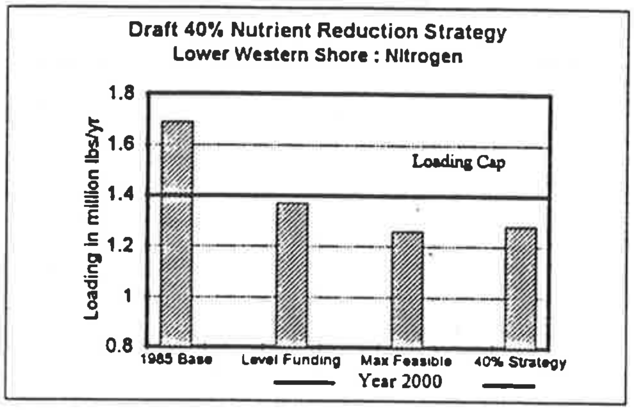
The figure and table that follow provide a summary of the estimated load reductions that will be achieved with the implementation of the Strategy recommendations.

Figure 2 provides a graphical summary of the nutrient loads and their estimated reductions by the year 2000 under different nutrient reduction scenarios. The figure illustrates the base nutrient loadings, two loading levels that set the lower and upper boundaries for nutrient reduction, and the loads resulting from Strategy implementation.

Figure 2. Graphical Summary of the Tributary Strategy for the Lower Western Shore Watershed

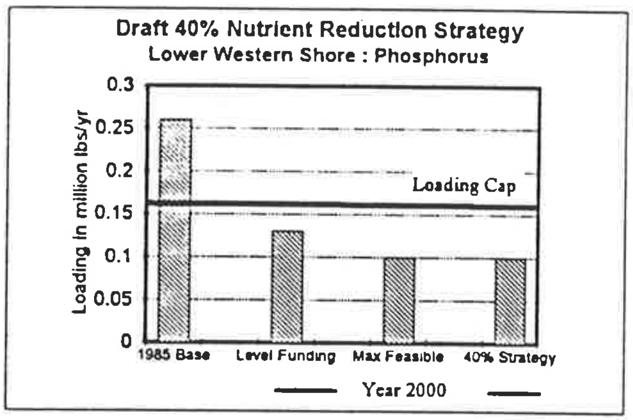
Nitrogen

Coverage	Load in million lbs/yr
1985 Base	1.69
Level Funding	1.37
Max Feasible	1.26
40% Strategy	1.28
Loading Cap	1.19



Phosphorus

Coverage	Load in million lbs/yr
1985 Base	0.26
Level Funding	0.13
Max Feasible	0.10
40% Strategy	0.10
Loading Cap	0.16



Notes:

1) "1985 Base" is the estimated total load from this watershed to the Bay under 1985 point and nonpoint source loading conditions.
2) "Level Funding" coverage is the load that can be expected by 2000 if current programs and practices were continued through 2000 with financial and staff resources comparable to the present.
3) "Maximum Feasible" coverage is the load that can be expected by 2000 with the highest feasible level of implementation of nutrient reduction options as determined by best professional judgment.
4) "40% Strategy" is the load estimated by the year 2000 if the Strategy is fully implemented.
5) "Loading Cap" is the loading expected if 1985 point and controllable nonpoint source loads are reduced by 40% and is shown as the dark horizontal line in the graphs.

Understanding the bounds of what the Strategy can accomplish is important to understanding the Strategy.

- The first bar, labeled "1985 Base," indicates the estimated amount of nutrients entering the tributary's tidal waters in 1985 as shown in Table 1. This is the starting point for the Strategy. The dark horizontal line indicates the loading cap after a 40% reduction of the "controllable" or pollution load.
- The second bar, labeled "Level Funding," shows the estimated load in 2000 if reductions achieved by current programs were continued at the same rates through 2000. This scenario includes projected growth and illustrates what will be achieved if we continue current program implementation with financial and staff resources comparable to the present.
- The third bar, "Max Feasible," shows the maximum nutrient load reduction that can be accomplished between 1994 and 2000 with projected growth in this tributary and with the highest feasible level of implementation of the nutrient reduction options as determined by the best professional judgment of the Tributary Strategy participants.
- The final bar, labeled "40% Strategy," shows what the loads will be in the year 2000 after growth is accounted for and if the Strategy recommendations are implemented. If the bar ends at or below the line, the cap is attained. In some cases, a strategy that achieves the loading cap for one nutrient may result in a load significantly lower than the cap for the other nutrient. This happens because the practices needed to achieve the loading cap for one nutrient may result in additional reductions in the other.

In summary, Figure 2 indicates that the Chesapeake Bay nutrient reduction goals for phosphorus in the Lower Western Shore watershed, can be achieved provided that:

- Planned wastewater treatment plant upgrades are implemented;
- State and local erosion and sediment control regulations and stormwater management programs are fully implemented on all new development;
- The Forest Conservation Act reduces forest loss by at least 20% between 1993 and 2000; and
- Implementation of other existing state and local nonpoint source pollution control efforts continue at current or expanded levels.

Table 2. Forty Percent Nutrient Reduction Strategy for the Lower Western Shore Watershed

Option	Unit	Coverage by 2000 w/ Level Funding	Coverage by 2000 w/ Maximum Feasible Resources	Coverage with 40% Strategy	N Load Reduction w/ 40% Strategy (lbs/yr)	P Load Reduction w/ 40% Strategy (lbs/yr)
Wastewater Treatment Plants						
Biological & Chemical Nutrient Removal**	# of plants	3	3	3	200,400	17,100
Developed Land						
Erosion and Sediment Control	acres	1,111	1,146	1,146	3,403	1,210
Enhanced Stormwater Management	acres	7,780	8,021	8,021	19,579	2,379
Stormwater Management Retrofits	acres	386	965	965	2,356	286
Stormwater Management Conversion	acres	59	119	119	290	35
Septic pumping	systems	?	1,400	1,400	1,696	0
Septic Denitrification	systems	?	67	67	815	0
Septic Connections	systems	231	231	231	3,082	0
Urban Nutrient Management	acres	?	10,073	10,073	4,426	0
Domestic Animal Waste	households	?	?	0		
Clustering of New Development	acres	?	602	602	1,605	241
Agricultural Land						
Soil Cons./Water Quality Plan Implementation	acres	1,288	4,934	4,934	7,894	1,480
Conservation Tillage	acres	1,388	2,914	2,914	13,404	2,331
Treatment of Highly Erodible Land	acres	972	5,539	5,539	13,294	4,431
Retirement of Highly Erodible Land	acres	?	69	69	621	110
Animal Waste Management System—Livestock	systems	3	8	8	1,232	248
Animal Waste Management System—Poultry	systems	0	0	0		
Runoff Control	acres	4	8	8	168	32
Stream Protection with Fencing	acres	10	90	90	216	9
Stream Protection without Fencing	acres	200	830	830	996	83
Nutrient Management - Fertilizer	acres	3,234	10,340	10,340	25,850	1,034
Nutrient Management - Organic	acres	0	0	0		
Cover Crops w/ Nutrient Management	acres	423	1,823	1,823	14,037	547
Cover Crops w/o Nutrient Management	acres	0	0	0		
Horse Pasture Management	acres	0	0	0		
Presidedress Soil Nitrate Test	acres	0	0	0		
Water Control Structures	acres	0	0	0		
Wetlands/Sediment Basins	acres	0	0	0		
Poultry Waste Distribution	acres	0	0	0		
Resource Protection & Watershed Planning						
Buffers						
Forested (overall)	acres	16	60	60	1,100	184
Forested (on agricultural land)	acres	?	?	0		
Forested (on developed land)	acres	?	?	0		
Grassed (on agricultural land)	acres	55	495	495	7,326	1,436
Structural Shore Erosion Control	linear feet	1,800	3,840	3,840	5,376	3,533
Nonstructural Shore Erosion Control	linear feet	4,900	25,200	25,200	20,664	13,608
Forest Conservation	acres	1,244	1,382	1,382	13,354	1,824
Tree Planting	acres	108	240	240	235	70
Forest Harvesting Practices	acres	415	664	664	730	478
Marine Pumpouts (installation)	marinas	55	85	55	41,580	9,350
Pumpout Education	boaters	12,500	12,500	12,500	*	*
				Total Reductions (million lbs/yr) >	0.41	0.06

Nitrogen (million lbs/yr)	Phosphorus (million lbs/yr)	
1.69	0.26	< 1985 Base Load (from Table 1)
1.19	0.16	< Loading Cap (from Table 1)
1.69	0.17	< Projected Total Load in 2000 with No Additional Implementation Effort
-0.41	-0.06	< Less: Total Reductions (from above)
1.28	0.10	< Projected Total Load in 2000 with Strategy
7%	-34%	< % above (+) or below (-) the Loading Cap

Legend:
** Assumes plant designed for seasonal BNR will be operated year-round; point source strategy includes chemical phosphorus removal.
? This information is not currently available
* Loads are not computed for these options because loading reduction rates have not been quantified.

Notes:
1) "1985 Base" is the estimated total load from this watershed to the Bay under 1985 point and nonpoint source loading conditions.
2) "Level Funding" coverage is the coverage that can be expected by 2000 if current programs and practices were continued through 2000 with financial and staff resources comparable to the present.
3) "Maximum Feasible" coverage is the coverage that can be expected by 2000 with the highest feasible level of implementation of nutrient reduction options as determined by best professional judgment.
4) "40% Strategy" is the coverage estimated by the year 2000 if the Strategy is fully implemented.
5) "Loading Cap" is the loading expected if 1985 point and controllable nonpoint source loads are reduced by 40%.
6) Coverages and reductions shown in this table are for 1994-2000. Projected total load in 2000 with no additional implementation effort includes nutrient reductions achieved over the period, 1985-1993.
7) Most options have benefits in addition to nutrient reduction, for example, forested buffers provide wildlife habitat, stormwater management prevents erosion, etc.
8) The Draft Strategy illustrates how the 40% reduction goal can be met through specific programs and practices. The Strategy is intended to be flexible to reflect public input and practical considerations such as available funding and new technologies.

Table 3. Nutrient Reduction Options Currently Not Quantified*

Point Sources/Developed Land

Infrastructure Improvement (e.g., leaking sewer pipes)
Stormwater Facility Maintenance
New Small WWTPs
Elimination of Combined Sewer Overflows
Water Conservation
Improved Site Design and Planning

Agricultural Land

Public Education/Outreach
Horse Pasture Management
Presidedress Soil Nitrate Test
Water Management Systems

Resource Protection

Stream Stabilization/Restoration
Land Easements and Acquisition
Wetlands Protection
Critical Area Law Implementation
Mine Reclamation
Restoring Aquatic Ecosystems (e.g., oyster restoration)

Watershed Planning

1992 Planning Act Implementation
Concentrating Growth
Agricultural Land Preservation
Stream Corridor Protection
Reservoir Protection
Roadside Drainage System Management

*Many of these options are defined in the attached glossary.

The 40% reduction goal for nitrogen cannot be met due to the highly urbanized nature of the watershed and the high growth rate projected for the watershed between 1994 and 2000. Maximum feasible levels of effort will be required for most of the nutrient reduction options. Nutrient reductions due to upgrade of sewage treatment plants are not expected to offset increased nitrogen loadings due to the further growth of this densely populated watershed. The phosphorus loading cap can be met with current programs, and will in fact drop further below the cap as nitrogen is reduced to the maximum possible extent.

Table 2 summarizes the practices and the nutrient reductions they are expected to achieve. There are also many unquantified options (listed in Table 3) which will further reduce the loads. In the face of continued population growth and development of the Lower Western Shore watershed, maintaining a load below the capped load beyond the year 2000 will eventually require additional options not presented in this Strategy.

The list of quantified options in Table 2 are recommendations for the level of implementation aimed at achieving the 40% reduction goal in this watershed. The first column names the options, which are described in more detail in the attached glossary. The second column indicates the units used to describe the physical measures of implementation such as "plants" for wastewater treatment, "systems" for septic systems, or "acres" for cover crops. The third and fourth columns set the boundaries for nutrient reductions that would attain nutrient loads that correspond to the "Level Funding" and "Max Feasible" levels in Figure 2. The fifth column is a set of recommendations which will result in 40% nutrient reduction in this watershed. The last two columns (shaded) translate the 40% Strategy recommendations from implementation units to actual pounds reduced for each option. Note that although these reduction benefits may appear to be fairly precise, the numbers are only a function of the calculations. The rounded values at the base of the column, which represent the sum of the reductions, are more reflective of the actual precision appropriate for these estimates. Finally, in the shaded box at the bottom of Table 2, a summary calculation shows the difference between the projected loads and projected reductions resulting from the implementation of the Strategy to the year 2000. This difference is then compared to the loading cap. If the difference is equal to or less than the cap, the 40% reduction goal is attained.

The 40% reduction goal specified by the Chesapeake Bay Executive Council was framed in quantitative terms, that is, 40% of the 1985 loads. Table 2 responds to those specific quantitative terms, and provides for accountability and measurement of progress. However, there are many practices for which nutrient reductions cannot be quantified at this time. These practices are a critical part of the Strategy even though they are not included in Table 2. Despite the current inability to estimate the nutrient reductions associated with these practices, their continued implementation will contribute substantially to nutrient reduction efforts between now and the year 2000, and toward maintaining the cap on nutrient loads. These options provide environmental and living resources benefits that are valuable to the Lower Western Shore Basin and go directly to the ultimate goal of the Bay Restoration:

improved habitat for the Bay's living resources. For example, land acquisition for recreation or wildlife habitat also helps to keep areas in forest, which has a naturally low nutrient pollution load. Wetland protection laws protect tidal and nontidal wetlands that act as natural filters. Watershed planning, which helps local governments to concentrate growth and protect sensitive areas, reduces nutrient pollution resulting from sprawling development and loss of forests, wetlands, and other open space.

As mentioned previously, the Strategy recommendations shown in Table 2 will change as new and more refined information and estimates become available. The Lower Western Shore Strategy will evolve to reflect the ideas and concerns of the public and the local, state, and federal governments. The final Strategy will embody the most efficient, effective, and practical methods of achieving the nutrient reduction goal.

Implementation

The implementation of the Tributary Strategies initiates a new phase of the Bay clean-up efforts that began over a decade ago. This Tributary Strategy is meant to be the start of a comprehensive watershed and locally-based approach that will reduce nutrient pollution from most controllable sources. The next challenge will be implementation. Existing programs may need to be refined or expanded, as needed, by state and local agencies, industries or individuals currently responsible for them. New programs may also have to be developed to meet needs identified in the Strategies, such as public education regarding septic maintenance or landscaping and lawn care. These programs will be developed and implemented through a collaborative process with state and local government agencies and citizens.

The implementation of the Strategy for the Lower Western Shore watershed will involve:

- identifying the agencies and groups who will implement needed programs;
- refining implementation mechanisms and identifying the types and amount of additional resources required;
- identifying and addressing any obstacles to implementation; and
- setting schedules for implementing any needed programs.

Tributary Implementation Teams

To assist with developing an implementation plan, a Tributary Implementation Team will be formed at the local level to represent the needs and concerns of the Lower Western Shore watershed. This team will consist of local and state government representatives, concerned citizens, and representatives of affected economic interests such as the agriculture and land development industries. It will promote watershed integration of activities by:

- developing and revising implementation plans to meet nutrient reduction goals;
- tracking Strategy implementation to help it proceed on schedule in a fair and flexible way with consideration given to sensitive areas such as reservoir watersheds and stream headwaters;
- coordinating cooperation among citizens, state and local government agencies, and other interested parties;
- identifying and communicating potential problems, needs, and concerns, as well as possible solutions to responsible state and local agencies; and
- promoting the Strategies through public education activities.

Additional Funding for the Strategies

Additional funding and staff for state and local agencies will be necessary to implement this Strategy. Of course, the amount and types of funding needed will depend upon the programs ultimately selected as part of the Strategy. For example, funds from MDE's Water Quality Revolving Loan Fund can be used for wastewater treatment plant upgrades and nonpoint source water quality improvement. Many agricultural options are implemented by providing technical assistance and cost-share funds available from federal, state, and county funding programs.

A "Blue Ribbon Panel" of financial experts from the investment community, local, state, and federal government, academia, and other private sector concerns was convened in June 1994. The Panel's final report, completed in January 1995, identified funding options to assist state and local agencies in financing portions of the Strategies and recommended ways to provide private sector support.

Tracking Progress

The Strategies set targets for the implementation of certain practices between 1994 and the year 2000. To evaluate the Strategies' effectiveness, monitoring and tracking programs are needed. Tracking and monitoring programs may be grouped into three categories:

- **Tracking implementation.** For some practices, tracking mechanisms are already in place because of program requirements, permit or other regulatory requirements, or funding mechanisms. For example, there is a system, which is currently being improved, for tracking the implementation of agricultural BMPs. For many voluntary options, such as incentive or cost-share programs for agriculture or resource protection, tracking programs are in place, but may need to be revised to provide watershed-based information.

- **Monitoring nutrient load reductions.** The nutrient load reductions that have been estimated for most of the options are listed in Table 2. These will continue to be refined using new research and field data and local data sources to improve the estimates of the impact of various practices. Monitoring programs are in place to track point and nonpoint source nutrient loads, but these programs are being re-examined to ensure that adequate information is being collected. In addition, the watershed and water quality computer models, primary scientific tools for developing the nutrient reduction Strategies, are being refined to improve estimates of nutrient loads and reductions in the watershed.

- **Monitoring status and trends in water quality, habitat, and living resources in response to the Strategies.** Many comments were received concerning the need to adequately monitor water and habitat quality in each of the ten tributary watersheds. Several existing programs will help us to evaluate the impact of the Strategies on water quality and living resources in the Lower Western Shore and the Bay.

  - MDE's Chesapeake Bay Water Quality Monitoring Program tracks changes in water and habitat quality in the mainstem of the Bay and the tidal portions of the tributaries.

  - Stream habitat and living resources monitoring data are currently being collected by DNR, MDE, and local jurisdictions. Biomonitoring can show changes in pollution-sensitive organisms. Stream walks for habitat assessment help to identify land use conditions that are harming aquatic resources. This information can also be used to evaluate existing management practices or to target future implementation of BMPs.

  - The Chesapeake Bay Program tracks the extent of Bay grass beds, which have shown rapid increase in some areas with improved water quality.

  - Volunteers conduct water quality monitoring and provide valuable information on status and trends in many tributaries. The use of volunteers can be expanded to assist government efforts.

These monitoring efforts are also being reexamined to ensure adequate tracking of the Tributary Strategies. There is also a need to integrate these statewide programs with any monitoring being conducted by local government agencies. One of the functions of the Tributary Implementation Teams will be to ensure that the necessary integration of state and local monitoring occurs.

All of these efforts will contribute to a reevaluation of the Tributary Strategies in 1997, which will allow us to assess how much progress has been made toward the 40% goal and what mid-course corrections may be needed.

Legacy

The Tributary Strategy for the Lower Western Shore presents an opportunity for all of us who are concerned about the Bay and the creeks and streams in our own backyards to work together to protect these irreplaceable resources for ourselves and our children. The plight of the Bay illustrates that every individual and every part of the economy have an impact on the Bay. The progress in the Bay—clearer water, more striped bass, returning Bay grasses—illustrates the positive results that can be achieved when governments, farmers, businesses, and active citizens work together toward a common goal.

We are now faced with a difficult and critical challenge: building management Strategies to provide a legacy of healthy rivers with abundant living resources that sustain the very water and food that each of us require to exist. The Tributary Strategy process aims to heighten the awareness of the citizens of Maryland that their lives and livelihoods are enriched by the Bay and its tributaries. This awareness will foster the actions needed today to ensure healthy waters for tomorrow.

Glossary of Option Terms

1992 Planning Act implementation — Requires local governments to update comprehensive plans and development regulations to incorporate the seven environmental principles or "visions" in the Act, protect sensitive areas, streamline development approval procedures in growth areas, and ensure that all development regulations are consistent with comprehensive plans.

Animal waste management system — Systems for the proper handling, storage and use of waste generated by confined animal facilities. These include ponds, lagoons, and tanks for liquid waste, and sheds or pits for solid waste.

Animal waste runoff control — Measures to prevent runoff from animal confinement areas, including upslope diversions and directed downspouts to minimize offsite water entering the facility.

Biological nutrient removal (BNR) for nitrogen — A temperature dependent process in which the ammonia nitrogen present in raw wastewater is converted by bacteria first to nitrate nitrogen and then to nitrogen gas. Annual BNR refers to the operation of this process for as much of the year as possible in order to maximize nitrogen removal.

Chemical phosphorus removal (CPR) — The addition of chemicals to wastewater in order to precipitate phosphorus which is ultimately settled out and removed with sewage sludge.

Clustering of new development — Voluntary or required measures to group new residential or other development on a smaller portion of the available land in order to preserve open space.

Concentrating growth — Reduces nutrient pollution by preserving open space and reducing transportation needs.

Conservation tillage — A process that uses tillage equipment to seed the crop directly into the vegetative cover or crop residue on the surface, with minimal soil disturbance.

Cover crops	Small grains (rye, barley or wheat) planted in September or early October on land otherwise fallow with no fertilizer applied. This practice reduces nitrate leaching losses during the winter, and also reduces erosion.
Critical Area Law implementation	Requires a special planning process for all lands within 1,000 feet of tidal waters including the designation of three land use categories (i.e., intensely developed areas, limited development areas, and resource conservation areas) and the establishment of a 100-foot vegetative buffer around the Bay.
Domestic animal waste	A public education program targeted at pet owners to properly dispose of pet waste.
Enhanced stormwater management	The regulatory requirement for the control of stormwater on all new development, including maintenance on new and existing facilities. Enhancements include improved standards and guidance emphasizing water quality controls in addition to water quantity controls.
Erosion and sediment control	The regulatory requirement for erosion and sediment control on all new development over 5,000 square feet. Assumes that the enhanced standards now being developed by MDE will be fully implemented and enforced.
Forested buffer	A linear strip of forest along rivers and streams that filters nutrients and sediment and enhances stream habitat.
Forest conservation	Implementation of the Forest Conservation Act, which requires the retention of a portion of forested lands on any newly developed site.
Forest harvesting practices	Application of regulatory and voluntary best management practices applied to timber harvests, including erosion and sediment control, streamside management zones, etc.
Grassed buffer	A linear strip of grass along rivers and streams that filters nutrients and sediment.
Highly erodible land (HEL) retirement	The removal of lands with a high potential for soil loss from crop or hay production for at least ten years.

Highly erodible land (HEL) treatment	An accelerated application of practices used in SCWQPs on lands with a high potential for soil loss (see definition of SCWQP).
Horse pasture management	The use of a range of practices to address erosion and animal waste problems on horse pasture operations in suburban to rural areas.
Land easements/ acquisition	Easements are voluntary, long-term restrictions on the permitted uses on a parcel of land that remains in private ownership, and are usually donated or purchased. Acquisition is the purchase of land by a public or nonprofit agency for conservation purposes.
Marine pumpout	A facility sited at marinas for pumping sewage from boat holding tanks to a dockside storage facility.
Mine reclamation	The restoration of lands disturbed by mining operations. May include seeding of areas to grass, reforestation, or creation of nontidal wetlands.
Nonstructural shore erosion control	A practice for stabilizing eroding shorelines by establishing marsh grasses; suitable for sites with lower wave energy. Also creates wetland habitat.
Nutrient management plan	A comprehensive plan to manage the amount, placement, timing and application of animal waste, fertilizer, sludge, or other plant nutrients.
Point source control	See definition for BNR and CPR.
Pumpout education	Boater education programs to encourage pumpout use and responsible environmental behavior.
Presidedress soil nitrate test	A test to determine if additional nitrogen is needed during the growing season for corn.
Restoring aquatic ecosystems	The restoration of tidal and nontidal ecosystems to a healthy state which maximizes nutrient recycling and biological diversity (e.g., oyster restoration, which is expected to improve water quality in the Bay for many other living resources).

Roadside drainage system management	The use of buffers, stormwater controls, and maintenance requirements to achieve nutrient reductions from roadside drainage systems.
Septic connections	The connection of failing septic systems to sewer lines.
Septic denitrification	The installation of new systems or retrofitting of existing systems with technology to remove nitrogen from individual systems.
Septic pumping	Pumping of individual septic systems once every three years, the average for routine maintenance of these systems.
Soil conservation and water quality plan (SCWQP) implementation	A comprehensive plan addressing natural resource management on farmlands directed toward the control of erosion and sediment loss and management of animal waste or agricultural chemicals to minimize their movement from agricultural land to surface waters.
Stormwater management conversion	Conversion of dry ponds for stormwater management to extended detention or retention facilities which are more effective at nutrient removal.
Stormwater management retrofits	Construction of stormwater management facilities on lands previously developed without such facilities.
Stream corridor protection	The use of a variety of tools (local ordinances, land acquisition and easements, buffers, etc.) to protect streams and their buffers for living resources, recreation, and other values.
Stream protection with fencing	Fencing along streams to completely exclude livestock from the stream. Also improves streambank stability and reduces sedimentation.
Stream protection without fencing	Providing troughs or other watering devices in remote locations away from the stream to discourage animals from entering the stream, and the provision of some fencing adjacent to stream crossings to limit access points.

Stream stabilization/ restoration	May include a variety of practices, depending on the needs of the site, including streambank erosion controls, re-establishment of riparian vegetation (see buffers), channel erosion control, in-stream habitat creation/enhancement, and mitigation of upstream pollution sources.
Structural shore erosion control	A practice for stabilizing eroding shorelines using stone riprap or timber bulkheads. Suitable for sites with high wave energy.
Tree planting	Reforestation or afforestation on any site except along rivers and streams (see Forested buffer).
Urban nutrient management	A public education program to reduce excess lawn fertilizer use, targeted at suburban residents and businesses.
Water management systems	The use of water control structures, sediment basins, and/or small constructed wetlands to reduce phosphorus and nitrogen levels in water flowing through farm drainage systems.
Wetland protection	Protection of tidal and nontidal wetlands through federal and state laws and planning processes.

For additional information and copies of other Maryland Tributary Strategies documents, please contact:

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