



# **A Bigger Bang for the Buck**

## **Offsets and Other Cost-Effective Strategies for Nitrogen Reductions for the Chesapeake Bay**

***Policy Analysis Workshop***

*Dr. Robert H. Nelson, Professor*

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### **MARYLAND SCHOOL OF PUBLIC POLICY**

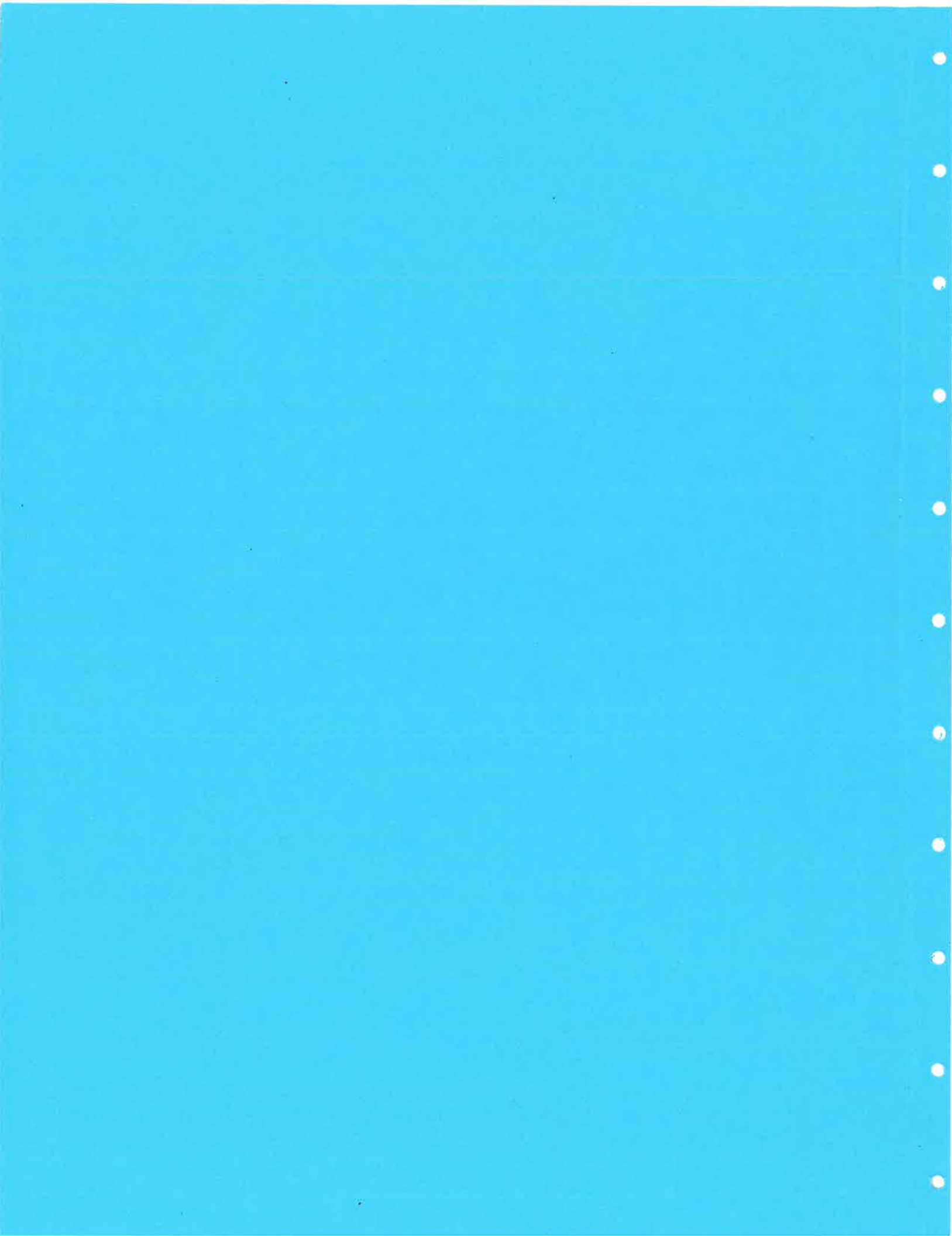
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VAN MUNCHING HALL

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## Preface

This report on new and more cost-effective strategies for cleaning up the Chesapeake Bay was prepared by the policy analysis workshop at the School of Public Policy of the University of Maryland. The policy analysis workshop is a course in the master's program of the School. Each student devotes a full semester of course work to the study of an important public policy issue. This year there were ten students with undergraduate majors ranging from biology to public policy to Russian literature. One member of the class is completing a joint program in law with the Law School of the University of Maryland.

The combined efforts of the students amounted to more than 750 hours, including review of the literature, meetings with experts on the Chesapeake Bay, and other methods of study. Professor Robert H. Nelson of the environmental policy program of the School of Public Policy supervises the environmental section of the policy analysis workshop.

The Executive Summary presents the principal findings, conclusions and recommendations. The Executive Summary and the full report are available on the web under "faculty papers" and "Robert Nelson" at [www.publicpolicy.umd.edu](http://www.publicpolicy.umd.edu).

### Contributing Students

Crystal Calarusse  
Alyssa Denzer  
Michael Fleg  
Andrew Gray  
Debra Kemp  
Katie Kerstetter  
Michelle Perez  
Amanda Vockerodt  
Ling Yang  
Sandra Young





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## Executive Summary

Better organization and coordination in the cleanup of Chesapeake Bay could achieve significantly greater environmental benefit to the Bay at little or no additional cost. There are many jurisdictions and programs that contribute to the cleanup of the Bay. However, the political and policy mechanisms do not exist at present to ensure that these efforts maximize the overall reduction of nutrients – nitrogen and phosphorus – that are the principal sources of pollution in the Chesapeake Bay. Although previous studies suggest that unmet financial requirements are the main hurdle to future success, this report concludes that the obstacles to cleaning up the Chesapeake Bay are more political and institutional. If available funds were spent in the most cost-effective ways, as this report advocates, they would be largely sufficient to achieve the current nutrient reduction targets for 2010.

The three original signatory states to the Chesapeake Bay Agreement have committed substantial new resources to cleanup efforts. Maryland's 2004 "flush tax" is expected to generate \$75 million per year; in 2005, Virginia committed \$50 million from the General Fund annually for ten years for Bay cleanup<sup>1</sup>; and Pennsylvania voters approved a new \$625 million "Growing Greener Bond" initiative in May 2005.<sup>2</sup> However, there is no assurance that these state funds will be spent in the most cost-effective manner to maximize environmental quality benefits for the Bay.

Existing policies necessitate the expenditure of significant funds for Bay cleanup by upgrading wastewater treatment plants and addressing other point sources of pollution. In some cases these funds could more efficiently be spent to reduce nutrient loads from non-point sources. Federal agricultural programs currently spend significant funds within the Bay watershed conservation and agricultural management programs. This money, however, could be redirected to farmers in other ways that would make greater overall contributions to the Bay cleanup. Curtailing future stormwater runoff by adopting low impact development techniques in new housing and in other development projects would, in many cases, not involve additional costs (and might even be less expensive than conventional infrastructure alternatives). The main obstacles to this particularly cost-effective step lie in existing zoning policies and other regulatory impediments.

Both the Clean Air Act and Clean Water Act mandate expenditure of significant funds for purposes that are not directly related to the Bay cleanup. These efforts – in essence zero cost (or "free") from the standpoint of the Bay cleanup – will nevertheless result in significant nutrient reductions for the Bay. The Clean Air Act requires power plants, for example, throughout the Eastern and Midwestern parts of the United States to sharply reduce their nitrogen air emissions, which will result in less nitrogen deposition on both land and water within the Bay watershed. In addition, the Clean Water Act requires Washington, D.C., Baltimore, and other cities to resolve their longstanding problems of combined sewer overflows, which will result in reduced nutrient loads to the Bay.

Additional nutrient reductions could be achieved by requiring that new housing and other land development in the Chesapeake Bay watershed "offset" any new nutrient pollution load it generates by reducing loading elsewhere. The offsets could be provided directly or through the payment by developers of an "offset development fee." The moneys from the fee could then be spent for offsetting nutrient reductions from other sources.

In total, this report finds that already committed funds are largely sufficient to pay for the necessary actions to reduce nutrient loads to reach Chesapeake Bay targets and water quality standards set for 2010 in the 2000 Chesapeake Bay Agreement, if the most cost-effective policies are implemented. Under the current policy and regulatory framework, however, this is not likely to happen. Funding is frequently provided for less cost-effective means of reducing nutrients, while more effective means receive little or no support.

This report does not address how to generate and sustain the political will to clean up the Bay more cost effectively. It does show how, if the political support is forthcoming, the practical solutions to the nutrient problems of the Bay are already at hand. With just five years remaining until 2010, the Chesapeake 2000 Agreement is in serious jeopardy of failing. The present mood is pessimistic, partly because financial requirements are commonly cited as very large and beyond the capacity of existing governments. There is little likelihood that many new billions of dollars of Bay funding will be forthcoming. However, as this report finds, a successful cleanup of the Bay is possible, even without such large additional infusions of government funds beyond existing and already committed sources. But it would require a new federal, regional, and state policy approach that would use existing resources more cost effectively.

This report describes some of the main elements of an economically realistic – if politically difficult – approach to achieve the mandated annual 103 million-pound nitrogen reduction goal for the Bay by 2010. As nitrogen is the most difficult nutrient problem in the Bay, and the sources of nitrogen are often also sources of phosphorous, it is likely that the phosphorus goal can be reached as well through many of the same actions.

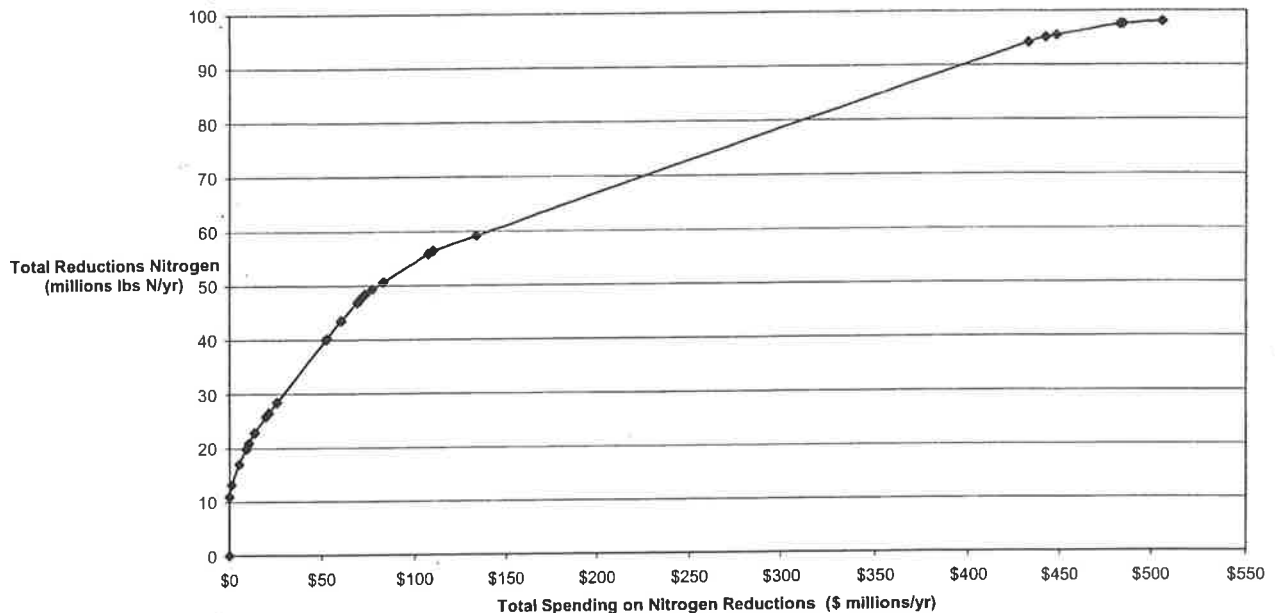
### **A Cost-Effective Approach**

As the following chapters demonstrate, and Table ES-1 and Figure ES-1 summarize, a variety of actions are available at low cost per pound to reduce nitrogen loading to the Chesapeake Bay. By implementing eighteen of the most common agricultural best management practices in Maryland, Pennsylvania, and Virginia, close to half of the nitrogen goal (45 million of 103 million pounds) could be achieved for \$110 million per year. None of these best management practices cost greater than \$5 per pound of nitrogen reduced. “Free” nitrogen reductions (11 million pounds per year) will result from reduced airborne deposition as the new Clean Air Act nitrogen control program is implemented, bringing total reduction to 56 million pounds per year for the same \$110 million per year. The projected point source nitrogen reductions from upgrades of sewage treatment plants in Maryland, Pennsylvania, and Virginia reduce 35 million additional pounds of nitrogen per year for an average of approximately \$8.50 per pound – an expense of about \$300 million per year.<sup>3</sup> Thus, employing these three approaches – the most cost-effective non-point agricultural management practices, “free” airborne reductions, and wastewater treatment plant upgrades – 91 million pounds of nitrogen could be reduced per year for about \$400 million per year. That is only 12 million pounds short of the goal for 2010.

Although not shown in Table ES-1, it is likely that similarly cost-effective actions could be taken in the three additional states of the Chesapeake Bay watershed, Delaware, New York, and West Virginia, as well as the District of Columbia. Moreover, six additional agricultural nutrient management strategies are shown in Table ES-1, which involve higher unit costs that range from \$8.31 to \$44 per pound of nitrogen reduced. Although less cost-effective and perhaps not economically justifiable, they could reduce an additional 6.8 million pounds of nitrogen per year for \$97 million per year. Finally, the nitrogen reduction measures in Table ES-1 are from the existing tributary strategies. There are no doubt additional cost-effective alternatives that may be developed. In short, it is very likely that the goal of reducing nitrogen loads to the Chesapeake Bay by 103 million pounds per year by 2010 can be achieved for less than \$500 million per year.

| TABLE ES-1. CHESAPEAKE BAY NITROGEN REDUCTION POTENTIAL FROM NUTRIENT MANAGEMENT STRATEGIES IN MARYLAND, PENNSYLVANIA, AND VIRGINIA   |  |                              |                          |                            |  |
|---|--|------------------------------|--------------------------|----------------------------|--|
| STRATEGY<br>(MOST TO LEAST<br>COST EFFECTIVE)   | ANNUAL<br>NITROGEN<br>REDUCTION<br>(LB/YR) | ANNUAL<br>COST<br>(\$/LB/YR) | TOTAL<br>COST<br>(\$/YR) | CUMULATIVE<br>COST<br>(\$) | CUMULATIVE<br>NITROGEN<br>REDUCTION<br>(LB/YR) |
| CAA Implementation (all)  | 1,000,000                                  | "free"                       | --                       | --                         | 11,000,000                                     |
| Cons. Tillage (PA)  | 2,228,580                                  | \$0.54                       | \$1,203,433              | \$1,203,433                | 13,228,580                                     |
| Nutrient Mgmt (MD)  | 3,821,210                                  | \$1.08                       | \$4,144,000              | \$5,347,433                | 17,049,790                                     |
| Chicken House Buyout (MD)   | 2,863,594                                  | \$1.37                       | \$3,923,124              | \$9,270,557                | 19,913,384                                     |
| Grassed Buffers (MD)  | 982,440                                    | \$1.39                       | \$1,360,999              | \$10,631,556               | 20,895,824                                     |
| Nutrient Mgmt (VA)  | 1,944,091                                  | \$1.60                       | \$3,109,556              | \$13,741,112               | 22,839,915                                     |
| Cons. Tillage (MD)  | 2,979,854                                  | \$2.09                       | \$6,221,296              | \$19,962,408               | 25,819,769                                     |
| 20% Poultry Litter Transport (VA)   | 694,300                                    | \$2.19                       | \$1,518,264              | \$21,480,672               | 26,514,069                                     |
| Grass Buffers (VA)  | 1,979,393                                  | \$2.22                       | \$4,393,697              | \$25,874,369               | 28,493,462                                     |
| Cover Crops, Early (PA)   | 11,514,082                                 | \$2.29                       | \$26,367,248             | \$52,241,616               | 40,007,544                                     |
| Land Retirement (MD)  | 226,693                                    | \$2.36                       | \$535,546                | \$52,777,162               | 40,234,237                                     |
| Animal Waste Mgmt Systems (PA)  | 3,279,108                                  | \$2.38                       | \$7,804,277              | \$60,581,439               | 43,513,345                                     |
| Cover Crops, Early (VA)   | 3,376,445                                  | \$2.56                       | \$8,637,573              | \$69,219,012               | 46,889,790                                     |
| Animal Waste Mgmt Systems (VA)  | 1,007,402                                  | \$2.65                       | \$2,667,141              | \$71,886,153               | 47,897,192                                     |
| Manure Transport (MD)   | 504,700                                    | \$2.77                       | \$1,400,000              | \$73,286,153               | 48,401,892                                     |
| Grassed Buffers (PA)  | 892,134                                    | \$4.36                       | \$3,889,704              | \$77,175,858               | 49,294,026                                     |
| Stream Protection with Fencing (PA)   | 1,336,716                                  | \$4.64                       | \$6,202,362              | \$83,378,220               | 50,630,742                                     |
| Cover Crops, Early (MD)   | 5,118,000                                  | \$4.69                       | \$24,000,000             | \$107,378,220              | 55,748,742                                     |
| Cons. Plans (VA)  | 565,188                                    | \$4.90                       | \$2,766,856              | \$110,145,075              | 56,313,929                                     |
| Land Retirement (PA)  | 2,817,796                                  | \$8.31                       | \$23,415,885             | \$133,560,960              | 59,131,725                                     |
| WWTP Upgrades (all)   | 35,000,000                                 | \$8.56                       | \$299,600,000            | \$433,160,960              | 94,131,725                                     |
| Animal Waste Mgmt Systems (MD)  | 994,643                                    | \$9.63                       | \$9,574,102              | \$442,735,062              | 95,126,369                                     |
| Cons. Plans (PA)  | 359,244                                    | \$16.75                      | \$6,017,337              | \$448,752,399              | 95,485,613                                     |
| Off-Stream Watering with Fencing (VA)   | 2,006,454                                  | \$17.50                      | \$35,121,097             | \$483,873,496              | 97,492,066                                     |
| Off-Stream Watering with Fencing (MD)   | 62,149                                     | \$27.70                      | \$1,721,319              | \$485,594,815              | 97,554,215                                     |
| Cons. Plans (MD)  | 480,263                                    | \$43.69                      | \$20,981,865             | \$506,576,680              | 98,034,478                                     |
| Source: For all the agricultural strategies, data sources are provided in Chapters 1, 2, and 3 of this report. References for the "free" nitrogen reductions are provided in Chapter 7. The data for the sewage treatment plants are from the Chesapeake Bay Commission, Cost-Effective Strategies for the Bay: Six Smart Investments for Nutrient and Sediment Reduction. December 2004. |  |                              |                          |                            |  |

**Figure ES-1. Nitrogen Reduction Potential per Dollar Spent in MD, PA, and VA on Agricultural Strategies, Sewage Treatment Plants, and free CAA reductions**



Source: Data for this figure listed in Table 11-1.

Although \$500 million is a significant annual commitment of funds, it is much less than the \$28 billion or other similarly implausible sums that have been suggested as necessary to achieve the Chesapeake Bay 2010 cleanup goals. Projections of excessive costs have themselves become a hurdle to effective policy and regulatory action among the states and other participants in the Bay cleanup. If very large sums of money are needed, and this money is not likely to be available, the danger is that resignation and acceptance of failure will set in. This report shows instead that Bay nitrogen reduction targets – and likely phosphorus reduction targets as well, although the report does not study this issue – can be achieved without large additional commitments of funds. What is required, however, is that the available funds be spent more cost effectively. This will require strong political leadership within the Bay states because many of the required actions are likely to be politically controversial.

As Table ES-1 shows, the most cost-effective means of reducing nitrogen loads to the Bay are predominantly found in addressing agricultural pollution. A cost-effective strategy for cleaning up the Bay will therefore involve wide funding in agricultural reductions. Admittedly, there are several concerns regarding a cost-effectiveness approach that emphasizes agricultural nitrogen reductions. First, from a Bay-wide watershed perspective, if policymakers are to reallocate existing funds, they may need to redistribute some existing state funds or federal funds across state boundaries to give highest priority to the lowest-cost reduction efforts. This is likely to encounter political resistance. For state funds, it will be a challenge to convince taxpayers in one state to pay farmers to reduce nutrients in a second state, even when it would serve the practical interests of these taxpayers by maximizing the total impact of the spending on Bay cleanup. For federal funds already earmarked for specific states, this may be less of a challenge but is still potentially a politically sensitive issue.

Additionally, uncertainty in reductions from agricultural sources could present another political challenge. When upgrades at a wastewater treatment plant reduce the concentration of nitrogen in its effluent, the nutrient reduction is relatively sure and

predictable. In contrast, agricultural reductions are less certain because new actions must be taken and funding provided every year, indefinitely, into the future. The compliance of farmers with plans for best management practices may also be difficult to monitor and verify. Uncertain adjustment factors may have to be applied to convert "edge of field" reductions in agricultural nitrogen runoff to estimates of actual nitrogen impacts on the Bay itself. Nevertheless, these complications, as this report argues in later chapters, can be addressed in various ways.

Obtaining the willing participation of farmers to achieve nutrient reduction goals is a critical factor for success. The example of past resistance to a regulatory regime from farmers in Maryland reminds policymakers that even the legal mandatory imposition of agricultural nutrient management requirements does not ensure corresponding compliance and actual nutrient reductions. Accordingly, this report emphasizes voluntary compliance within the agricultural sector, typically based on payments to farmers to adopt appropriate new nutrient reduction practices. This may require the development of new governmental and private sector institutions to serve this purpose. Farmers might enter into contracts with public and private bodies for this purpose, and the compliance would then consist of the monitoring and enforcement of a legal private contractual agreement.

In summary, this report offers a new policy and institutional framework that not only seeks to allocate existing private and public resources to the most cost-effective solutions for Bay cleanup, but also works to enlist greater voluntary participation. Cleaning up the Bay will require an appropriate combination of public mandates and private incentives, making use of market-based approaches and incentives where they are the most workable approach.

### **Rethinking the Chesapeake Bay as a Water Quality Non-attainment Area**

If the Chesapeake Bay were an airshed rather than a watershed, it would be declared a "non-attainment" area under the provisions of the Clean Air Act. A "non-attainment" area is an airshed that fails to meet the ambient air quality standards of the Clean Air Act for one or more pollutants (most commonly ozone). The states in the airshed are required to develop State Implementation Plans (SIPs) to achieve air quality standards, subject to approval of this plan by the U.S. Environmental Protection Agency (EPA). The implementation of the Clean Air Act also denies entry of major new sources of pollution unless they can generate "offsets" for at least the same amount of air pollution. Given the slow progress under the existing regional Chesapeake Bay partnership, the overarching federal total maximum daily load (TMDL) framework, and the potential for significant additional new sources of nutrient pollution, this report recommends establishing a strict cap on total future loadings of nutrients into Chesapeake Bay. This could be achieved by treating the Chesapeake Bay watershed as a "water quality non-attainment area." Then, under such a policy, new housing projects and other land uses would be prohibited from adding to the total nutrient pollutant load in Chesapeake Bay, unless they generated appropriate nutrient offsets.

In practice, any new residential, commercial, or industrial use within the Bay watershed would either have to prevent any additional flows of nutrients into the Bay from its project, or it would have to obtain offsets from existing sources of nutrient loading. As noted above, there is an ample supply of such offsets available for modest levels of cost in the agricultural sector. By requiring offsets at a ratio of greater than 1:1 (as is the practice under the Clean Air Act), the entry of a new use into the Bay watershed might then even contribute to overall movement toward reaching Bay nutrient reduction goals. Offsets purchased by housing developers and others planning new land uses within the Bay watershed could provide a major source of funds to pay for voluntary agricultural nutrient reductions and other lower cost nutrient load reductions.

Besides the Clean Air Act, state policies, such as the current use of forest and stormwater offsets under the Critical Area Act in Maryland, also provide precedents for this approach. For example, if a development destroys 100 acres of forest in the



Chesapeake Bay watershed, the state may require the developer to restore 200 acres of forest elsewhere. Instead of physically implementing an offset, a developer may also be allowed to pay a development fee. Development impact fees are widely used around the United States for purposes other than nutrient reductions. According to McConnell and Walls (2004), twenty-eight states have legislation that permits the use of impact fees to cover the infrastructure costs of providing public services such as roads, sewers, and schools.<sup>4</sup> Fees average around \$6,000 in these states for a single-family home, and vary depending on the type of dwelling and development. Development fees to compensate for nutrient impacts could be used in addition to offsets to cover the costs of offsetting new nutrient pollution loads associated with new housing and other significant land development projects within the Chesapeake Bay watershed.

### **A Cap and Trade System of Nutrient Trading**

An offset program of the simplest kind is based on direct trading between individual parties. The Clean Air Act Amendments of 1990 took a further step with the development of a cap and trade system of pollution allowances for sulfur dioxide (SO<sub>2</sub>) that can be bought and sold in an allowance market. Under this system, pre-existing sources, as well as new sources, must have permission for their current emission levels. Thus, the government sets a total "cap," allocates "pollution rights" (air emission allowances) among existing polluters, and then requires that each polluter hold allowances equal to their level of pollution for any given year.

Under such an approach, the governments in the Chesapeake Bay region might agree to set a cap for some future year – for example, 175 million pounds of nitrogen emissions to water for 2010. Nitrogen allowances equal to 175 million pounds would then be allocated among existing sources of nitrogen pollution. In practice, each of the six states in the Chesapeake Bay watershed and the District of Columbia would probably receive its own share of this overall nitrogen allocation for the land uses within its portion of the Bay watershed. Each state would then distribute its nitrogen allowances within the state (the precise manner of this allocation is an important policy issue that could be resolved separately by each state). The holders of the nitrogen allowances would then be permitted to buy and sell them. As most such systems work, transactions would be permitted across state boundaries.

In this way, land users in the Chesapeake Bay watershed would be able to enter a market for nitrogen allowances instead of buying an offset from an individual farmer or other individual party. They would have to purchase sufficient allowances to equal any nutrient loadings resulting from their development project. An overall cap on nutrient pollutants might be particularly important in light of the expected significant increases in land development within the Chesapeake Bay watershed, and thus potentially significant increases in pollutant loads.

EPA recently created a system based on this model for major sources of nitrogen air emissions for the "No<sub>x</sub> SIP Call Region" – 21 states in the Eastern and Midwestern parts of the United States (including all the states of the Chesapeake Bay watershed). According to EPA guidance, this involves a "No<sub>x</sub> Budget Trading Program" that provides for an emissions market in nitrogen air allowances. Each of the 21 states within this large multi-state regional airshed is assigned an individual overall cap for nitrogen air emissions from power plants and other major sources of nitrogen emissions within that state. In the future, any of these sources must possess (by purchase if necessary) sufficient allowances to equal its nitrogen air emissions. EPA recently reported that this system is working very successfully and already achieving major reductions in nitrogen air emissions in a cost-effective manner for the east coast of the United States.<sup>5</sup> The European Union recently adopted a similar Europe-wide system of emissions trading for carbon dioxide among its nations.

The advantages of a cap and trade system for nitrogen land emissions, if it was adopted for the Chesapeake Bay watershed, include a definite guaranteed reduction of

planned nutrient loadings within the time frame desired. Those parties responsible for obtaining sufficient allowances to cover their nutrient emissions would provide the funds internally. Additional state taxes or other revenue sources would not be needed. The development of a cap and trade nutrient system for Chesapeake Bay would involve a number of administrative and policy complexities, as explored in Chapter 8. Nevertheless, it would provide the surest of guarantees and the most direct route for cleaning up the Chesapeake Bay by 2010.

## **Overall Conclusions & Recommendations**

Along with the specific recommendations provided in the ten chapters of this report, as summarized below, this report recommends three “big picture” policies (presented in order of least to most groundbreaking) that would work to promote a more cost-effective cleanup of the Chesapeake Bay.

### ***Allocate existing and future financial resources within each signatory state to fund the most cost-effective actions first.***

Funding a myriad of agricultural best management practices, non-point urban runoff control practices, and wastewater treatment plant upgrades with specifically earmarked local, state, and federal funds is failing to reduce the nitrogen loadings that are required to clean up the Bay. State policymakers should allocate new and existing funds to first pay for nutrient reductions that get “the biggest bang for the buck.” This economically efficient approach will help to show the public that policymakers are serious about making scarce public resources go as far as possible and not just paying lip service to mottos and slogans.

### ***Reinvigorate the Chesapeake 2000 Agreement by adopting a non-attainment area offset policy for new sources of nitrogen water pollution.***

Achieving the goals of the 2000 Chesapeake Bay Agreement for nitrogen will be complicated by additional housing and other development prior to 2010 that may generate additional nitrogen loads. The goal of reducing the nitrogen load by 103 million pounds per year by 2010 would then require considerably larger reductions from a “business as usual” strategy. Improving water quality will require not only reducing emissions from current sources, but also limiting or preventing altogether new additions to the sources of Bay nitrogen loads. The Chesapeake Bay watershed, therefore, should be designated as a water quality non-attainment area for nitrogen emissions. As of some future date, new nutrient pollution sources would be denied entry to the watershed unless they created appropriate offsets. A private system of “offset brokers” might be given government accreditation to facilitate the creation and monitoring of acceptable offsets. This policy proposal could also be implemented through a development fee. It would be modeled on offset policies that have long been implemented under the provisions of the Clean Air Act.

### ***Establish a “cap and trade” nitrogen nutrient trading mechanism to clean up the Chesapeake Bay.***

The most far-reaching of these three “big picture” policies is to establish a full-fledged trading system for major sources of waterborne nitrogen pollution. EPA pioneered such a trading system in the 1990s for sulfur dioxide and more recently among 21 eastern states for airborne nitrogen emissions. There should be a firm cap set at an amount equal to the pounds of water nitrogen emissions allowable to maintain the desired water quality of the Chesapeake Bay. The cap would be initially allocated among existing states, which would distribute their “allowances” to major nitrogen emitters within the state. The further redistribution of allowances would follow the principles of supply and demand to permit the buying and selling of these allowances among

individual nitrogen sources. Such a market-oriented solution to the problem of nutrient pollution may stimulate significant farmer participation because farmers who implemented best management practices could sell allowances on a voluntary basis. Capping pollution could ensure that the desired nitrogen reductions will actually occur and the Bay's water quality restored within a reasonable time frame.

## **Chapter Summaries**

This report consists of three parts. Parts I and II address the major factors contributing to nitrogen nutrient pollution of the Bay: agriculture, urban sources, and air deposition. Part III reviews some promising institutional and policy steps that could promote cost-effective spending. The main findings and policy recommendations of each chapter follow.

### **Chapter One – Nutrient Reductions in Maryland Agriculture**

The agricultural sector in Maryland contributes about 39 percent of all nitrogen and roughly half of the phosphorus entering the Bay from the state. Although Maryland has one of the oldest and most extensive agricultural pollution reduction efforts in the country, a solution to the excess nutrient runoff problem remains out of reach, mainly due to excess poultry manure.

The core of Maryland's poultry manure problem is found in three "Lower Eastern Shore" (LES) counties and in one "Upper Eastern Shore" (UES) county. Each of these four counties generates more nutrients from poultry manure than can be absorbed by nearby cropland soils, overshooting nutrient targets by approximately 33 percent. However, the remaining Eastern Shore counties require additional manure for fertilizer, and could use the excess manure. This problem may have a potential solution: transport manure from the counties that have excess manure to the counties with additional absorptive capacity. A voluntary buy-out of some poultry houses in counties with excess manure may also generate cost-effective nutrient reductions. This chapter makes the following recommendations:

*Target available funding to best management practices according to their cost-effectiveness.* Maryland projects a Tributary Strategy funding shortfall of \$203 million or 41 percent for meeting its agricultural best management practice (BMP) goals. Thus, it is critical that Maryland spend its available funds in the most cost-effective manner. This report finds that the two most cost-effective agricultural BMPs, nutrient management and manure transport, could provide 46 percent of the nitrogen reductions at only 8 percent of the cost of all eleven BMPs in the Maryland Tributary Strategy. The four least cost-effective BMPs provide only 7 percent of the nutrient reductions but at 46 percent of the total cost of the eleven BMPs.

*Establish a cap on new poultry house construction in counties with excess manure on the Eastern Shore, and buyout poultry houses on a voluntary basis.* At least 41,000 tons of excess manure will remain even if Maryland achieves its annual manure transport goal. Therefore, using the Clean Air Act offset policy as a model, Maryland could limit the construction of new poultry houses until the excess manure problem is solved and then only allow new poultry house construction using an offset policy principle. Also, the state should consider offering to buyout chicken houses in the four counties with excess manure in order to eliminate permanently the problem. By offering \$227,104 per chicken house to 345 chicken houses, the state could spend \$78 million over 20 years (or \$3 million annually) at \$1.37/lb nitrogen reduced/year.

*Prioritize state business development funds for projects using poultry manure for alternative uses.* Several proposed alternative use projects might be able to pay a positive price per ton of manure and still break even. Given the recent, higher energy prices, implicit values for poultry manure for electricity generation facilities may now be positive. State business development funds should prioritize funding

awards to encourage alternative manure use projects such as forest fertilization, cogeneration, composting, and electricity generation.

*Maintain state participation in the poultry manure transport program in cooperation with the four poultry processors operating in Maryland.* Given the complexity of identifying the appropriate manure burden-sharing arrangement between poultry processors and growers, the state should continue its current funding arrangement with existing poultry processors to pay for 50 percent of the manure transport program. To transport the full 70,000 tons of manure per year costs \$1.4 million, which would require \$700,000 from the poultry processors. In the past, the annual cost-share of the processors has been as high as \$236,000. If the processors continue to fund half of the annual costs of manure transport in the future, projected state funds will have a greater impact in this area.

*Begin a point source-non-point source nutrient trading program within Maryland to increase the likelihood of achieving the tributary strategy goals.* Achieving the nitrogen reduction goals stated in its tributary strategy depends on the willingness of Maryland's farmers to participate. If the cost-shares provided by the state for BMPs are at the funding levels of the past decade, the extent of farmer participation may not be sufficient to meet nutrient reduction goals. A nutrient trading program not only makes available state and federal funds by re-distributing private funds from costly urban point sources to relatively inexpensive agricultural BMPs, but its voluntary nature may also motivate greater farmer participation.

## **Chapter Two – Nutrient Reductions in Pennsylvania Agriculture**

The agricultural sector in Pennsylvania accounts for 1.4 percent of the state's gross product, and occupies approximately 25 percent of its land area. As in Maryland, agriculture in Pennsylvania is the greatest nutrient pollution source to the Bay, contributing approximately 50 percent of the state's nitrogen load and around 60 percent of its phosphorus load. Pennsylvania's main tributary is the Susquehanna River, which provides about half of the total fresh water to the Bay. Nutrient reductions in the Susquehanna watershed thus are crucial to both Pennsylvania's ability to meet its reduction targets and to the overall success of the Chesapeake Bay cleanup program.

As with Maryland, excess manure is the greatest nutrient run-off problem in Pennsylvania, although the largest source of manure is from cattle, not poultry. Concentrated animal feeding operations (CAFOs) and concentrated farm siting also create "hot spots" of nutrient pollution. Pennsylvania attempted to address these issues by requiring nutrient management plans for CAFOs, as well as targeting specific BMPs to prevent cattle intrusions to stream banks.

This chapter recommends the following to assist Pennsylvania in meeting its nutrient reduction targets:

*Target available funding to best management practices according to their cost-effectiveness.* Pennsylvania is currently spending its scarce funding on a variety of BMPs, regardless of their cost-effectiveness. Reallocating funding to maximize application of the most cost-effective BMPs would improve the long-term impact of the state's efforts. As an example, analysis shows that soil conservation plans are cost-ineffective, especially compared to BMPs such as conservation tillage or nutrient management.

*Implement a nutrient trading plan to help farmers meet goals at the lowest cost.* A trading program may allow farmers in hot spot areas (e.g., Lancaster County) to more cost-effectively implement nutrient reduction measures. Farmers that are able to surpass their nutrient reduction targets could receive payments for the additional reductions from farmers who are unable to meet their targets.

*Provide more education for farmers to help them choose the most effective BMPs.* A better understanding of BMP methods, such as diet and feed changes for poultry and livestock, may provide benefits to farmers above and beyond nutrient reductions. However, farmers may not be aware of these BMPs. If additional technical assistance on BMP options was available, more farmers might choose to implement them voluntarily.

### **Chapter Three – Nutrient Reductions in Virginia Agriculture**

The agricultural sector in Virginia accounts for 12.3 percent of the state's gross product, and occupies approximately 24 percent of its land area. Agriculture is the state's greatest source of nutrient pollution to the Bay, contributing approximately 70 percent of the state's nitrogen load and around 60 percent of its phosphorus. Virginia's Bay watershed drains several tributaries, stretching from the Shenandoah River (which flows into the mid-Potomac River) to the James and York Rivers at the mouth of the Chesapeake Bay.

Virginia has adopted a series of programs to help reduce agricultural pollution, and has established a cap on agricultural loadings in its tributary strategy. With full implementation of Virginia's tributary strategy, the state could fully comply with the reduction target of the Chesapeake 2000 Agreement. However, several considerations must be addressed before this will become feasible. This chapter proposes the following recommendations to assist Virginia in reaching its nutrient reduction target:

*Prioritize the spending of available funds to target the most cost-effective BMPs.* From an analysis of the cost-effectiveness of seven common agricultural BMPs in Virginia, the most cost-effective BMP is nutrient management planning. It alone can reduce total nitrogen by 16.8 percent for only 5.3 percent of the total cost of all seven BMPs. The five most cost-effective BMPs are: nutrient management plans, poultry litter transport, grass buffers, cover crops, and animal waste management. Combined, they can reduce annually about 9 million pounds of nitrogen from 2005 to 2010. This represents 77.8 percent of the total projected reduction from all 9 BMPs for only 34.9 percent of the total costs.

*Strengthen the Agricultural Stewardship program.* Virginia needs to strengthen its existing Agricultural Stewardship program in order to educate farm owners and other state residents about the importance of reducing pollution from agriculture. The program should create more financial incentives for farmers to voluntarily comply with the agricultural pollution standard.

*Provide a voluntary buyout program to reduce the number of farms.* Given that more than half of Virginia's farms are small with annual sales of less than \$9,999, buying out some of these farms and transitioning the land to open space may be a feasible, direct method for nitrogen reduction. This may also be cost-effective, as the small size of farms may make many farmers willing to sell for a modest cost relative to the nutrient reductions achieved.

### **Chapter Four – The Urban Challenge: Growth without Nutrients**

Development pressures within the Chesapeake Bay watershed increase pollution and make the goals of the Chesapeake 2000 Agreement more difficult to reach. Increased impervious surfaces, cleared land, lost open space, greater stormwater and sewage treatment needs, and increased vehicular traffic all contribute to increasing nutrient loads to the Bay. The Bay watershed population is expected to grow by over 2 million people by 2020, with even faster projected growth in the number of housing units. With a "business as usual" scenario, this implies that population growth and new development will increase nitrogen loads to the Bay by as much as 40 million pounds by 2020.

Growth without corresponding growth in nutrients may be possible, however, mainly via the use of offsets. New development would be required to offset its total new

loading by finding some other source that could reduce its runoff by a commensurate amount. In the Bay watershed, this is most likely to be from an agricultural source. In Maryland, the Chesapeake Bay Critical Area Protection Act sets the framework for an offset program. Virginia's Chesapeake Bay Preservation Act and Pennsylvania's Growing Greener Bond programs also work somewhat toward mitigating the effects of land use changes and new development.

This chapter proposes the following recommendations to mitigate the effects of increased development within the Bay watershed:

*Improve implementation of Maryland's Chesapeake Bay Critical Area Protection Act and use it as a model throughout the watershed.* Although not without its critics, the Chesapeake Bay Critical Area Protection Act aims to regulate development in the most ecologically important areas of the watershed. Recognizing the impact of land use beyond this area, the Act or its principles could be extended to other environmentally sensitive areas. With this authority, the more effective implementation of other recommendations in this report, such as low impact development, will become more feasible.

*Expand and enhance offset provisions within the Critical Area Act.* Currently, the Critical Area Act allows developers to offset or even "pay" for an amount of stormwater runoff created by a new activity, or for the number of trees cut down. To expand this practice, projects could be required to meet a higher standard for controlling runoff than is currently prescribed, which would in turn increase the required offset. Further, a developer could also offset its nutrient load across pollutant sources, for instance in the agricultural sector or within a different watershed, although it requires changes to the Critical Area Act offsets. This would help prevent an issue that has arisen with the forestation offset program -- that an area (over time) lacks suitable mitigation areas. In addition, developers could be required to offset for other new sources of nutrients from developed land, including increased sewage flows.

*Supplement an offset program with the collection of additional development fees.* Instead of physically implementing an offset, a developer could be allowed to pay a fee, as is used in the both the stormwater and forest offsets under Maryland's Chesapeake Bay Critical Area Protection Act. This money could be used to implement cost-effective nutrient reductions throughout the watershed. For the purposes of nutrient reduction, the cost associated with mitigating the load could be added to an existing development fee, which typically pays only for infrastructure. The impact of this approach would be partially limited by the fact that development fees are often associated with new construction, and may not be an effective means of collecting the marginal cost of nutrient pollution from other construction activities, including land clearing, additions, and paving.

## **Chapter Five – Stormwater Reductions by Low Impact Development**

Urban stormwater runoff currently contributes approximately 11-21 percent of the nitrogen pollution and 16-26 percent of the phosphorus pollution reaching the Bay. Due to the development pressure in the Bay watershed, its contribution will likely increase over time. Current Bay mitigation strategies, however, typically tend to overlook the possibility of controlling stormwater contributions, often regarding the potential solutions as impractical, expensive, and/or ineffective. This report finds, however, that this view is misleading.

The field of low impact development (LID) offers several cost-effective solutions to reduce nutrient loads. LID design factors include bioretention, permeable pavements, green roofs, and other techniques that reduce impervious surfaces on a site. For new development, controlling stormwater is often one of the largest portions of the capital costs; implementing LID components that allow stormwater to be controlled at the source often allow the developer to avoid other costly stormwater controls. For new

development, implementing many LID designs can mitigate all but a small fraction of the nitrogen loadings to the Bay at zero cost to developers. Thus, contrary to much current opinion, controlling nitrogen runoff from stormwater through the use of LID is very cost effective when applied to new development in the Bay region.

Typically, retrofitting existing structures is considerably more costly and less cost effective. Despite the higher costs, however, retrofits are still an attractive opportunity for nutrient reduction, if properly addressed. Achieving a proper timeframe for implementation is one way to mitigate the costs of retrofits. As a housing or other land development ages, many of the roads and other structures will have to be resurfaced and otherwise reworked. Retrofitting existing structures to limit stormwater runoff in coordination with such activities can often be less expensive than traditional site designs and structures.

Currently, zoning laws, subdivision controls, and other regulatory hurdles prevent wide acceptance of LID techniques. This chapter proposes the following recommendations to increase knowledge about and acceptance of LID techniques:

*Remove the regulatory impediments to using LID techniques and designs.*

Municipalities often have zoning requirements that prevent implementation of LID techniques. On-site stormwater management can include the redirection of residential downspouts from the municipal sewer system to on-site rain barrels or bioretention areas. Municipal regulations that require downspout connection are an obvious impediment to this process. Requirements for roadways, driveways, and parking lots are also significant as they can require larger areas of impervious surfaces than typical LID design strategies suggest. Governments in the Bay region should revisit their land use controls to eliminate unnecessary obstacles to the adoption of LID designs.

*Shorten the length of the permitting process for integrated site design.* Because many of the technologies are innovative, permitting is slow. For example, a designer from the Somerset subdivision in Prince George's County, Maryland, claims the permitting process for LID would take six to twelve months longer than permitting for a traditional development.<sup>6</sup> It is unlikely that most developers would be willing to wait an additional year to complete a project, even if they could foresee a cost savings from using the LID techniques. Planning departments and municipalities could overcome this obstacle by implementing an expedited permitting process for "green" development.

*Amend stormwater regulations to provide more stringent controls on stormwater at the source.* Stormwater management is already regulated, but often not for water quality results. Each municipality, county, state, and stormwater district has specific regulations for site design. More stringent water quality requirements could be written into stormwater manuals. For example, requiring 100 percent equivalent management could provide a strong regulatory cap for a potential nutrient trading system in the Bay watershed.

*Provide incentives for using LID techniques, and build local markets for "green" design.* Incentives may be an appropriate investment, even for municipalities struggling to upgrade their storm sewer systems. Offering some small incentive can help build local markets for new technologies and assist homeowners with residential retrofits. Another potential incentive would be direct funding for installations. Requiring new municipal and other government buildings to use green design could help increase awareness and build the market for these techniques.

*Create stormwater utilities to fund and maintain local water systems.* Some municipalities in the Chesapeake Bay watershed created stormwater utilities to fund and maintain local stormwater systems, such as the cities of Takoma Park and



Virginia Beach. Expanding this throughout the watershed could help provide critical funding for maintenance and support.

## **Chapter Six – Wastewater Treatment Plant Upgrades**

Point sources have a significant overall impact on nutrient loadings to the Chesapeake Bay. Wastewater treatment plants (WWTPs) and industrial dischargers account for an estimated 21 percent of nitrogen load and 22 percent of the phosphorus load entering the Bay. These point sources have been the target of many nutrient reduction measures because reducing loadings from point sources is perhaps the administratively simplest way to achieve quantifiable nutrient reductions. Point sources are also highly regulated entities by the National Pollutant Discharge Elimination System permits under the authority of the federal Clean Water Act. Loadings from these sources are also readily quantified and monitored, and advanced technologies are currently available for implementation. From 1995 to 2004, point sources have achieved a 32 percent reduction in the annual loadings of nitrogen delivered to the Bay (approximately 26 millions pounds annually).

However, upgrading WWTPs can be quite costly, especially for smaller or older plants. Several states have implemented creative financing measures in order to increase funding grants to assist WWTPs with upgrade costs. For instance, Maryland in 2004 passed a "flush tax," which imposes a user fee on sewer connections. The fees collected directly fund upgrading the 66 major sewer plants in the state. Virginia in 2005 approved funding of \$50 million per year from general revenues to be applied for similar purposes. Given the increasing costs to upgrading WWTPs across the watershed, other states are also looking for innovative funding measures.

This chapter proposes the following recommendations for upgrading WWTPs in the most effective manner:

*Enhance funding for cost-effective plant upgrades.* The primary obstacle to point-source upgrades is the high capital costs of the infrastructure. Municipalities and states should continue to be creative in seeking out these funds to continue point-source reductions. Initiatives that bring in funds from non-governmental funding sources, such as user fees or development assessments, should be strongly considered.

*Implement offset or trading programs for the most expensive upgrades.* Some WWTP upgrades may be too expensive to justify for their nutrient reduction potential alone. In these cases, where upgrades are expensive and nutrient discharges do not have significant local environmental effects, offset programs should be considered to achieve Bay reductions. This could be achieved through a trading program or through direct purchase of a nutrient reduction at an alternate location. For many dischargers, offsets will be an attractive alternative to the large capital costs per unit of reduction they otherwise would face.

## **Chapter Seven – Reducing Airborne Nitrogen Deposition**

The Bay has an airshed of approximately 418,000 square miles, or six times the size of its watershed. The political and management issues of a watershed that drains six states are even more difficult when attempting to manage atmospheric deposition. Airborne nitrogen, emitted primarily from mobile sources such as cars and trucks, as well as fixed sources such as fossil fuel-burning power plants, falls either directly on the Bay or washes off the land into the Bay. Air sources currently represent approximately 25 to 32 percent of the total nitrogen loadings to the Bay. The complicated scientific nature of the problem, coupled with gaps in understanding of the nitrogen cycle and the fragmented structure of environmental regulations, all impede the development of policy solutions for airborne nitrogen.

Several policy instruments exist that could be used to address this problem. The Clean Air Act (CAA) and its amendments set national standards for air quality, including

nitrogen levels. The NO<sub>x</sub> Budget Trading Program is a cap and trade program that uses the market to reduce atmospheric nitrogen amounts in the most cost-effective manner. Other programs, such as the Bush administration's proposed Clear Skies Initiative and the Clean Air Interstate Rule, also provide mechanisms by which atmospheric nitrogen can be reduced.

This chapter recommends the following for reducing the amount of nitrogen reaching the Bay through atmospheric deposition:

*Implement and enforce the CAA's "secondary standards."* The CAA's primary standards for air pollutants (e.g., NO<sub>x</sub>) are based on human health effects, whereas the secondary standards for these same pollutants are based upon wider environmental effects. It was once assumed that policies that met the primary standards would also serve to meet the secondary standards but this is not the case. EPA, in many cases, never set independent secondary standards based on environmental factors despite the explicit requirement of the Clean Air Act. EPA should more stringently implement the language of the current law by setting and enforcing new secondary standards.

*Encourage greater fuel efficiency and cleaner technology in new vehicles.* Since mobile sources produce the greatest percentage of airborne nitrogen, policymakers should seek methods to decrease the amount of vehicle-emitted nitrogen. Innovative new programs to buy-back older (and more polluting) cars, vehicle-based taxes, such as a nitrogen tax assessed per car according to its emissions, and programs that require new car buyers to "offset" their new emissions through payment of an offset fee are all policy instruments that would encourage lower nitrogen emission levels.

## **Chapter Eight – Increasing Cost Effectiveness through Offsets and Other Nutrient Trading**

To date, point sources (e.g., WWTPs) have borne the brunt of the cost of meeting water quality regulations through mandatory capital upgrades to meet nutrient concentration limits. Further regulation of point sources may prove to be cost-ineffective in many cases, with capital improvement costs creating very high costs per pound of reduction generated. Non-point sources, although producing the majority of the remaining nutrient pollution reaching the Bay, are currently not regulated by permits or under the Clean Water Act. As opposed to upgrading point sources, implementing BMPs on farms to reduce nutrient pollution can be relatively cheap and cost-effective.

This chapter discusses the use of trading as a method by which point sources could "trade" with non-point sources to lower the general nutrient loading in a more cost-effective manner. Trades would be accomplished by allowing point sources to pay non-point sources to implement BMPs, producing a net reduction in nutrient loads between the two to bring the point source down to its regulated limit.

Setting up a successful trading program will require addressing several policy areas. These include the need for reliable measures of non-point source reductions, determining who will monitor and enforce contracts for reductions, as well as who is liable if BMPs fail to achieve their stated objectives. Also, trading may cause hotspots, or localized areas of high pollution, if not carefully monitored and controlled.

Of the Bay states, Virginia and Pennsylvania have begun to establish the groundwork for a trading program. Other states have either created economic disincentives for trading, or have shown little interest. This chapter proposes that a nutrient trading program be adopted to enable the Bay states to more cost-effectively meet their reduction targets. It might involve separate nutrient targets for each state but allow interstate trading so that an individual source may comply with its emission allowances, following the models of the Clean Air Act and the inter-nation trading program for greenhouse gases recently adopted by the European Union. The following recommendations would serve that goal:

*Encourage legislation that promotes nutrient trading throughout the Bay watershed.* Without both authorizing legislation and policy directives that address the numerous uncertainties inherent to estimation, nutrient trading will face resistance from both market participants and the public. This should also include more open communication and intensive education on the trading concept, as well as promoting transparency. Trading is still quite misunderstood outside of the professionals in the field, and in order to win approval from the public, more discussion of the topic, its risks, and the protections available is necessary.

*Increase research funding within the state and national agriculture bureaus to better quantify and calibrate baseline estimates and reduction efficiencies.* Uncertainty about the actual effect of reductions and the accuracy with which measurements can be made are two of the largest obstacles to the acceptance of non-point source trading. Promoting more research on this issue will hopefully increase the accuracy of estimation, with beneficial results for both the watershed and public acceptance.

*Consider establishing a nutrient trading broker system, which is recognized by the Bay states.* This broker system should be liable for monitoring, enforcing, and verifying the implementation of BMPs. This would remove the liability from the buyer for ensuring the validity of purchased credits, and would increase market participation. Brokers could also potentially bundle credits from multiple non-point sources, thus reducing the burden on potential buyers from entering in to multiple contracts.

*Consider establishing a regional nutrient exchange board to promote a Bay-wide view and protect against hotspot and other local issues.* In order to avoid hotspot issues, as well as to perhaps support the idea of cross-tributary or even Bay-wide trading, a regional Board of Nutrient Exchange could allow states to coordinate their trading programs. Program coordination could allow for better targeting of reductions, as well as allow for a better overall view of the watershed. If trading were opened up to the entire watershed, a regional Board could better orchestrate the reductions.

## **Chapter Nine – Redirecting Federal Agricultural Assistance**

Authorized approximately every five years, the federal Farm Bill provides conservation and commodity payments throughout the nation through a variety of programs. Since its implementation, the Farm Security and Rural Investment Act of 2002 has provided approximately \$15 billion in commodity payments and \$3.3 billion in conservation payments nationwide to U.S. farmers. Within their portions of the Chesapeake Bay watershed, the states of Maryland, Pennsylvania, and Virginia in fiscal year 2004 received in total \$60.9 million for commodity payments and \$30.1 million for conservation payments.

Chapter 9 examines how well these funds work to achieve the nutrient reduction goals for the Bay. In general, conservation programs are poorly targeted to specific nutrient reduction goals and commodity programs provide support for additional crops that require high amounts of nutrient application.

This chapter makes the following recommendations to improve the coordination, targeting, and flexibility in federal agricultural assistance in order to contribute more to the achievement of Bay nutrient reduction goals:

*Target commodity payments to better achieve nutrient reduction goals.* Commodity payments could provide incentives for farmers to switch to crops that require a lower application of nitrogen and phosphorous. Commodity payments also could provide farmers with incentives and crop insurance to reduce nutrient application on their crops.

*Target conservation payments to better achieve nutrient reduction goals.* Conservation payments could also be awarded more efficiently – perhaps based on a

bidding process. In this process, for example, farmers might select their preferred BMP and have the cost per pound of reductions calculated for their BMP. Farmers could then be ranked according to the efficiency and effectiveness of their BMP in achieving Chesapeake Bay water quality goals. The farmers with the most efficient and effective BMP proposals would be awarded conservation payments.

*Create a Chesapeake Bay block grant within the Farm Bill to allow greater flexibility in funding disbursement.* Block granting federal agricultural funding and tying its distribution to the achievement of specific nutrient reduction goals would grant a regional financing authority the flexibility it needs, while still maintaining accountability to the federal government for achieving nutrient reduction goals.

## **Chapter Ten – Rethinking the Tributary Strategies**

The states within the Chesapeake Bay watershed have assigned – or will assign – nutrient reduction targets to each major tributary within the state. Tributary strategies are essentially roadmaps to plan the way by which a state will meet its required reductions in nutrient loadings to the Bay. Developed in collaboration by state representatives and individual tributary teams, each state has multiple strategies that are then aggregated into a statewide summary. Although designed to help each state work through its allocation, the tributary teams were never central players in the development of local water quality plans. Instead, they functioned mostly as advisory boards.

The tributary plans put forth are often based on unrealistic technical assumptions or are economically and/or politically infeasible. As a result, a large amount of money and time was spent on meetings and reports that are not implemented, not enforced, nor widely respected.

The tributary strategies were an initial, voluntary and stakeholder-driven attempt to help the states reach their allocated reduction amounts. As 2010 draws closer, the next stage of nutrient reduction efforts may out of necessity become less voluntary and more regulatory, potentially including the federally mandated application of TMDLs for tributaries.

This chapter makes the following recommendations for improving the implementation and use of the tributary strategy process:

*Develop a leadership program drawing together a variety of stakeholders to discuss Bay water quality issues.* Successful tributary strategy implementation will not occur without strong leaders with a vision to inspire action despite funding uncertainty. Improved training of tributary leadership is needed to fulfill this demanding role.

*Incorporate tributary strategy principles into local plans to decentralize the process.* The current incentive structure discourages stakeholders from being involved in the tributary strategies. The most powerful regulatory tools are oriented towards point sources, which limits the involvement and input of city/county stakeholders. Strengthening the role for representatives of non-point sources would help alleviate this disincentive. Decentralizing decision-making or allowing for more collaborative efforts between tributary teams, local municipalities/counties, and the state may also help achieve this result.

*Take steps to achieve stronger enforcement of agricultural nutrient management plans, combined sewer overflow upgrades, and conservation zoning ordinances.* Existing laws must be enforced in order to prepare for the implementation of future programs. In Maryland, the agricultural community is skeptical – and rightly so – because of the lack of enforcement of nutrient management plans and the Chesapeake Bay Critical Area Protection Act.

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## Endnotes to Executive Summary

<sup>1</sup> Blankenship, Karl. 2005. "VA approves \$50 million to reduce nutrients." Bay Journal. April.  
<http://www.bayjournal.com/newsite/article.cfm?article=2510>

<sup>2</sup> Pennsylvania Environmental Council. "Vote May 17th on the Growing Greener Bond Issue Question."  
[http://www.pecpa.org/\\_final\\_pec/html/g2bond/background.htm](http://www.pecpa.org/_final_pec/html/g2bond/background.htm).

<sup>3</sup> Chesapeake Bay Commission. *Cost-Effective Strategies for the Bay. Six Smart Investments for Nutrient and Sediment Reduction*. December 2004.

<sup>4</sup> McConnell and Walls, 2004. "Incentive-Based Land Use Policies and Water Quality in the Chesapeake Bay." Resources for the Future, March 2004, Discussion Paper 4-20.

<sup>5</sup> U.S. Environmental Protection Agency. *Evaluating Ozone Control Programs in the Eastern United States: Focus on the NO<sub>x</sub> Budget Trading Program, 2004*. Washington, D.C., August 2005.

<sup>6</sup> Clar, Michael. Conference presentation at "Putting the LID on Stormwater Management." College Park, MD, September 21-23, 2004.

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## Introduction

The cleanup of the Chesapeake Bay is one of the highest environmental priorities in the region and perhaps the nation. At present, the available resources for Bay cleanup are not being spent in a cost-effective manner. The obstacles to a cost-effective cleanup of the Bay lie mainly in existing water quality policies and procedures and a lack of transboundary flexibility among the different states. Removing these obstacles could result in large gains in efficiencies and effectiveness of cleanup efforts. This report shows how nitrogen reduction goals to restore Chesapeake Bay water quality may be attained in a timely fashion and in a financially practical manner largely within existing resources.

## The Bay Watershed

Draining a watershed of 64,000 square miles, the relatively shallow Chesapeake Bay has the highest watershed land to water volume ratio of any major estuary in the world - an extraordinary 2,743 square kilometers of land to every one cubic kilometer of water.<sup>1</sup> This figure translates into a Bay that has little ability to absorb or dilute any pollutants that drain into it from the six states - Maryland, Virginia, Pennsylvania, West Virginia, Delaware, and New York (plus the District of Columbia) - that lie within its watershed. During the 1970s, this unique characteristic, combined with rapid urban growth, more intensive agriculture, and higher levels of nitrogen air pollution, finally proved too much for the Bay's resiliency. As one fishery crashed after another, starting with shad, then rockfish, and in the 1980s, the dramatic collapse in oyster populations, concern for the health of the Bay became of increasing importance to bordering states.

By the early 1980s, intensive studies by the Bay states and the U.S. Environmental Protection Agency (EPA) concluded that the primary factor affecting the health of the Bay was a lack of dissolved oxygen caused by nutrient over-enrichment of both nitrogen and phosphorus.<sup>2</sup> This led to the signing, in 1983 and 1987, of the Chesapeake Bay Agreements by the three main Bay states (Maryland, Pennsylvania, and Virginia), the District of Columbia, EPA, and a tri-state legislative body known as the Chesapeake Bay Commission. As a condition of acceptance, the signatories agreed in 1987 to reduce the amount of nutrients entering the Bay to 40% of 1985 levels by the year 2000. In 2000, another agreement, Chesapeake 2000, recognized that this level of reduction would not be sufficient, and proposed more significant reductions with the goal of removing the Chesapeake Bay and its tidal tributaries from the federal list of impaired waters by 2010.<sup>3</sup> Achieving this goal would require that nitrogen reaching the Bay be reduced from 278 million pounds per year in 2000 to a level of 175 million pounds in 2010 - a further reduction of 37 percent.

Excess nutrients enter the Bay through a variety of routes. Nitrogen, phosphorus, and sediment wash naturally off the land during rainstorms and other events, and move down the tributary rivers and streams to the Bay. However, the amount of nutrients washed into the tributaries has increased due to discharges of human and animal wastes, fertilizer application, deforestation, suburban land development, and other changes in land use. In addition, air pollution has grown over the past half-century with the dependence on the automobile and coal power production, thus increasing deposition of airborne nitrogen on both land and water, much of which washes into the Bay, representing as much as 25 percent of the total Bay nitrogen load.

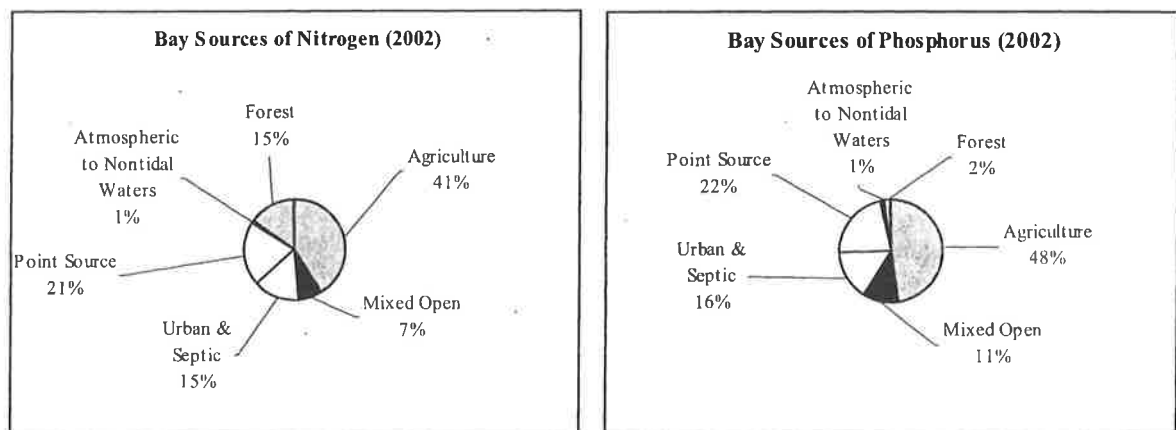
Nutrients originate from two basic types of sources: point sources and non-point sources. Point source pollution occurs whenever the discharge to a water body can be linked to a discrete origin (such as a pipe discharge from a sewer plant). Conversely, non-point source discharge is more diffuse in nature, and no precise point of origin can be determined (such as farm, urban, or construction area run-off).<sup>4</sup> Under the Clean Water Act (CWA), the primary focus of pollution reduction and permitting has been on regulating point sources, via standards established by the National Pollutant Discharge Elimination System (NPDES). Hence, when the Chesapeake Bay states first began to



address nutrient over-enrichment in the Bay, they focused on point sources, mainly wastewater treatment plants (WWTPs).

However, point sources are no longer the primary contributors to the nutrient problems in the Bay. As seen in Figure 1, agricultural and other non-point sources are now the major contributors to nutrient pollution. Although point source regulation is a primary means of controlling nutrient discharge to the Bay, given the current distribution of nutrient loadings, the Bay signatories must focus on finding better ways to control non-point nutrient discharge. Non-point sources contribute almost half the nutrient load to the Bay, and may be able to reduce nutrient loadings in a more cost-effective manner than would be possible by pushing point sources to the limits of available technology.

**FIGURE 1. SOURCES OF NITROGEN AND PHOSPHORUS LOADINGS TO THE CHESAPEAKE BAY<sup>5</sup>**



### Water Quality Standards

The Clean Water Act requires states to designate intended uses for their water bodies and then to set standards of water quality that are required to serve these uses. Although this legislative requirement was enacted in 1972, it was largely ignored nationwide for several decades, as EPA and the states focused their initial efforts on the permitting of and mandating technology standards for large industrial facilities, wastewater treatment plants, and other large individual sources of water pollution. In the Chesapeake Bay, the process of setting water quality standards thus only began in 1995.

Maryland's water quality standard for dissolved oxygen has been 5 mg/L for the entire Bay; yet, the Bay's deep trough never reached this level of dissolved oxygen. Therefore, Maryland never applied the 5 mg/L dissolved oxygen standard to the deep trough. Changing interpretations of the Clean Water Act and court rules forced Maryland to apply this unenforceable standard anyway. This led to lawsuits filed by environmental groups in the late 1990s. The outcome of similar legal actions also required Virginia to write cleanup plans to reduce its impacts on the Bay. The final legal outcome was a court-approved agreement to attain Bay water quality standards by 2011. In 1999, the states came to an agreement with EPA to re-write the water quality standards for the Bay, and Delaware became the first state to receive EPA approval for adopting new water quality standards in December 2004.<sup>6</sup> EPA approved water quality standards for Maryland in August 2005.<sup>7</sup>

The Chesapeake Bay water quality standards reflect a compromise between Bay designated uses and the feasibility of attainment. Based on these standards, the

signatories and headwater states agreed to reduce their loads of nitrogen from 278 million pounds in 2002 to 175 million pounds per year by 2010. For phosphorus, they agreed on a reduction from 19.49 million pounds to 12.8 million pounds per year by 2010. The Chesapeake Bay water quality model shows that this would attain the dissolved oxygen water quality standards for all but the deepest waters of one segment of the Chesapeake Bay (between the Patapsco and Patuxent Rivers in Maryland).

### **Tributary Strategies**

As early as 1992, after recognizing the need for a more precise long-range plan to achieve a cleanup of the Chesapeake Bay, the states of Maryland, Pennsylvania, and Virginia, along with the District of Columbia, agreed to develop specific tributary strategies. The strategies planned for large reductions from non-point sources of pollution flowing from each tributary into the Bay. Although much work went into the development of tributary strategies over the next decade, the strategies were never finalized and were never implemented. More recently, with the new water quality standards and overall targets for Bay pollution loads for 2010, the tributary strategies have been revisited and new load allocations assigned for specific types of pollution in each tributary basin.

A Memorandum of Understanding (MOU) was signed by the three headwaters states that had not previously joined the Chesapeake Bay agreement – Delaware (September 2000), New York (November 2000), and West Virginia (June 2002) – that now binds them and the original signatory states to the latest water quality goals and commitments.<sup>8</sup> Thus, for the first time, all six states in the Bay watershed, along with the District of Columbia, agreed to work cooperatively to solve the Bay's water quality problem. Figure 2 shows the eight basins of the Chesapeake Bay region as they have been delineated for planning purposes, the development of individual tributary strategies, and the allocation of pollution reduction goals.

**FIGURE 2. MAIN BASINS IN THE CHESAPEAKE BAY WATERSHED**



*Source: Chesapeake Bay Program website*

The basins have been further subdivided into 20 state-specific segments (e.g., the Susquehanna River Basin was divided into New York, Pennsylvania, and Maryland segments). Finally, each state divided its segments into sub-basins, for a Chesapeake watershed total of 44 tributary sub-basins.

Allowable pollution loads for nitrogen and phosphorus were allocated to each of the basins and sub-basins. Reductions in nitrogen loads are the greatest obstacle in the efforts to reaching Bay-wide goals. The steps necessary to achieve nitrogen goals would in many cases also yield the achievement of phosphorus goals. The sub-basin allocations by state under the tributary strategies for nitrogen are shown in Table 1.

**TABLE 1. NITROGEN ALLOCATION<sup>9</sup>**

| <b>SUB-BASIN</b>      | <b>2002<br/>LOAD</b> | <b>2010 CAP LOAD<br/>ALLOCATION</b> | <b>PERCENT<br/>REDUCTION</b> |
|-----------------------|----------------------|-------------------------------------|------------------------------|
| Susquehanna - PA      | 102.43               | 63.67                               | 38%                          |
| Susquehanna - NY      | 18.23                | 11.78                               | 35%                          |
| Susquehanna - MD      | 1.43                 | 0.80                                | 44%                          |
| Eastern Shore MD - MD | 17.69                | 10.58                               | 40%                          |
| Eastern Shore MD - DE | 5.02                 | 2.77                                | 45%                          |
| Eastern Shore MD - PA | 0.48                 | 0.27                                | 45%                          |
| Eastern Shore MD - VA | 0.12                 | 0.06                                | 49%                          |
| Western Shore MD - MD | 15.34                | 11.08                               | 28%                          |
| Western Shore MD - PA | 0.04                 | 0.02                                | 53%                          |
| Patuxent - MD         | 4.16                 | 2.38                                | 43%                          |
| Potomac - VA          | 22.84                | 12.32                               | 46%                          |
| Potomac - MD          | 18.12                | 11.42                               | 37%                          |
| Potomac - WV          | 7.11                 | 4.37                                | 39%                          |
| Potomac - PA          | 6.26                 | 3.83                                | 39%                          |
| Potomac - DC          | 3.58                 | 2.38                                | 34%                          |
| Rappahannock - VA     | 7.90                 | 5.05                                | 36%                          |
| York - VA             | 7.68                 | 5.51                                | 28%                          |
| James - VA            | 37.26                | 25.71                               | 31%                          |
| James - WV            | 0.04                 | 0.03                                | 20%                          |
| Eastern Shore - VA    | 2.00                 | 1.11                                | 44%                          |
| <b>Total</b>          | <b>277.73</b>        | <b>175.15</b>                       | <b>37%</b>                   |

These allocations do not necessarily reflect a cost-effective solution for nitrogen reduction for the Chesapeake Bay. No coordinating body acted to ensure that the marginal costs of nitrogen reduction are equal – a condition for maximum cost-effectiveness – among the sub-basins. Greater flexibility in allocating resources will be required to achieve a cost-effective reduction of nitrogen for the Bay watershed as a whole. Such flexibility will require new policy mechanisms and also changes in funding policies.

### **Agricultural Funding Sources**

Many of the most cost-effective actions are found in agriculture, but farmers often have fewer funds available for implementing these actions than other land users. Moreover, partly because farmers have sometimes been in business in the same family

for several generations, there is a common expectation that costs of new regulatory burdens imposed on agriculture will be borne in significant part by society at large. Politically, farmers are a powerful group who have often been successful in resisting new regulations that might threaten their economic well being.

Thus states will often need to find the necessary funds to pay farmers to implement the most cost-effective nutrient reductions in agriculture. This goal can be accomplished in practice in several ways.

**Require offsets.** The use of offsets was pioneered in the clean air program. When one source of pollution faces a high cost of reduction, it may instead achieve its mandated reduction at another place and involving another use. Substantial financial resources thus might be directed to agriculture from other higher cost sources of nitrogen pollution in the Bay watershed.

**Adopt nutrient trading.** Water quality trading is a more formal version of an offset system, based in part on the model of past successful emissions trading for air quality purposes. Trading would work as follows, for example, for wastewater treatment plants. Each plant has a different cost curve for upgrading its capital equipment to address regulatory compliance measures (e.g., decreasing a plant's discharge level from 13 mg/L of nitrogen to 5 mg/L). Cost curves depend on a variety of factors, including the size, scale, age, and overall efficiency of the plant. Upgrades for Plant A, a large, fairly modern facility, may have costs that are much less per pound of reduction than Plant B, a small, fairly old facility. Agricultural sources might thus profitably sell emission reductions to Plant B, while Plant A might opt for the technological solution.

**Reallocate federal agricultural assistance funds.** The 2002 Farm Bill authorized eleven separate conservation programs for farmers in the United States. Eight of these programs provide funding to states or directly to producers to encourage voluntary conservation practices. In FY2004, about \$30 million in such funding was available to the parts of the Chesapeake Bay watershed within Maryland, Pennsylvania, and Virginia. Yet, few of these farm programs use their funding to promote the achievement of specific nutrient reduction goals for the Bay. If the allocation of these funds is revised to assign a higher priority to nutrient management goals in the Chesapeake Bay, and the funds were spent cost-effectively for this purpose, these Farm Bill funding sources could add significantly to the total financial resources available to the Bay cleanup effort. In addition, the U.S. Department of Agriculture spends more than \$60 million per year in crop support payments within the Chesapeake Bay watershed. The availability of these funds might be altered to make them conditional at least in part on a farmer's willingness to adopt management practices that reduce nutrient loadings.

**Impose urban development fees.** Urban land development increases stormwater loads, sewage flows, and otherwise adds to the nutrient burdens on the Bay. The developers of new housing and other land use projects might be required to mitigate these negative impacts on Bay water quality. Indeed, land development in the Bay watershed can be a main source of new revenue for addressing nutrient pollution problems in future years. If the developer of each new housing unit paid a one-time nutrient impact fee of \$1,000, the expected future level of housing development would generate about \$100 million per year for Bay cleanup. Partly due to the rapid increases in housing prices in the Chesapeake Bay watershed in recent years, this would not be a large burden compared with the overall cost of new housing.

## Conclusion

Cleaning up Chesapeake Bay is a practical possibility within the next decade. It is less likely to happen under current policies and procedures, however, which have

become bogged down in lengthy, formal planning processes and unrealistic plans for nutrient reductions that are often included in current tributary strategies. With greater political leadership, however, many more cost-effective nutrient reduction measures could be adopted, and the funds already largely exist to implement these measures. Using new funding resources (such as those described above) and other existing resources, it is reasonable to expect that \$500 million per year in funding could be generated for Bay cleanup throughout the watershed. As this report shows, this is likely sufficient to achieve the nitrogen reduction goals for the Bay by 2010. The phosphorus goals are also likely to be achieved in large part by many of the same actions.

The available funds, however, are not being spent at present for the most cost-effective cleanup actions. Establishing this linkage will be the key to cleaning up the Bay. In the following chapters, this report offers a number of policy alternatives and Bay cleanup strategies that serve to direct available resources to more cost-effective patterns of spending for Bay nutrient cleanup. The focus will be on nitrogen as it is the most important and most difficult nutrient cleanup problem for the Chesapeake Bay.

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### Endnotes to Introduction

<sup>1</sup> Horton, T. *Turning the Tide: Saving the Chesapeake Bay*. Island Press. 2003.

<sup>2</sup> Wiedeman, A. Nutrient Trading for the Chesapeake Bay. April 2001.

<sup>3</sup> Background description from Saving a National Treasure, Chesapeake Executive Council.

<sup>4</sup> Greenhalgh, S. and A. Sauer. *Awakening the Dead Zone: An Investment for Agriculture, Water Quality, and Climate Change*. World Resources Institute. February 2003.

<sup>5</sup> Chesapeake Bay Program. "Sources of Phosphorus Loads to the Bay" and "Sources of Nitrogen Loads to the Bay." <[www.chesapeakebay.net](http://www.chesapeakebay.net)>.

<sup>6</sup> Blankenship, K. "Maryland water quality standards a watershed event for Bay cleanup". Bay Journal. January/February 2005. 17 May 2005, <<http://www.bayjournal.com/article.cfm?article=2447>>.

<sup>7</sup> Blankenship, K. "Water quality standards approved for MD's part of Bay: Stormwater plants, industry dischargers will be the first to be affected by regulatory action." Bay Journal. October 2005. 10 October 2005, <<http://www.bayjournal.com/article.cfm?article=2631>>

<sup>8</sup> U.S. Environmental Protection Agency. Chesapeake Bay Program. Memorandum of Understanding. June 2002. 17 May 2005, <<http://www.chesapeakebay.net/pubs/sixstatemou.pdf>>.

<sup>9</sup> U.S. Environmental Protection Agency. Chesapeake Bay Program. Chesapeake Bay Watershed Nitrogen Loads and Cap Load Allocations. 31 March 2004. 17 May 2005, <[www.chesapeakebay.net/pubs/doc-85-01\\_Loads\\_2010\\_Allocations\\_060403.xls](http://www.chesapeakebay.net/pubs/doc-85-01_Loads_2010_Allocations_060403.xls)>.

## **Part I – Cost-Effective Agricultural Nitrogen Reduction**

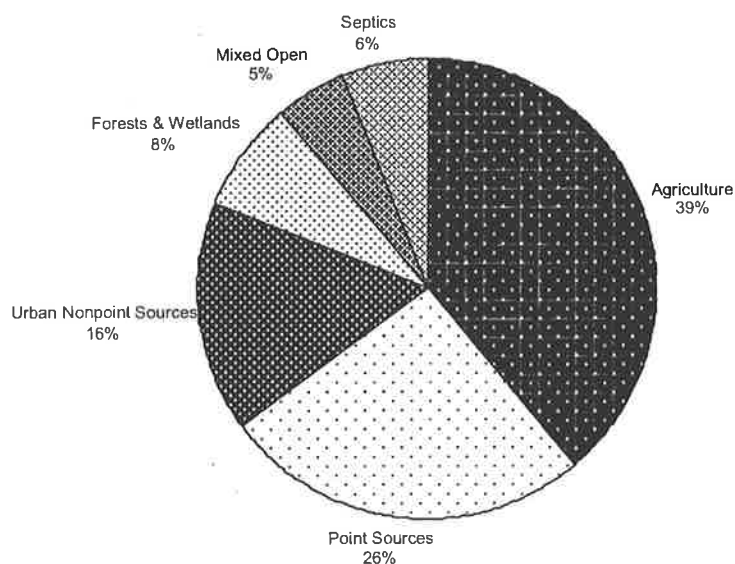




## CHAPTER 1 – NUTRIENT REDUCTIONS IN MARYLAND AGRICULTURE

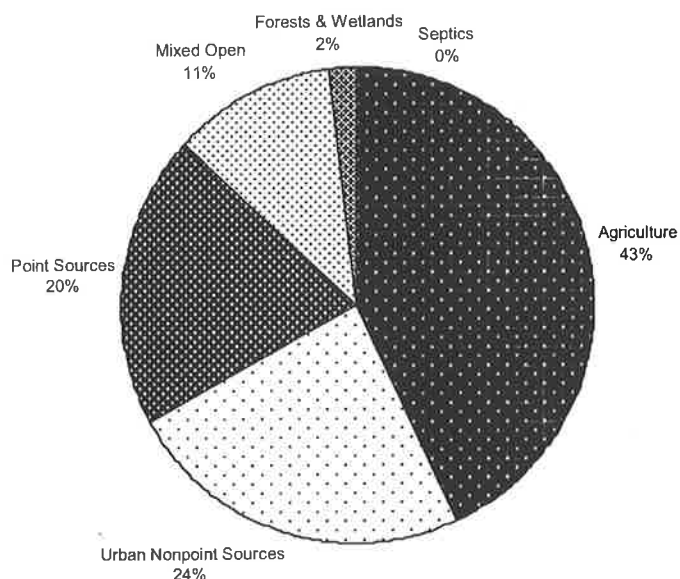
Although the agricultural sector contributed only about three percent (\$5 billion) of Maryland's gross state product in 1999, farming occurs on about 35 percent (2.15 million acres) of the state's land area, second only to forestland (40 percent of the land area).<sup>1</sup> According to the Maryland Department of Natural Resources Tributary Strategies Program, agricultural non-point source pollution contributes nearly 40 percent of the total nitrogen and roughly half of the total phosphorus entering the Chesapeake Bay from Maryland.<sup>2</sup>

**FIGURE 1-1. SOURCES OF NITROGEN IN MARYLAND, 2002**



*Source: Maryland Tributary Strategies Program, Department of Natural Resources*

**FIGURE 1-2. SOURCES OF PHOSPHORUS IN MARYLAND, 2002**



Source: Maryland Tributary Strategies Program, Department of Natural Resources

A large part of Maryland's agricultural nutrient pollution problem stems from the state's dominant agricultural industry: poultry production. Maryland's poultry industry is located on the Eastern Shore of the Chesapeake Bay on the Delmarva Peninsula,<sup>a</sup> and generates over 30 percent of the state's annual agricultural cash receipts,<sup>3</sup> employs over 15,000 people,<sup>4</sup> and places Maryland seventh in the nation for the number of broilers (chickens raised for meat consumption) processed.<sup>5</sup> Almost half of Maryland's 2.1 million acres of farmland is planted in corn and soybeans, primarily to supply the poultry and livestock industries with feed.<sup>6</sup> Over 280 million broilers<sup>7</sup> and nearly 340,000 tons of manure<sup>8</sup> are produced every year in Maryland. This manure contains significant amounts of nitrogen and phosphorus and often exceeds the capacity of nearby fields to absorb these levels of nutrients. Excess nutrients then run off into nearby water bodies and eventually reach the waters of Chesapeake Bay, causing significant environmental problems.

This chapter highlights key aspects of Maryland's agricultural nutrient pollution problem, reviews the current approach for reducing agricultural nutrient pollution, and provides a new policy approach to reducing agricultural nutrient loads according to the principle of cost-effectiveness.

### **Nutrient Pollution Problem in Maryland**

The core of Maryland's poultry manure problem occurs in three Lower Eastern Shore (LES) counties – Wicomico, Somerset, and Worcester – and one Upper Eastern Shore

<sup>a</sup> The Delmarva Peninsula includes nine Maryland, three Delaware, and two Virginia counties.

(UES) county (Caroline).<sup>b</sup> Each of these four counties generates more poultry manure nutrients than can be absorbed by nearby cropland soils. When more manure fertilizer is applied to crops than they need, nutrient losses occur. Nutrient runoff pollutes local waterways and eventually the Chesapeake Bay. The magnitude of this problem is approximately 110,653 tons of excess poultry manure, or about one-third of the 338,681 tons of poultry manure produced in Maryland annually.<sup>9</sup>

The University of Maryland Center for Agricultural and Natural Resource Policy estimates that the four, core problem counties would have to transport manure out of the area to avoid exceeding the agronomic nutrient needs of the crops in those counties.<sup>10</sup> Maryland's remaining four Eastern Shore counties (Kent, Queen Anne's, Talbot, and Dorchester) have soils with surplus manure absorbing capacity. They can accept approximately 196,648 tons of poultry manure for application at agronomic rates, more than the 110,000-ton excess produced in the four problem counties. Thus, the excess poultry manure problem has at least one potential solution: transport the excess poultry manure from farms in the four "excess" counties to farms in the four "surplus capacity" counties. Of course, there are a number of policy challenges to implementing this solution, including monetary costs, which will be addressed in subsequent sections.

### **Successes and Shortcomings of the Current Approach**

Maryland has over two decades of experience providing farmers with technical and financial assistance to install agricultural best management practices (BMPs) that conserve soil, manage manure, and reduce nutrient losses and application. Advances in aquatic and soil nutrient science over the last decade, however, indicate that more aggressive management of agricultural activities is warranted. This section provides a brief overview of current nutrient reduction policies in Maryland; it highlights the successes and shortcomings of Maryland's voluntary nutrient management strategies, including the manure transportation and alternative use programs; it also discusses and evaluates the mandatory nutrient management strategies in Maryland.

### **Maryland's Voluntary Nutrient Reduction Efforts**

Maryland has one of the oldest and most extensive state agricultural pollution reduction programs in the country. The 1987 Chesapeake Bay Agreement set a 40 percent nutrient reduction goal for the state.<sup>11</sup> To achieve that goal Maryland established a voluntary Nutrient Management Program and a series of tributary strategies. These two programs were intended to complement the existing Maryland Agricultural Water Quality Cost-Share (MACS) program.

Since its inception in 1983, the MACS program has provided up to 87.5 percent of funds for adopting agricultural best management practices. In FY2003, for example, the program made \$9.2 million in grant payments to farmers who invested more than \$1 million of their own funds for 3,500 BMPs.<sup>c</sup> These practices will prevent an estimated 19,630 tons of soil loss annually and 1,860 tons of manure daily from impacting Maryland waterways.<sup>12</sup>

Despite these successes, the rate and scale of implementation of BMPs remain inadequate. The need for greater reductions in nutrient pollution is reflected in the more ambitious goals of the Chesapeake 2000 Agreement and in Maryland's updated tributary strategies. To achieve its portion of Chesapeake 2000, Maryland agreed to reduce 19 million pounds of nitrogen flows delivered to the Bay every year between 2002 and 2010.<sup>13</sup> To achieve this goal, the tributary strategies ambitiously promise that:

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<sup>b</sup> The Eastern Shore of Maryland is divided into four counties on the southern end of the Delmarva Peninsula called the Lower Eastern Shore (LES) while the four counties at the northern end of the Peninsula is referred to as the Upper Eastern Shore (UES).

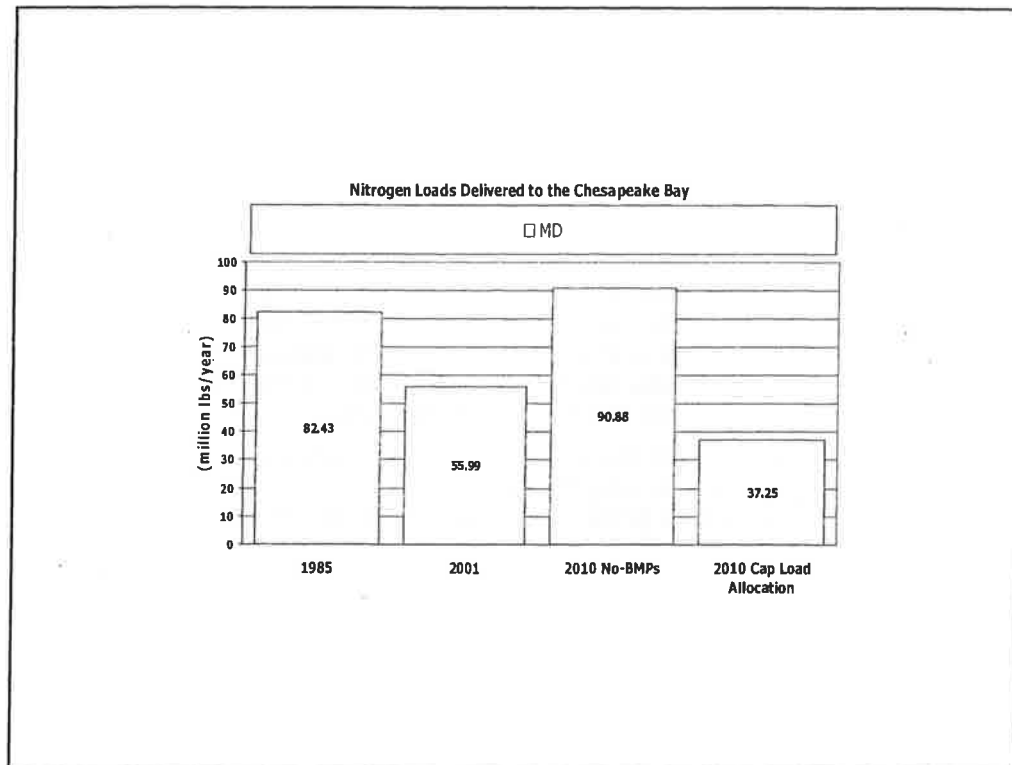
<sup>c</sup> The top 10 best management practices installed with cost-share assistance in 2003 were: nutrient management services, cover crops, riparian forest buffers, filter strips, watering facilities, conservation cover, manure transport, stream fencing, grassed waterways, and animal waste storage structures.

- All 1.3 million acres of cropland in the state will be managed each year with nutrient management plans,
- 600,000 acres of “early planted cover crops” will be planted every year, and
- Over 700,000 acres of crops will be tilled each year using conservation tillage practices.<sup>14</sup>

Given that only 60 percent of the state’s farmers have filed nutrient management plans as of July 2004 and that only 117,000 acres of cover crops were planted in 2003, the gap between some of the tributary strategy goals and current implementation levels for some BMPs remains quite large.

The nitrogen reduction from implementing all the tributary strategy best management practices (agricultural, stormwater, septic, and WWTP) at the intended levels is significant. As Figure 1-3 illustrates, the annual nitrogen load that Maryland delivers to the Bay will increase to about 90 million pounds per year, up from 56 million pounds in 2001, if none of the BMPs are implemented. If all of the tributary strategy goals are achieved, Maryland will meet its nutrient reduction goal and reduce its nitrogen annual loads by about 37 million pounds to the Bay.

**FIGURE 1-3. MARYLAND’S NITROGEN LOADS DELIVERED TO THE BAY**



Source: Maryland Tributary Strategies Program, Department of Natural Resources

### **Maryland’s Mandatory Nutrient Reduction Efforts**

In 1996 and 1997, the debate over whether voluntary nutrient management programs were sufficient to address agricultural nutrient pollution re-surfaced following several fishkills likely caused by the toxic form of *Pfiesteria piscida*, a microorganism. A Blue Ribbon Commission appointed by the Governor of Maryland (1997) determined that several of Maryland’s Lower Eastern Shore tributaries of the Chesapeake Bay were

enriched with excess nutrients. Scientists concluded that the fish kills were caused primarily by the low oxygen conditions resulting from nutrient pollution, but also that skin lesions on the fish, and those on the watermen and scientists, were associated with pfiesteria. Some of those affected also suffered from nausea, headaches, and short-term memory loss. Poultry production and crop farming are the dominant land uses in the watersheds of the affected tributaries, and commercial fertilizer and poultry manure run-off was identified as the main source of nutrients causing the fishkills.<sup>15</sup>

The Maryland General Assembly in 1997 held public hearings in response to the economic damage to the state's seafood and Bay-related recreational industries because of the fishkills.<sup>16</sup> Policymakers learned that nearly a decade after the inception of the voluntary nutrient management program, only 45 percent (996,000 acres) of Maryland farmland was under a voluntary nutrient management plan at some point.<sup>17</sup> It became clear that, in addition to encouraging voluntary plans, mandatory requirements were necessary.

In 1998, the Maryland General Assembly responded to the pfiesteria outbreak by enacting the Water Quality Improvement Act (WQIA), making Maryland the first state in the nation to make nutrient management mandatory for all agricultural sectors. All farmers must manage their fertilizer use to optimize the agronomic nutrient needs of planted crops, while ensuring that nutrient applications do not exceed the soil absorption capacity or are lost due to specific topographical and hydrological characteristics of the cropland. For the first time, all farms in the state had to file state-certified nutrient management plans<sup>d</sup> and had to manage both nitrogen and phosphorus using a site-specific management tool called the Phosphorus Site Index (PSI). Farmers using commercial fertilizers had to file their nutrient management plan with the state by 2001 and implement their plan by 2002. Farmers using manure fertilizers had until 2004 to file their nutrient management plan and until 2005 to implement the plan. Farmers were either able to get free assistance from county nutrient management advisors, or cost-share funds were allocated to hire private consultants to prepare plans.

Regulatory compliance by farmers, however, is a problem. Only 30 percent of the farmers required to file a nutrient management plan by the 2001 deadline had done so by the 2002 implementation deadline.<sup>18</sup> As of July 2004, only 60 percent of all farmers had filed the required nutrient management plans.<sup>19</sup> Despite statutory provisions for economic penalties to result after sufficient warnings for noncompliance, the state has neither taken enforcement actions nor conducted site inspections.<sup>20</sup>

In short, Maryland's unprecedented efforts at both voluntary and mandatory regulation of nutrient pollution have been undermined by a lack of implementation, compliance, and enforcement. The gap between pollution reduction goals and reality remain large and are growing.

### **Cost-Effectiveness – A New Approach**

The traditional policy approach in the signatory states has been to "go it alone" to meet nutrient reduction goals. Each state uses federal and state funding to pay farmers to install BMPs and to fund costly technology upgrades of sewage treatment plants. Maryland, as well as the other tributary states, should adopt an integrated cost-effectiveness policy for addressing noncompliance with regulations, transporting excess manure, and implementing agricultural BMPs to achieve nutrient reduction goals. Government policies should be redirected to focus on implementation of those agricultural nutrient reduction practices that involve the least cost per unit of nutrient reduction achieved – and thus maximize the total environmental benefit per dollar spent.

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<sup>d</sup> Nutrient management plans specify the optimum use of commercial and manure fertilizers to minimize nutrient loss to the environment while achieving realistic crop yield goals. The nutrient management plans provide recommendations for the amount, timing, and placement of nutrient applications on each type of crop planted.

The principle of cost-effectiveness may be applied either as a mechanism to fund best management practices that represent the least cost per pound of pollution reduction, or it may be used to set the initial prices of BMPs in a market-based, nutrient trading approach. If Maryland or other Bay states adopt a nutrient trading policy approach, farmers who are currently unwilling to comply with state regulations or adopt the voluntary BMPs may be inclined to participate in order to maximize their profit-earning potential.

### **Cost-Effectiveness of BMPs**

Maryland's current tributary strategy identifies 22 agricultural BMPs that, if implemented at the indicated levels, would achieve the agricultural portion of the state's nutrient reduction goals. To determine how the BMPs compare to each other in terms of cost-effectiveness, nine BMPs were selected: animal waste management systems (AWMS) for livestock and poultry,<sup>e</sup> alternative manure management—transport, conservation tillage, cover crops, grassed buffers, nutrient management, retirement of highly erodible lands, soil conservation and water quality planning implementation, and stream protection with fencing. Each of these BMPs is among the most common and long-running BMPs for nutrient management and soil conservation. And, except for the AWMS—Poultry BMP that neither Pennsylvania nor Virginia have in their tributary strategy, and the Manure Transport BMP that only Virginia has, these BMPs allow comparison of the cost-effectiveness across the states.

Each of the nine BMPs reduces both nitrogen and phosphorus, and implementation levels were selected to achieve Maryland's nitrogen and phosphorus reduction goals. However, this initial analysis focuses on nitrogen, given that separate costs for implementing the BMP for either nitrogen or phosphorus alone were unavailable. Thus, this analysis should be interpreted conservatively as calculating the cost-effectiveness of the BMP for nitrogen reductions alone, and with all the costs assigned to nitrogen, even though phosphorus benefits are in reality also achieved. This approach is also reasonable because of the greater difficulty of achieving and higher priority of nitrogen reductions in the Bay. The results are conservative in the sense that they show a maximum cost per unit of nitrogen reduction achieved. The data for this analysis come from two sources: Maryland's nitrogen reduction effectiveness factors for each BMP from the Chesapeake Bay Program, and Maryland's tributary strategy implementation goals and annual costs.<sup>f</sup> The analytical methods were limited to simple mathematical calculations (as opposed to complex modeling) to derive the total pounds of nitrogen reduction achievable from fully implementing each of the nine BMPs each year and the annual cost per pound of nitrogen reduction from each BMP.

Additionally, based on communication with the Chesapeake Bay Program, the pounds of nitrogen reductions in this analysis correspond roughly to what is known as reductions "delivered to the Bay" because, on average, only about 90 percent of Maryland's nitrogen reductions, which are measured at "edge of stream," actually reach the Bay. Also, despite being "delivered to the Bay" figures, without access to the dynamic modeling system used by the Bay Program, our approach to determine the total number of pounds of nitrogen reduction "delivered to the Bay" from each BMP results is an overestimate. This is because the "edge of stream" factors reflect the scientific consensus of what each BMP, in isolation, can potentially reduce at the "edge of stream." By combining one or more BMPs on the same acre, there will be less nitrogen reduction

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<sup>e</sup> The tributary strategy data for the livestock and poultry animal waste management systems were eventually combined into one BMP as the data for nitrogen reduction effectiveness for these two BMPs provided by Jeff Sweeney of the Chesapeake Bay program listed them only as one BMP.

<sup>f</sup> The data for Maryland's "delivered to the bay nitrogen reductions per BMP" were derived from nitrogen reduction effectiveness factors that were provided by Jeff Sweeney, Non-point Source Data Manager for the Chesapeake Bay Program. The data for the state's Tributary Strategy agricultural best management practices (BMPs) implementation goals were available from the "Table 2 – Maryland's Tributary Strategy Best Management Practices. 7/30/04." The data for the Tributary Strategy annual costs were derived from the "Final Draft Costs, Funding Estimates and Implementation Levels – Revised 11/5/04" was provided by Helen Stewart, Section Chief, Maryland Department of Natural Resources.

potentially achievable. For example, if one BMP is reducing the amount of nutrients that are being applied (as is the case with nutrient management) then another BMP preventing nitrogen from running off during wintertime (e.g., cover crops) will have less nitrogen in the soil to prevent from running off.

As shown in Table 1-1 below, the annual costs per pound of nitrogen reduction vary considerably for the nine selected practices.

**TABLE 1-1. POTENTIAL NITROGEN REDUCTIONS AND COST-EFFECTIVENESS OF NINE MARYLAND TRIBUTARY STRATEGY AGRICULTURAL BEST MANAGEMENT PRACTICES**

| BEST MANAGEMENT PRACTICE  | GOAL (SYSTEMS, TONS EXPORTED, OR ACRES) | ANNUAL TRIB STRATEGY COSTS (CAPITAL AND O&M) | DELIVERED TO THE BAY REDUCTION FACTORS (LB/UNIT/YR) | POTENTIALLY AVAILABLE REDUCTION (LB/YR) | COST PER POUND REDUCED (\$/LB/YR) |
|---|---|--|---|---|-----------------------------------|
| Animal Waste Management System (manure acres maintained for 15 yrs)   | 640                                     | \$9,574,102                                  | 1554.13   | 994,643                                 | \$9.63                            |
| Conservation Plans (acres maintained for 10 years)  | 578,630                                 | \$20,981,865                                 | 0.83  | 480,263                                 | \$43.69                           |
| Conservation Tillage (acres needed every year until 2010)   | 718,037                                 | \$6,221,296                                  | 4.15  | 2,979,854                               | \$2.09                            |
| Cover Crops, Early (acres needed every year until 2010)   | 600,000                                 | \$24,000,000                                 | 8.53  | 5,118,000                               | \$4.69                            |
| Grassed Buffers (acres maintained for 10 years)   | 57,352                                  | \$1,360,999                                  | 17.13   | 982,440                                 | \$1.39                            |
| Manure Transport (tons for export every year until 2010)  | 70,000                                  | \$1,400,000                                  | 7.21  | 504,700                                 | \$2.77                            |
| Nutrient Management (acres needed every year until 2010)  | 1,364,718                               | \$4,144,000                                  | 2.8   | 3,821,210                               | \$1.08                            |
| Land Retirement (acres maintained for 10 years)   | 26,329                                  | \$535,546                                    | 8.61  | 226,693                                 | \$2.36                            |
| Off-Stream Watering with Fencing (acres maintained for 10 years)  | 10,155                                  | \$1,721,319                                  | 6.12  | 62,149                                  | \$27.70                           |
| <b>TOTAL</b>  |   | <b>\$69,939,127</b>                          |   | <b>15,169,951</b>                       |                                   |
| Source: The data for Maryland's "delivered to the Bay nitrogen reductions per BMP" were derived from nitrogen reduction effectiveness factors provided by Jeff Sweeney, Non-point Source Data Manager for the Chesapeake Bay Program. The data for the state's Tributary Strategy agricultural best management practices implementation goals were available from the "Table 2 – Maryland's Tributary Strategy Best Management Practices. 7/30/04" except for Animal Waste Management Systems, which was provided by Jeff Sweeney. The data for the Tributary Strategy annual costs were derived from the "Final Draft Costs, Funding Estimates and Implementation Levels – Revised 11/5/04," which was provided by Helen Stewart, Section Chief, Maryland Department of Natural Resources. |   |  |   |   |                                   |

Full implementation of these nine BMPs could result in 15 million pounds of "delivered to the Bay" nitrogen reductions, or approximately 80 percent of Maryland's 19 million pound nitrogen reduction goal. The annual cost for this reduction is \$70 million. The first five most cost-effective BMPs (nutrient management, grassed buffers, conservation tillage, land retirement, and manure transport) are under \$3 per pound of nitrogen reduced per year. This could provide 56 percent of the total nitrogen reductions (8.5 million pounds) for just 20 percent of the cost (\$13.7 million).

The cost-effectiveness of the BMPs ranges from \$1.08 per pound of nitrogen reduced to \$43.69 per pound. The most cost-effective BMP, nutrient management, would cost only \$1.08/lb nitrogen if 100 percent of the state's cropland acres were properly managed under nutrient management plans, which would contribute the second highest

number of pounds of nitrogen reduction (3.8 million pounds). The least cost-effective BMP is soil conservation and water quality plans (SCWQP) or conservation plans, at \$43.69/lb nitrogen reduced, and only provides 480,263 pounds of nitrogen reduction.

The two most cost-effective BMPs, nutrient management and grassed buffers, could reduce a total 4.8 million pounds of nitrogen each year, if fully implemented, providing 32 percent of the 15 million pounds of nitrogen reduced and costing only \$5.5 million (8% of the total nutrient reduction cost). Nutrient management must be implemented on each cropland acre each year to be effective and the plans must be updated at least every three years; the grassed buffer BMP occurs once and is maintained for 10 years. For grassed buffers, the land area surrounding a stream will be taken out of production for 10 years and grasses are planted and maintained for 10 years to prevent nutrient run-off.

The next three most cost-effective BMPs are in the range of \$2/lb of nitrogen reduced. Together, conservation tillage, land retirement, and manure transport could provide 3.7 million pounds of nitrogen reduction (24 percent of the total reduction for \$8 million, or about 12 percent of the total cost). Conservation tillage is a practice of using specific equipment to disturb only a minimal amount of the soil surface during planting, and it must be done annually to achieve nitrogen reduction benefits. Land retirement takes "highly erodible" agricultural land (e.g., steep slopes) out of production for at least 10 years and plants grasses or trees for nutrient absorption. If achievable, Maryland's manure transport BMP would pay to move 70,000 tons of livestock and poultry manure to alternative use project sites or cropland that can use the manure as fertilizer while ensuring a low risk of nutrient losses, annually.

The next two most cost-effective BMPs, early planted cover crops and animal waste management systems, cost approximately \$4.69 and \$9.63 per pound of nitrogen reduction per year, respectively. Together, these two BMPs could provide 6 million pounds of nitrogen reduction (40 percent of the total) but would cost 32 percent (\$22.7 million) of the total cost. Cover crops immobilize nitrogen over the winter when most cropland is fallow and prevent nitrogen from leaching to the groundwater. When planted early, the cover crop seed is planted when the commodity crop is still in the ground and provides more nitrogen reduction benefits than when planted late. Animal waste management systems are structures (that are capitalized over 10 years) that prevent manure from releasing nutrients to the environment until a suitable location for use or disposal is determined. In its tributary strategy, Maryland commits to 1,016 livestock waste management systems and 213 poultry waste management systems, which represents approximately 650 manure acres and nearly one million pounds of nitrogen reduction per year.

The final two agricultural BMPs are offstream watering for dairy cows or beef cattle with stream fencing and conservation plans. Offstream watering systems on only 10,000 acres would cost \$27.70 per pound of nitrogen reduction while conservation plans on 480 thousand acres would cost \$43.69/lb/acre/year. By providing cows with alternative watering sources and preventing them from entering the stream where direct discharge of nutrients can occur and stream bank erosion is likely, this BMP is cost-ineffective compared to others. As for the conservation plans, two reasons explain the high cost and low nitrogen-reduction benefits. First, the conservation plans are comprehensive natural resource management plans that encompass many objectives, including erosion, runoff, forestry, and wildlife habitat, in addition to nutrient management. Second, the way in which costs and nitrogen benefits are sometimes included in the plan, and sometimes removed and included in other BMP calculations, makes the SCWQP the least cost-effective BMP on the list.

### **Manure Transport, Alternative Manure Use, and a Buyout**

While the assessment of a range of BMPs is informative, it is also important to consider the feasibility of individual practices. This section looks more closely at two BMPs: manure transportation and alternative manure use, and also presents a novel



alternative: reducing the excess poultry manure problem via a voluntary poultry house buy-out program.

### ***Maryland's Manure Transportation Program***

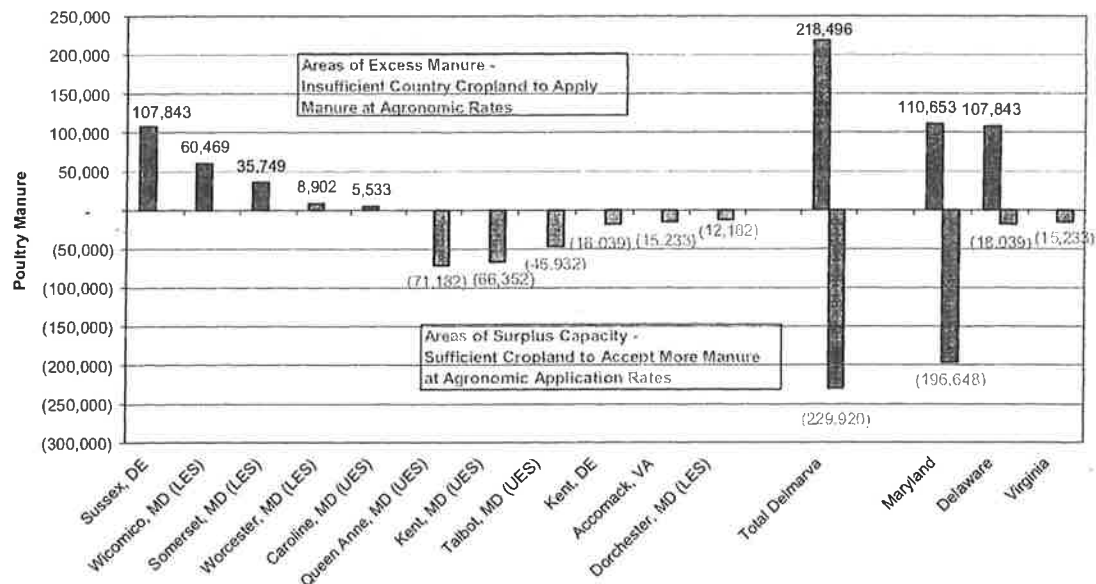
The WQIA also established a goal of transporting 20 percent of the poultry litter produced in the four Lower Eastern Shore counties with excess manure to locations that could use the manure appropriately and to alternative manure use projects. Maryland established a four-year manure transport pilot project in 1999 and provided up to \$18/ton for transporting excess manure. The state's four poultry processing companies, which contract to independent poultry growing farmers (called "growers"), agreed to provide half the cost for the poultry manure transport program. In FY2003, processing companies provided half of the \$463,000 to transport 29,000 tons of manure.

To target the counties with the surplus manure, cost-share rates are 20 percent higher for farms located in Wicomico, Worcester, and Somerset counties – the counties with excess absorption capacity. In addition, the state established a Manure Matching Service to serve as an information clearinghouse for transport programs linking farmers who want manure with those who have excess manure.

Despite these efforts, reports suggest that the program is under performing. The surplus capacity for nutrient absorption in Maryland is substantial; it is not only sufficient to address the excess manure produced in Maryland, but Maryland's capacity is also large enough to absorb the 107,843 tons of excess manure that Delaware produces (see Figure 1-4). Indeed, given the volume of excess manure produced and the absorptive capacity of soil in other counties in Maryland, the program's goal should be to transport annually all of the excess manure produced annually in the state (110,653 tons), an amount equal to 33 percent of the total manure produced annually (338,681 tons).

And yet, in 2003, only 29,000 tons of manure,<sup>21</sup> or just eight percent of the state's total manure production, was transported. Most of this manure was moved over 150 miles to Pennsylvania for use as a growing medium by the mushroom industry.<sup>22</sup> Matching Service reports indicate that over 110,000 tons of manure have been requested since 1999, but only 23 matches for 11,000 tons of manure have been successfully completed.<sup>23</sup>

**FIGURE 1-4. AREAS WITH EXCESS POULTRY MANURE OR SURPLUS CAPACITY**



Source: Adapted from data presented in Faber, Scott. "Study finds market for chicken litter much closer to home." Bay Journal, April 2004.

It is unclear why the demand for manure so greatly exceeds the delivery of manure under the transportation program. The lack of farmer compliance with nutrient management plan requirements discussed earlier may be a contributing factor. Another may be the instability of funding. According to several Annual Reports by the Maryland Department of Agriculture, state funding for the program has fluctuated between less than \$10,000 and over \$200,000 between 1999 and 2003. If farmers cannot rely on stable delivery schedules, they will be unable to make use of available supplies. Currently, the high rise of fuel costs may also be an increasingly important influencing factor. The cost of natural gas, which is a feedstock for commercial nitrogen fertilizer, is causing the price of commercial nitrogen to rise as well. Therefore, many farmers may be interested in using manure to meet their crop nitrogen needs instead of commercial nitrogen. However, the rise in the price of petroleum has increased gasoline and diesel prices to over \$2 per gallon, which increases the transportation costs over long distances. Since three of the four Maryland counties with excess manure problems are located on the Lower Eastern Shore, distances between the northern-most LES county and the northern-most UES county can be over 80 miles.

Maryland's tributary strategy goal for manure transportation is set at 70,000 tons per year. If this goal were realized, manure transportation in Maryland would be the fifth most cost-effective BMP, costing only \$2.77 per pound of nitrogen reduction and providing 505,000 pounds of nitrogen reduction every year.

Realizing this transportation goal (if all of the manure transported was poultry manure) could solve as much as 60 percent of the 110,653-ton excess manure problem. However, because the 70,000 tons of manure to be transported is not restricted to poultry manure, the program most likely could not transport that much poultry manure. In addition, all of this transported manure may not be used as a commercial fertilizer substitute, but may be used in alternative use projects (e.g., composting and palletizing).

A major drawback to the program is that it may not be a long-term solution. Depending on the history of manure use on the recipient fields, many farmers may find that after a few years of transportation and application, that the soils will become too





# UNIVERSITY OF MARYLAND

SCHOOL OF PUBLIC POLICY

2101 Van Munching Hall  
College Park, Maryland 20742-1821  
301.405.6330 TEL 301.403.4675 FAX

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To Whom It May Concern:

The attached report, *A Bigger Bang for the Buck: Offsets and Other Cost-Effective Strategies for Nitrogen Reductions for the Chesapeake Bay*, was produced by the policy analysis workshop at the School of Public Policy of the University of Maryland. The policy analysis workshop consisted of 10 masters students who worked throughout the spring 2005 semester on this project. I was the faculty advisor to their efforts. Final revisions and other updating of the report continued after the conclusion of the school year.

A *Bigger Bang for the Buck* finds that existing policies are not likely to achieve their nitrogen reduction targets for Chesapeake Bay by 2010. Nitrogen is the most difficult pollution problem in the Bay at present. It would be possible, however, to achieve these nitrogen targets – or at least make much greater progress – if available resources were allocated more efficiently. Indeed, changes in policy to achieve greater cost effectiveness might be able to achieve the desired nitrogen reductions largely within the levels of funds now available.

Agriculture is the leading source of nitrogen. Much of this nitrogen originates in chicken, pig and cow manure on the Eastern Shore of Maryland, in Lancaster County in Pennsylvania, in Rockingham County in Virginia, and in other important agricultural production areas within the Chesapeake Bay watershed. The Clean Water Act until recently has focused on point sources of pollution, leaving agriculture largely unregulated at the federal level and modestly regulated at the state level. Nitrogen (and phosphorus)

saturated in phosphorous for them use manure as a fertilizer substitute. Thus, as time passes, the numbers of acres in counties that can accept manure may decrease as soils reach the saturation point for phosphorus.

Thus, manure transport may be a short-term solution, requiring more substantial and long-term solutions such as alternative use projects for manure and changing the diet and feed composition for poultry and dairy cows. However, until phosphorous saturation of recipient fields becomes a reality, this is a viable and cost-effective strategy. The state should invest in studying and overcoming the obstacles that seem to have hampered the program to date.

### ***Maryland's Alternative Manure Use Efforts***

Although the WQIA provided research and development funds for alternative use projects for poultry manure, only two alternative use projects operate on the Delmarva peninsula, and only one of them is in Maryland.

Furthermore, these two operations consume less than 10 percent of the annual production of poultry manure on the entire peninsula (706,400 tons).<sup>24</sup> Perdue's AgriRecycle plant in Delaware consumes about 65,000 tons of poultry manure annually (primarily from Delaware) to manufacture pellet and granule fertilizers. A single composting facility in Maryland consumes about 10,000 tons of manure.

Despite the lack of high-volume alternative manure use projects, there are a number of potential projects. Available estimates indicate that the market for composted litter in landscaping may be approximately 15,000 tons per year.<sup>25</sup> On Delmarva tree farms, another 23,750 tons per year of composted litter could be consumed if tree farm operators were interested in using manure as a fertilizer supplement. Together, these two markets could account for 38,750 tons per year or 18 percent of the excess poultry manure produced on the entire Peninsula. Poultry litter may also serve as fuel to produce electricity and steam in boiler processing plants accounting for up to 80,000 tons per year.<sup>26</sup>

Lichtenberg et al. (2002) examined the net value of poultry litter given its several potential uses.<sup>9</sup> They determined that the most valuable use of poultry manure is as fertilizer. The highest average net value of \$34.19/ton (minus costs for cleanout, nutrient testing, and land application) is for a continuous corn rotation using phosphorus-based application rates, while the lowest average net value is for nitrogen management of continuous corn production.<sup>27</sup> The second and third most valuable use of poultry manure is for a corn-wheat-soybean crop rotation managing for phosphorous and nitrogen.

Also, Perdue's AgriRecycle plant transforms bulk raw manure into pellets or granules for precision farming. This achieves a net value of \$8.50/ton, which suggests that Perdue could afford to pay as much as \$8.50/ton of litter and still break even in pellet production.

Several proposed and hypothetical alternative uses for manure have positive implicit values. As fertilizer for private forests, forest property owners could pay an average of \$9.50/ton of litter and break even. Of the kinds and scales of composting facilities, including those bagged for a retail market or those sold bulk for a wholesale market, the largest bagged facilities could pay \$4.39/ton while an on-farm facility for the bulk market could only pay \$1.10/ton.

In July 2005, a phosphorus nutrient management deadline takes effect for all agricultural manure users. After that, farmers in counties with excess manure capacity are prohibited from using the excess manure on their land. Thus, it will be illegal to spread the 111,000 tons of excess poultry litter in the four excess manure counties.

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<sup>9</sup> This evaluation was conducted in 2002 and manure value for these alternative uses may be differ today due to the higher prices of natural gas and petroleum, especially for the pelletization uses, and given the corresponding higher prices of commercial fertilizer and for electricity generation.

This transforms manure from an asset into a potential liability. Hence, alternative uses could provide an opportunity for farmers to sell their excess poultry manure. As discussed above, nutrient saturation of recipient fields is a concern in the transportation program. This may be a limiting factor for the long-term viability of that program. If that is the case, it provides an even stronger argument for reconsidering and supporting alternative manure use projects.

### ***Buyout of Chicken Houses with Excess Manure***

This section assesses the merits of a novel nutrient management program as proposed by the authors of this report – a voluntary buyout of certain chicken houses. Even if the annual manure transportation goal of 70,000 tons were met, 40,000 tons of excess poultry manure would remain in counties without sufficient cropland on which to spread the manure at agronomic rates. If 40,000 tons of excess manure were applied to cropland, 2.8 million pounds of nitrogen<sup>h</sup> (roughly 15 percent of Maryland's annual reduction goal) would run into local waterways and ultimately, the Chesapeake Bay. Currently, less than 10 percent of the manure produced on the entire Delmarva Peninsula is going into alternative use projects. Therefore, it may be necessary to remove the annual production of 40,000 tons or more of poultry manure that may not be transported.

A voluntary chicken house buyout program would offer a profit-making opportunity for poultry growers who have insufficient land on which to agronomically spread their poultry manure and who have limited financial resources to dispose of their manure in other ways. Poultry growing can be a part-time job, requiring only 75 hours per flock or about 15 hours a week for five weeks.<sup>28</sup> A typical net income (after variable and fixed costs are accounted for, including a \$8.50/hr labor rate) each year for raising 5.5 flocks in one house is about \$21,437 per year. Each house requires an investment that amounts to approximately \$180,000 for the house (tunnel house, electric generator, equipment, well and water systems, etc.) and the economic life of an average poultry house is 20 years – although many upgrades are required during its 20-year life.<sup>29</sup> Thus, many growers work one or two other jobs that may or not be farm-related.

If the annual manure transport goal of 70,000 tons of manure applies only to poultry manure and if the goal is achieved, 40,653 tons of manure will remain. If each chicken house produces about 118 tons of litter each year in Maryland,<sup>i</sup> then buying out 345 of the 2,874 houses would eliminate the remaining 41,000 tons of excess manure. This represents approximately 12 percent of chicken houses in Maryland.

If the net income of a typical grower of \$21,437 were calculated in present value for 20 years at a 7 percent discount rate, then the present value of a chicken house over 20 years would be \$227,104. If that amount were provided as a voluntary buyout offer, the estimated total cost for 345 houses would be \$78 million. The annualized cost of this buyout is \$3.19 million, which is less than the \$4.1 million cost of nutrient management. The buyout reduces 2.8 million pounds – just one million short of the 3.8 million pounds of nitrogen reduction from nutrient management. Thus, the house buyout cost is \$1.37 per pound of nitrogen reduced per year, ranking it second to nutrient management (\$1.08/lb N/yr) and just a few cents more than grassed buffers (\$1.39/lb N/yr).

**TABLE 1-2. COST-EFFECTIVENESS OF THE CHICKEN HOUSE VOLUNTARY BUYOUT POLICY PROPOSAL**

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<sup>h</sup> Approximately 70.44 pounds of nitrogen per ton of poultry manure (Lichtenberg et al, 2002).

<sup>i</sup> This figure was derived from data in Lichtenberg et al, 2002, who stated that 282,233,700 broilers were produced in Maryland in 2001. Faber, 2004, states that Maryland generated 338,680 tons of poultry litter. Chase et al, 2001, states that there are 958 growers in Maryland, and if growers typically operate an average of three chicken houses, there are roughly 2,874 chicken houses in Maryland. Thus, roughly 118 tons of poultry manure would be produced by each chicken house each year.

|  |             |
|--|-------------|
| Implementation Goal in Lower Eastern Shore Counties (number of houses) | 345         |
| Annual Costs (dollars)   | \$3,917,280 |
| Nitrogen Reduction Rate per House (lb N/house/yr)                      | 8,312       |
| Total Nitrogen Potentially Available to Reduce (lb/yr)                 | 2,867,612   |
| Annual Cost of House Buyout per Pound Nitrogen Reduced (\$/lb N/yr)    | \$1.37      |

*Source: Data adapted from Chase, Robert A., Wesley N. Musser, and Bruce Gardner, "The Economic Contribution and Long-Term Sustainability of the Delmarva Poultry Industry." Report prepared for the Maryland Agro-Ecology Center, Inc., Queenstown, Maryland, April 2003: Table 3, p. 12 and Table 9, p. 22. Data also adapted from Lichtenberg, Erik, Doug Parker, and Lori Lynch, "Economic Value of Poultry Litter Supplies in Alternative Uses." Center for Agricultural and Natural Resource Policy. October 2002: Table 1, p. 31. Data also adapted from Faber, Scott. "Study finds markets for poultry litter closer to home." Bay Journal, April 2004.*

Buyout offers would be made first to those chicken houses located in the four excess manure counties in Maryland. The highest priority would be given to those houses with the highest environmental risk, given a number of factors including: oversaturation of phosphorus in soils, lack of cropland for manure application at agronomic rates, lack of adequate storage facilities, proximity to surface water or groundwater, and topography and soil characteristics that make nutrient runoff and leaching likely. Additionally, chicken houses located in remote areas and thus with the longest transportation distance, would be high on the priority list.

Poultry growing provides a fairly reliable income stream and some farmers whose chicken houses match the high priority description above may be unwilling to accept the buyout offer if concerned about alternative employment. Given that the average farmer in Maryland is 56 years old, the prospects for job training for a new non-farming related occupation is low and the prospects of switching to more labor-intensive farming businesses is even lower. However, some older farmers may be planning to retire and welcome a buyout as a good opportunity to leave the business.

The impact of this buyout program on the poultry processors and associated industries would be acceptable. The poultry industry on the Delmarva Peninsula has suffered a comparative economic disadvantage for several decades. Since the 1960s, the cost of poultry production on the peninsula is 15 percent higher than the cost of production in several Southeastern states, primarily due to lower wage rates in the Southeast.<sup>30</sup> For the last decade, the largest costs of production on the Peninsula come from the chicken feed, accounting for nearly 70-75 percent of the grow-out costs for boilers. Virtually all the soybeans and corn grown in Maryland and Delaware are purchased by feed mills owned by processing companies on the Peninsula, while 25 percent<sup>31</sup> of the feed is imported from outside of these states.

### Cost-effectiveness

In addition to ranking the nine tributary strategy BMPs and the voluntary chicken house buyout proposal in order of cost-effectiveness, this chapter analyzes the practices from the perspective of cumulative spending and cumulative nitrogen reduction. Table 1-3 reveals that the ten practices discussed in this chapter could provide as much as 18 million pounds in annual nitrogen reduction for a cost of \$73 million. This is just one million pounds short of Maryland's Chesapeake 2000 Bay Agreement goal to reduce nitrogen flows to the Bay by 19 million pounds per year from all point and non-point sources combined.

The 2004 "flush tax" by itself is expected to contribute about \$75 million per year to Bay cleanup, suggesting that, if these funds were spent in the most cost-effective ways, they might well be sufficient in themselves to achieve Maryland's nitrogen reduction target for 2010. That would require, however, that existing plans to spend most of this money on wastewater treatment plant upgrades would have to be significantly altered.

Given that Maryland, in 2003, spent about only about \$17 million<sup>j</sup> to implement all of these 10 BMPs and several others, Maryland should consider re-allocating its existing agricultural BMP funds to the six most cost-effective proposals listed in Table 1-3. If Maryland's Department of Agriculture did this, the Department could ensure that state and federal resources would be used to generate as much nitrogen reduction as possible, for the least cost. Based on the calculations made for this report, the first six policies in Table 1-3 could yield as much as 11 million pounds of nitrogen reduction per year for \$17.6 million. The six most cost-effective policies include: nutrient management on all 1.3 million crop acres, a voluntary buyout of 345 chicken houses, grassed buffers on 57 thousand acres, conservation tillage on 718 thousand acres, land retirement of 26 thousand acres, and transport of 70,000 tons of poultry litter.

A closer look at the six most cost-effective practices shows that just the first three (nutrient management, chicken house buyout, and grassed buffers) each cost below \$1.50 per pound of nitrogen reduction and could yield as much as 43 percent (7.7 million lbs) of the entire 18 million pound reduction effort for just 13 percent of the cost (\$9 million). The next three most cost-effective policy proposals (conservation tillage, land retirement, and transport of 70,000 tons of poultry litter) each cost between about \$2 per pound of nitrogen reduction and could supply as much as 21 percent (3.7 million pounds) of the reduction effort for just 11 percent (\$8 million) of the cost.

**TABLE 1-3. CUMULATIVE SPENDING ON STRATEGIES AND CUMULATIVE POUNDS OF NITROGEN REDUCTIONS**

| PRACTICE                        | REDUCTION (LB/YR) | UNIT COST (\$/LB/YR) | TOTAL COST (\$/YR) | CUMULATIVE COST (\$) | CUMULATIVE REDUCTIONS (LB) |
|---------------------------------|-------------------|----------------------|--------------------|----------------------|----------------------------|
| Nutrient Management             | 3,821,210         | \$1.08               | \$4,144,000        | \$4,144,000          | 3,821,210                  |
| Chicken House Buyout            | 2,863,594         | \$1.37               | \$3,923,124        | \$8,067,124          | 6,684,804                  |
| Grassed Buffers                 | 982,440           | \$1.39               | \$1,360,999        | \$9,428,123          | 7,667,244                  |
| Conservation Tillage            | 2,979,854         | \$2.09               | \$6,221,296        | \$15,649,419         | 10,647,098                 |
| Land Retirement                 | 226,693           | \$2.36               | \$535,546          | \$16,184,965         | 10,873,790                 |
| Manure Transport                | 504,700           | \$2.77               | \$1,400,000        | \$17,584,965         | 11,378,490                 |
| Cover Crops, Early              | 5,118,000         | \$4.69               | \$24,000,000       | \$41,584,965         | 16,496,490                 |
| Animal Waste Management Systems | 994,643           | \$9.63               | \$9,574,102        | \$51,159,067         | 17,491,134                 |
| Off-Stream Watering w/ Fencing  | 62,149            | \$27.70              | \$1,721,319        | \$52,880,386         | 17,553,282                 |
| Conservation Plans              | 480,263           | \$43.69              | \$20,981,865       | \$73,862,251         | 18,033,545                 |

Source: Data adapted from: Maryland Department of Natural Resources. "Maryland Tributary Strategy: Final Draft Costs, Funding Estimates and Implementation Levels - Revised 1/5/04" and Maryland Department of Agriculture. "Maryland Nutrient Reductions (2002 Assessment)" and Chase, Robert A., Wesley N. Musser, and Bruce Gardner. "The Economic Contribution and Long-Term Sustainability of the Delmarva Poultry Industry." Report prepared for the Maryland Agro-Ecology Center, Inc. Queenstown, Maryland. April 2003 and from Lichtenberg, Erik, Doug Parker, and Lori Lynch. "Economic Value of Poultry Litter Supplies in Alternative Uses." Center for Agricultural and Natural Resource Policy. University of Maryland College Park. October 2002.

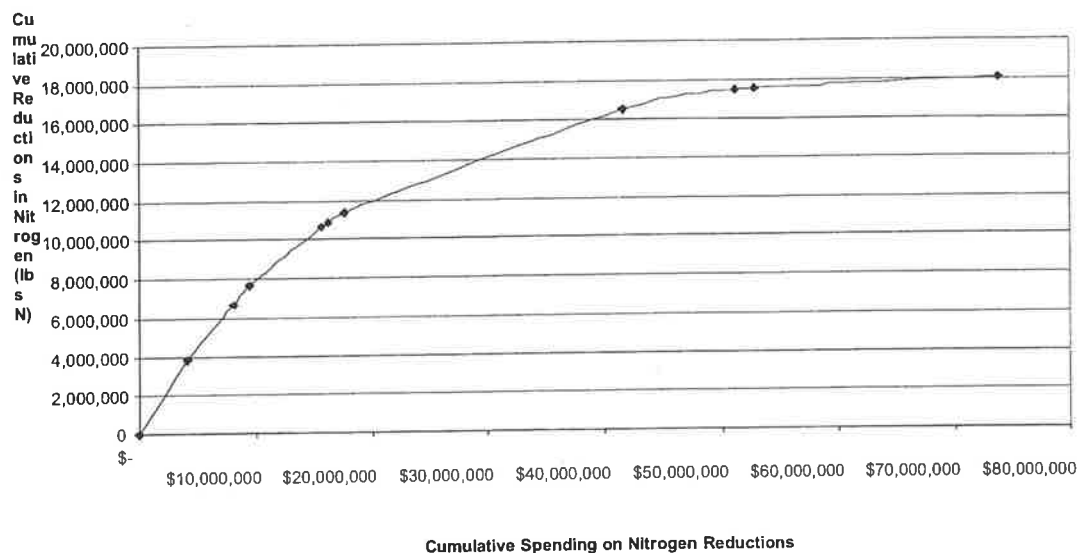
When the cumulative expenditures and cumulative pounds of nitrogen reductions are graphed in Figure 1-5 below, the turning point in the curve after the first six proposals reveals where Maryland's investments in agricultural best management practices become less cost-effective. The per pound cost of nitrogen reductions of the seventh policy

<sup>j</sup> Maryland Department of Agriculture's 2003 Annual Report indicates \$463,000 in state, federal, and private spending on poultry manure transport, \$9.2 million on 10 best management practices with \$1 million provided through private farmer funds, \$3.5 million on retiring highly erodible lands, \$700,000 in nutrient management planning, and \$2.3 million on cover crops for a total of \$17 million. The annual report did not provide information for spending on conservation plans.



proposal, early-planted cover crops, jumps to \$4.69/lb N/yr and flattens the curve. If the tributary strategy goal of 600,000 acres of early-planted cover crops is achieved, it could reduce as much as 5 million pounds of nitrogen, the single largest source of reductions, costing \$24 million per year. Thus, cover crops alone would provide nearly a third of the total nitrogen reductions of these ten policy proposals for nearly a third of the total cost. If additional funds became available, Maryland should consider spending those funds on cover crops.

**Figure 1-5. Maryland's Nitrogen Reduction Potential per Dollar Spent on 10 Agricultural BMP Strategies**



Source: Data sources described in Table 1-3.

According to the Maryland tributary strategy, the State anticipates needing \$233 million<sup>32</sup> in state and federal funds for the years 2003 to 2010, including roughly \$33 million per year for all 22 of its agricultural BMPs. Should these resources become a reality, Maryland may have \$16 million more than the \$17 million it currently spends. This could be used to plant cover crops on at least 400,000 acres (about 200,000 acres short of the 600,000 acre Tributary Strategies goal for cover crops) at about \$4.69 per nitrogen reduction per acre.

After cover crops, the remaining three best management practices increase significantly in cost per pound of nitrogen reduced, as shown in Table 1-3 and Figure 1-5. Together, animal waste management systems, off-stream watering systems with fencing, and conservation plans provide just nine percent (1.5 million pounds) of the nitrogen reduction potential of these ten management strategies, but would demand 44 percent (\$32.3 million) of the total cost.

### Policy Recommendations

The following nitrogen reduction policies are recommended for Maryland's agricultural sector:

#### **Target available funding to BMPs using a cost-effectiveness approach.**

Given that Maryland projects a tributary strategy funding shortfall of \$203 million (41 percent) for meeting its agricultural BMP goals, the state should spend its available funds

in the most cost-effective manner. Our analysis shows that the two most cost-effective agricultural BMPs, nutrient management and manure transport, could provide 46 percent of the nitrogen reductions at only 8 percent of the cost of all the selected BMPs. The four least cost-effective BMPs provide only 7 percent of the nitrogen reductions at 46 percent of the costs.

***Apply an offset principle to any new chicken houses in four counties in Maryland and provide a voluntary chicken house buyout.***

Given that 41,000 tons of excess manure will remain if Maryland transports 70,000 tons of poultry litter per year, the state should employ an offset policy to limit new chicken house construction until the excess poultry manure problem is resolved. This would only allow the construction of new chicken houses under an offset policy. Any new chicken houses would either have to show zero manure runoff or else provide reductions from other sources to fully offset its nutrient impacts.

The state should offer to buy out chicken houses in the four "excess manure" counties to eliminate permanently the annual generation of excess poultry manure. By offering \$227,104 per house, the state could spend \$78 million over 20 years (or \$3 million annually) at a cost-effectiveness of \$1.37 per pound of nitrogen reduced per year to buyout 345 chicken houses.

***Prioritize state business development funds to emphasize projects using poultry manure for alternative uses.***

Given that there may be insufficient "willingness to accept" the excess poultry manure in the four Maryland counties with soils that can still absorb poultry manure, the state may not achieve its annual manure transport goal though land application alone. Also, given new regulations on the application of manure, many farmers will need to give away their excess manure. Lichtenberg et al indicate that several proposed alternative use projects could offer a positive price per ton of manure and still allow the businesses to break even. Given the recent, higher energy prices, implicit values for poultry manure for the electricity generation facilities may now be positive. Therefore, state business development funds should prioritize funding awards for alternative manure use projects, such as forest fertilization, cogeneration, composting, and electricity generation.

***Continue the 50 percent funding split of the poultry manure transport program with the four poultry processors operating in Maryland.***

Given the complexity of determining the appropriate manure transport burden-sharing arrangement between poultry processors and growers, the state should continue its current funding arrangement with processors to pay for half of the manure transport program. To transport 70,000 tons of manure each year costs \$1.4 million, \$700,000 of which would be from the poultry processors. In the past their annual cost-share has been as high as \$236,000. This cost increase is commensurate with the magnitude of the problem. If the processors could fund half of the annual costs of manure transport, the projected state funds would extend for six years as opposed to the three years currently projected.

***Begin a point source—non-point source nutrient trading program within Maryland to achieve the tributary strategy goals and motivate all stakeholders.***

Achieving the nitrogen goals of the Maryland tributary strategy depends on the willingness of Maryland's farmers to participate. There is no assurance that farmers would participate at sufficient levels, even if the state did acquire the necessary funds to pay the farmers. A nutrient trading program not only frees state and federal funds by re-distributing private funds from costly urban point and non-point source reductions to relatively inexpensive agricultural BMPs, but it also may motivate farmer participation because it allows farmers to recover their private costs spent of implementing the BMPs or even make a profit on the nutrient trades. Under such a program, less cost-effective

wastewater treatment plants might substitute reductions in agricultural nutrient runoff for more expensive actions that they would otherwise be required to take at these plants to reduce nutrient loads.

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## Endnotes to Chapter 1

- <sup>1</sup> Center for Agricultural and Natural Resource Policy. *Economic Situation and Prospects for Maryland Agriculture*. University of Maryland, Department of Agricultural and Natural Resources. Policy Analysis Report No. 02-01. 2001: vii.
- <sup>2</sup> Maryland Tributary Strategies Program, Department of Natural Resources.
- <sup>3</sup> Center for Agricultural and Natural Resource Policy: 30.
- <sup>4</sup> Maryland Department of Agriculture. Highlights 2003, Celebrating 30 Years of Service.
- <sup>5</sup> Chase, Robert A., Wesley N. Musser, and Bruce Gardner. *The Economic Contribution and Long-Term Sustainability of the Delmarva Poultry Industry*. Maryland Cooperative Agricultural Extension Pub-2003-02: 9.
- <sup>6</sup> Maryland Department of Agriculture. Annual Report 2003, Celebrating 30 years of Service: 12.
- <sup>7</sup> Maryland Department of Agriculture. Annual Report 2003, Celebrating 30 years of Service: 9.
- <sup>8</sup> Lichtenberg, Erik, Doug Parker, and Lori Lynch. "Economic Value of Poultry Litter Supplies in Alternative Uses." Center for Agricultural and Natural Resource Policy. University of Maryland College Park. October, 2002: 32.
- <sup>9</sup> Faber, Scott. "Study finds markets for chicken litter much closer to home." *Bay Journal*. April, 2004: 7.
- <sup>10</sup> Lichtenberg, et al: 6.
- <sup>11</sup> Smith, M.F. "Nutrient Management. Evaluation of Maryland's Statewide Nutrient Management Program." College of Agriculture and Natural Resources, University of Maryland. September, 1999: 5.
- <sup>12</sup> Maryland Department of Agriculture. Annual Report 2003, Celebrating 30 years of Service: 12.
- <sup>13</sup> Chesapeake Bay Commission. "Cost-Effectiveness Strategies for the Bay. Six Smart Investments for Nutrient and Sediment Reduction." December, 2004: 4
- <sup>14</sup> Maryland Tributary Strategies Program, Department of Natural Resources. "Maryland's Tributary Strategy Best Management Practices, Table 2." 7/30/04.
- <sup>15</sup> Smith, M.F. "Nutrient Management Practices of Farmers in Pocomoke River Watershed – 1996." College of Agriculture and Natural Resources, University of Maryland. June, 1998: 1.
- <sup>16</sup> Blue Ribbon Citizens Pfiesteria Piscicida Action Commission. "Report of the Governor's Blue Ribbon Citizens Pfiesteria Piscicida Action Commission." November 3, 1997.
- <sup>17</sup> Ibid, 3.
- <sup>18</sup> Ernst, Howard R. Chesapeake Bay Blues. Science, Politics and the Struggle to Save the Bay. Rowman & Littlefield Publishers, Inc.: Lanham. 2003: 78.
- <sup>19</sup> Maryland Department of Agriculture. "Nutrient Management Plan and Justification for Delay Forms Filed with MDA." A table provided by the Nutrient Management Program. July 29, 2004.
- <sup>20</sup> Riley, Lewis R. 2005. "We are counting on you with the countdown." *The Delmarva Farmer*. March 8.
- <sup>21</sup> Maryland Department of Agriculture. Annual Report 2003, Celebrating 30 years of Service: 11.
- <sup>22</sup> Personal communication with Dr. Doug Parker, Professor, Department of Agricultural Economics, University of Maryland, March 10, 2005.
- <sup>23</sup> Maryland Department of Agriculture. Annual Report 2003, Celebrating 30 years of Service: 11.
- <sup>24</sup> Faber, 7.
- <sup>25</sup> Faber, 7.
- <sup>26</sup> Faber, 7.
- <sup>27</sup> The term net value means that if farmers had to buy commercial fertilizer for growing continuous corn, they would have to buy approximately \$34.19/ton worth.
- <sup>28</sup> Chase et al: 22.

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<sup>29</sup> Personal communication with Dr. Doug Parker, Professor, Department of Agricultural Economics, University of Maryland, March 10, 2005.

<sup>30</sup> Chase et al, p. 9.

<sup>31</sup> Delmarva Poultry Industry, Inc. 2005. "Delmarva Soybeans and Corn Production and Broiler Chicken Use." February.

<sup>32</sup> Maryland Tributary Strategies Program, Department of Natural Resources. "Maryland Tributary Strategy: Final Draft Costs, Funding Estimates and Implementation Levels - Revised 1/5/04" provided by Helen Stewart, Maryland Tributary Strategies Program.

## **CHAPTER 2 – NUTRIENT REDUCTIONS IN PENNSYLVANIA AGRICULTURE**

Agriculture in Pennsylvania makes up 1.4 percent of gross state product, which is relatively small compared to other states in the Chesapeake Bay watershed and the nation. Agriculture provides about 1.2 percent of the total employment, again small considering that 25 percent of Pennsylvania is agricultural land.<sup>1</sup> Most of Pennsylvania's farms lie in the south-central and southeastern portions of the state and are fairly small – over 70 percent of farms have less than 180 acres.<sup>2</sup> Dairy products comprise approximately one-third of all agricultural products in Pennsylvania. Poultry is also a large industry, representing approximately one-fifth of all agricultural products. In general, Pennsylvania's land is more suitable for hay and pasturage than for row crops, so dairy farming is efficient. The state ranks fourth in the nation in dairy farming, producing 7 percent of the nation's dairy products.<sup>3</sup>

Although Pennsylvania has two tributaries that drain into the Chesapeake Bay, the Susquehanna River accounts for 92 percent of Pennsylvania's 22,612 square miles of Bay drainage area. (The Potomac River watershed in Pennsylvania accounts for the remaining 8 percent.) The Susquehanna River is the Chesapeake Bay's largest tributary, contributing fully half of the fresh water delivered to the Bay. Therefore, in terms of Bay cleanup, the Susquehanna is critical to any future success.<sup>3</sup>

### **Nutrient Pollution**

Agriculture contributes approximately 50 percent of Pennsylvania's total nitrogen load to the Bay. By comparison, point sources only contribute about 11 percent of Pennsylvania's nitrogen load. For phosphorus, agriculture contributes about 60 percent and point sources contribute about 19 percent.<sup>1</sup> Thus, compared to Maryland and Virginia, agriculture is a larger contributor in Pennsylvania to nitrogen and phosphorus loads, while point sources are smaller.<sup>3</sup> This reflects the more rural character of the areas in Pennsylvania that drain into the Chesapeake Bay watershed.

Pennsylvania has fallen considerably short of its goal to reduce nitrogen loads into the Bay. Between 1985 and 2000, the state reduced the nitrogen load by approximately 5.7 million pounds, far shy of the 15.5 million pound goal. Moreover, the Chesapeake 2000 Agreement significantly increased Pennsylvania's nitrogen reduction goal to 37 million pounds per year. If only a 5.7 million pound reduction was obtained in 15 years, achieving a 37 million pound reduction annually will seemingly require heroic efforts. On the other hand, it also suggests that Pennsylvania, because it has done less in the past, may be an especially promising state for finding new cost-effective reduction actions in terms of the Chesapeake Bay watershed as a whole.

Table 2-1 shows the programs under which the 5.7 million pound reduction since 1985 was achieved:

**TABLE 2-1. 2000 TOTAL NITROGEN LOAD REDUCTIONS BY PROGRAM**

| <b>PROGRAM</b>   | <b>NITROGEN REDUCTION (LB)</b>  |
|--|---------------------------------|
| <b>STATE PROGRAMS</b>  |                                 |
| Chesapeake Bay Implementation Grant  | 1,566,000                       |
|  | 1,128,000                       |
|  | 210,000                         |
|  | 87,200                          |
|  | 31,000                          |
|  | 18,000                          |
| Nutrient Management Act  | 1,365,000                       |
| Abandoned Mine Land Restoration  | 86,200                          |
| Erosion and Sediment Control Program   | 66,100                          |
| Forest Stewardship Program   | 43,000                          |
|  | 5,000                           |
| Watershed Groups   | 350                             |
| Total State Programs   | 4,606,000                       |
| <b>FEDERAL PROGRAMS</b>  |                                 |
| Environmental Quality Incentive Program  | 2,105,000                       |
|  | 1,646,000                       |
|  | 1,540,000                       |
|  | 210,000                         |
|  | 4,000                           |
|  | 2,000                           |
|  | 1,000                           |
|  | 1,000                           |
| Conservation Reserve Program   | 592,000                         |
| Rural Development  | 238,000                         |
| Conservation Reserve Enhancement Program   | 43,000                          |
| Total Federal Programs   | 6,382,000                       |
| <b>TOTAL PROGRAM REDUCTIONS</b>  | <b>10,988,000</b>               |
| <b>LOADING SOURCE</b>  | <b>NITROGEN INCREASES (LBS)</b> |
| Forest Land  | 1,673,000                       |
| Point Source   | 1,447,000                       |
| Urban Land   | 900,000                         |
| Septic Systems   | 457,000                         |
| Mixed Open Land  | 445,000                         |
| Hay Land   | 340,000                         |
| Air Deposition to Water  | 64,000                          |
| <b>TOTAL LOADING INCREASES</b>   | <b>5,326,000</b>                |
| <b>NET DECREASE IN NITROGEN LOADS</b>  | <b>5,662,000</b>                |
| NOTES: Reductions based on data from the Chesapeake Bay Program Watershed Model Ver. 4.3 |                                 |

From now until 2010, Pennsylvania would achieve 73 percent of its cap goal of nitrogen simply from agricultural-related practices if it fully implemented all current tributary strategies. Additionally, it would achieve 88 percent of the cap for phosphorous, and 99 percent of the sediment goal.<sup>4</sup>

Unlike nitrogen, Pennsylvania reached (and exceeded) its phosphorus reduction goal for 2000 with its reduction of 793,100 pounds. Because Pennsylvania exceeded the phosphorous goal, its newest tributary strategy primarily addresses the nitrogen cap. However, in 2000, a new phosphorous reduction goal was set, and Pennsylvania agreed to reduce loads by 1.3 million pounds per year between 2002 and 2010. This goal seems more attainable than the nitrogen goal, but nevertheless, it will also be difficult to achieve.

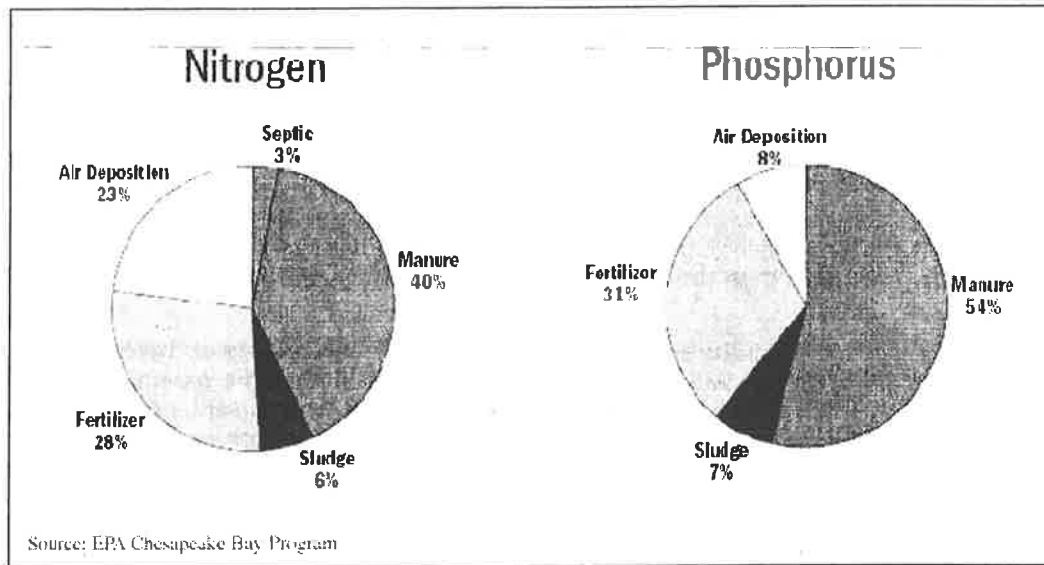
In Pennsylvania, agriculture accounted for about 315,400 pounds of the phosphorus reductions achieved from 1985 to 2000, almost half of the total. The main agriculture-related cleanup efforts included nutrient management planning, implementation of soil conservation and water quality plans, utilization of animal waste management systems, barnyard runoff controls, streambank fencing, and retirement of highly erodible land through Conservation Reserve Programs. Since 1985, every Pennsylvania sub-basin reduced phosphorous except for the Juniata River and the Potomac River.<sup>3</sup>

### Manure

Livestock outnumber the human population in the entire Bay watershed by 11 to 1. Lancaster County, located in the lower Susquehanna River Basin, is a "hot spot" for manure. Indeed, the manure produced by Lancaster County contributes an estimated 12 percent of the total nitrogen pollution from manure in the Chesapeake Bay watershed, while the county only occupies 1.5 percent of the watershed area.<sup>5</sup> Table 2-2 and Figure 2-1 below show manure's impact on the entire Bay. While these tables are not specific to Pennsylvania, they emphasize the importance of manure to the Bay cleanup.

| <b>TABLE 2-2. ANIMAL MANURE GENERATED IN THE BAY WATERSHED</b>  |                          |                       |                         |
|---|--------------------------|-----------------------|-------------------------|
| <b>ANIMAL TYPE</b>  | <b>NUMBER OF ANIMALS</b> | <b>NITROGEN (LBS)</b> | <b>PHOSPHORUS (LBS)</b> |
| Beef  | 1,846,923                | 208,979,305           | 74,153,947              |
| Dairy   | 697,595                  | 161,380,163           | 25,103,581              |
| Swine   | 1,254,026                | 38,448,422            | 14,647,018              |
| Poultry   | 181,560,180              | 185,873,604           | 51,780,397              |
| Total   | 185,358,723              | 594,681,494           | 165,684,943             |
| <i>Source: Chesapeake Bay Program website, <a href="http://www.chesapeakebay.net">www.chesapeakebay.net</a></i> |                          |                       |                         |

**FIGURE 2-1. BAY-WIDE SOURCES OF NITROGEN AND PHOSPHORUS**



Manure can be both a waste and a resource. At times it is spread on crops to fertilize. At other times, it is spread throughout a farm as a method of disposal because there is no other place to put it. In either case, soon after manure is spread, large amounts of ammonia gas – a compound of nitrogen and hydrogen – are released into the atmosphere. Much of this gas stays in the air, contributing to nitrogen pollution in the Bay by direct deposition. The gas may also fall on nearby land, much of it eventually reaching groundwater and ultimately the Bay.<sup>3</sup>

Much nitrogen that does not turn into ammonia gas is left in the manure. This manure can help fertilize plants, but once a plant has enough nitrogen, the rest stays in the soil. With the excessive amounts of manure in Pennsylvania, a large amount of nitrogen and phosphorous enters the soil. Besides direct flows in rivers and streams, the groundwater can pick up the nutrients and carry them into the Bay. Bay-wide crops do not use approximately 50 percent of the nitrogen in manure; for certain crops, this rate is as high as 70 percent.<sup>3</sup>

New ways of raising animals increase the manure problem. For instance, the average dairy farm has five times as many animals today than it did fifty years ago. This resulted in what is known as "recoverable manure," which is manure that is collected and needs to be stored or disposed. In a farm that is spread out, there might not be any recoverable manure because the manure is so sparse and spread out among the land. Recoverable manure is a problem because, while it can be used as a fertilizer, in excess it contributes to Bay pollution.<sup>3</sup> Farms can be classified as CAOs (Concentrated Animal Operations) or CAFOs (Concentrated Animal Feeding Operations). CAOs have between 300 and 1000 "animal equivalent units," while CAFOs have over 1000. Pennsylvania's Nutrient Management Act currently regulates CAFOs and CAOs that have more than two animal equivalent units per acre of suitable cropland.<sup>6</sup> CAFO regulations are quite controversial in Pennsylvania.

In addition to crowded farms, large corporations have revolutionized farming by creating networks of farms. To maximize efficiency, these corporations deal with farms in concentrated regions, where the infrastructure for meat production is the most efficient. This adds to the creation of compact, "hot spots" such as Lancaster County. The Bay could be improved by more evenly distributing the nutrients.<sup>3</sup>



## **Current Nutrient Management Efforts**

Pennsylvania's Chesapeake Bay Implementation Grant Program is supported by EPA, and also uses matching state funds. The program provides technical assistance to farmers to implement best management practices to reduce nutrient loads into the Bay. The program supports many Bay technicians and engineers who help with conservation practices. In addition, the program provides funding to landowners to pay directly for best management practices. The program provides up to 80 percent of the total cost of the BMPs, up to \$30,000.<sup>3</sup>

Two BMPs are especially targeted in Pennsylvania within the Chesapeake Bay Program. First, stream bank fencing is a particularly well-supported BMP. The Chesapeake Bay Program provides 100 percent funding for stream bank fencing. This involves placing a fence along a stream, typically at least 20 feet away from the stream, which allows native vegetation to grow between the stream and the nearby agricultural lands. Stream fencing has some surprisingly large impacts; one study at Iowa State University reported that native grass buffers as narrow as 20 feet can result in a 90 percent reduction of nutrients and an 80 percent reduction of sediment entering the stream. Moreover, the costs are relatively small, as they simply include building a fence to keep animals from disturbing this native vegetative buffer.<sup>7</sup>

Stream bank fencing can actually improve the health of livestock. For instance, if cattle wander freely near streams, they create areas of water, mud, urine, and other secretions that can cause infections, foot problems, or gastrointestinal diseases. Still another beneficial outcome of stream fencing is healthier fish. In one study, the total fish weight in a section of a stream increased 400 percent after stream fencing.<sup>7</sup>

Another well-supported BMP in the Chesapeake Bay Program is barnyard runoff control. When barnyards are located near streams, they can contribute large amounts of nutrients to streams. Barnyard runoff controls help to keep clean water away from barnyards in the first place, by catching water from rooftops and up-slopes. This water is then routed around the barnyard. Furthermore, barnyard runoff controls directly clean the water exiting the barnyard. Rainwater inevitably falls directly into the barnyard, eventually leaving and taking large amounts of nutrient-filled manure with it. However, with barnyard runoff controls, the water is filtered, usually through a grass-buffered area.<sup>8</sup> Milk production may decrease when large amounts of water are in the barnyard.<sup>5</sup>

The next important state program is Pennsylvania's Nutrient Management Act, which is a regulatory program, unlike the programs mentioned above. It covers farms classified as concentrated animal operations (CAOs). This act regulates the nutrient plans of CAOs and encourages them to use BMPs to control their animal manure, or find alternate uses for it.<sup>1</sup>

The last major state program in Pennsylvania is the Growing Greener project, which helps fund certain environmental protection and conservation programs. It has provided over \$100 million in watershed grants, and groups receiving these grants have matched over \$206 million in their own money.<sup>3</sup> This money is spent in many ways, and is not specifically directed to agricultural BMPs. In May 2005, Pennsylvania voters approved an additional "Growing Greener Bond" initiative of \$625 million. The way in which these funds will be spent has not yet been fully determined.

## **Future Solutions**

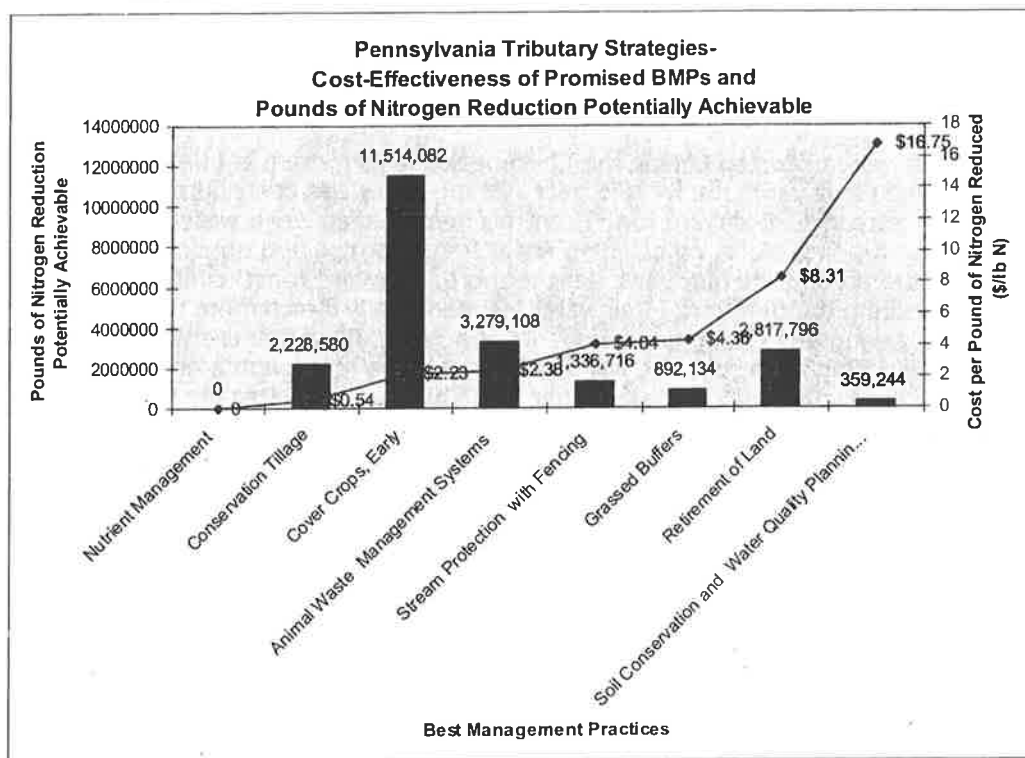
As stated above, if all of the tributary strategies were followed, much of the Bay would be cleaned up. However, there still would be a significant gap, and therefore, it is important to find the most cost-effective solutions. It is estimated that it would cost over \$2 billion to implement all of Pennsylvania's tributary strategies just for agricultural practices.<sup>3</sup>

Manure is obviously a big problem in Pennsylvania, and several of the most cost-effective strategies listed above could exacerbate manure problems. Therefore, the state should examine possible alternative uses for manure. Manure can be transported

and used on virtually any area, including golf courses, sports fields, and much more. However, manure is relatively heavy and expensive to transport. It is estimated that manure costs \$10 per ton to transport within a small, 25-mile radius. If providing state subsidies can solve the transportation problem, alternative uses for manure are real possibilities. Processing the manure may be economically feasible, but further research is needed to fully examine the costs of both transportation and processing of manure.<sup>5</sup>

The following tables explain the cost-effectiveness of eight BMPs that are commonly adopted in Maryland, Virginia, and Pennsylvania (see Figure 2-2). The data used for the analyses originate from Pennsylvania's tributary strategies documents. These documents estimate the costs of the BMPs by tributary, as well as the total amount of acres available for each BMP. The left side of the graph shows the total amount of reduction possible in Pennsylvania, if the maximum amount specified by the tributary strategy was applied. The right side shows the cost per pound of each BMP. Finally, the BMPs are arranged in order of cost-effectiveness, with the lowest cost BMPs listed first. The nutrient management goals had already been reached at the time of this report, so there are no further costs to be spent on them. This explains nutrient management's place in the graphs, because it is not necessarily the lowest cost of the BMPs.

**FIGURE 2-2. COST-EFFECTIVENESS OF BMPs IN PENNSYLVANIA**



### Policy Recommendations

The first three BMPs – conservation tillage, cover crops, and animal waste management systems – can provide more than two-thirds of the total reductions of all seven strategies where data are available. This shows how important it is to consider cost-effectiveness information before implementing or providing funding for BMPs. There are significant differences between the cost-effectiveness of the BMPs, and these differences vary between states and sub-basins.

### ***Spend money on cost-effective strategies.***

According to the analysis of Pennsylvania's tributary strategies, it is evident that Pennsylvania is spending money on all of the BMPs. Some of this spending might be based on historic factors, and needs to be reallocated based on cost-effectiveness information above. For instance, it seems that the state should curtail implementation of soil conservation plans, and spend more money on more cost-effective BMPs such as conservation tillage or nutrient management. Funding should not be spent on a more expensive BMP if more cost-effective BMPs are not being used to their maximum level.

### ***Implement a nutrient trading program.***

Pennsylvania needs to address hot spots such as Lancaster County, as they hold and produce an excessive amount of manure. If farmers do not eliminate this excess manure, they must pay for their pollution. A nutrient trading program would not make those current farmers pay an additional amount who are not producing excessive amounts of nutrients. Moreover, a trading program would actually allow such farmers to get paid for the amount they reduce nutrients below their required nutrient level. However, a trading program also would hold certain farmers responsible for their high levels of pollution.

### ***Inform farmers about BMPs that improve farm production.***

Certain BMPs, including diet and feed changes, barnyard runoff controls, and stream-bank fencing, may have benefits beyond just nutrient reduction. These BMPs also benefit farm production, and, if informed, farmers might voluntarily implement them. One diet and feed change is to include phytase in feed. This makes phosphorous easier to digest, and can eliminate the need to add additional supplements to the feed. Farmers can actually save money by not having to buy additional supplements. Hence, if farmers were more informed, they might voluntarily buy feed that includes phytase.

Barnyard runoff controls and stream-bank fencing are beneficial to the health of livestock on a farm. They both help stop the accumulation of water, which can attract disease. If more farmers knew about the health benefits of these practices, they might opt to implement them voluntarily. All of these practices would be cost-effective if implemented voluntarily.

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## **Endnotes to Chapter 2**

<sup>1</sup> Schiller, Timothy. "Agriculture In the Third District." <http://www.phil.frb.org/files/brj00ts.pdf#search='agriculture%20percent%20of%20GDP%20in%20Pennsylvania'>

<sup>2</sup> Department of Agriculture. "1997 Census of Agriculture: Pennsylvania." <http://usda.mannlib.cornell.edu/reports/census/ac97apa.pdf#search='Pennsylvania%20size%20of%20farms'>

<sup>3</sup> Pennsylvania Department of Environmental Protection. "Tributary Strategies of Pennsylvania." December 2004.

<sup>4</sup> Chesapeake Bay Watershed Blue Ribbon Finance Panel. "Tributary Strategy Costs and Goals." June 30, 2004.

<sup>5</sup> The Chesapeake Bay Foundation. *Manure's Impact on Rivers, Streams, and the Chesapeake Bay*. 28 July 2004. 17 May 2005. <[http://www.cbf.org/site/DocServer/0723manurereport\\_noembargo\\_.pdf?docID=2143](http://www.cbf.org/site/DocServer/0723manurereport_noembargo_.pdf?docID=2143)>.

<sup>6</sup> Department of Environmental Protection. "Deadlines in Place for CAFO Permits." <http://www.dep.state.pa.us/dep/deputate/polycomm/update/05-04-01/0504011595.htm>

<sup>7</sup> Tri-County Conewago Creek Association. "Stream Bank Fencing and Riparian Buffer Planting." 17 May 2005. <<http://conewagocreek.net/ActionAlerts/RiparianBuffers.html>>.

<sup>8</sup> *Corralling Manure: Barnyard Runoff Systems Protect Water Quality, Improve Management*. 17 May 2005. <<http://clean-water.uwex.edu/pubs/stewards/P010.pdf#search='barnyard%20runoff%20control'>>.

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## CHAPTER 3 – NUTRIENT REDUCTIONS IN VIRGINIA AGRICULTURE

Land devoted to agriculture in Virginia accounts for approximately 24 percent of the state area.<sup>1</sup> Agriculture has been a backbone of the state economy for almost four centuries and now generates approximately \$36 billion per year, or 12.3 percent of all output value in the state. More than 98 percent of Virginia's farms are owned and operated by families.<sup>2</sup>

While agriculture plays a large role in Virginia's economy, it also generates pollution that degrades the environment. According to the 1998 CWA 303(d) Total Maximum Daily Load Priority List report, agricultural non-point source pollution is the largest single source of pollution in the state, and a main cause of non-attainment of designated water uses in monitored segments of Virginia's rivers.<sup>3</sup> The 2004 Water Quality Assessment found that about 70 percent of the total non-point source nitrogen load and over 60 percent of the total non-point source phosphorous and sediment loads come from agriculture.<sup>4</sup>

This chapter reviews briefly the characteristics of Virginia's agriculture, analyzes the pollution each tributary contributes to the Chesapeake Bay, compares existing federal and state agricultural practices to restore the Bay by reducing agricultural runoff, and provides policy recommendations based on cost-effectiveness analyses.

### Production Characteristics

The top agriculture commodities in Virginia are broilers, cattle and calves, dairy products, greenhouse/nursery, and turkeys by value of receipts. The top five counties in agricultural sales in 2002 were Rockingham, Augusta, Accomack, Page, and Shenandoah. Except Accomack County, these counties are in the Shenandoah River basin.

As shown in Table 3-1, about 56 percent of Virginia drains into the Bay through several major rivers, including the Potomac, Rappahannock, York, and James rivers. The commonwealth also has 5,818 miles of shoreline on the Bay's mainstream and tidal tributaries.<sup>5</sup>

| TABLE 3-1. BAY-WIDE AGRICULTURAL LAND HYDROLOGICAL CHARACTERISTICS |                        |             |                |
|--|------------------------|-------------|----------------|
| STATE  | AREA IN BAY WATERSHED* | TOTAL AREA* | % IN WATERSHED |
| West Virginia  | 3,592                  | 24,358      | 14.7%          |
| Virginia   | 23,945                 | 42,878      | 55.9%          |
| Pennsylvania   | 22,626                 | 46,103      | 49.1%          |
| New York   | 6,260                  | 54,459      | 11.5%          |
| Maryland   | 11,572                 | 12,405      | 93.3%          |
| Delaware   | 716                    | 2,487       | 28.8%          |
| District of Columbia   | 68                     | 68          | 100%           |

Source: Chesapeake Bay Program, <http://www.chesapeakebay.net/maps.htm>

### Virginia's Watershed Tributaries

Virginia's Eastern Shore is on the long and narrow southern end of the Delmarva Peninsula, consisting of two counties and fifteen towns. About half of the Virginia Eastern Shore drains to the Chesapeake Bay. Forest accounts for about 51 percent of Virginia's Eastern Shore land use, agriculture about 38 percent, and urban areas about 6 percent.<sup>6</sup> Agriculture is a primary source of nitrogen and phosphorus runoff, contributing

about 68 percent of the total controllable nitrogen in 2000. In addition, 62 percent of the total controllable phosphorus load in the Eastern Shore's Chesapeake Bay watershed was from farmland.

**TABLE 3-2. VIRGINIA NUTRIENT CAPS BY RIVER BASIN**

| <b>BASIN</b>                 | <b>NITROGEN<br/>CAP LOAD<br/>(M LB/YR)</b> | <b>% OF VA<br/>BASIN-WIDE<br/>TOTAL</b> | <b>PHOSPHORUS<br/>CAP LOAD<br/>(M LB/YR)</b> | <b>% OF VA<br/>BASIN-WIDE<br/>TOTAL</b> |
|------------------------------|--|---|--|---|
| Potomac                      | 12.84                                      | 25%                                     | 1.40   | 23%                                     |
| Rappahannock                 | 5.24                                       | 10%                                     | 0.62   | 10%                                     |
| York                         | 5.70                                       | 11%                                     | 0.48   | 8%                                      |
| James                        | 26.40                                      | 51%                                     | 3.41   | 57%                                     |
| Eastern Shore<br>(MD and VA) | 1.22                                       | 2%                                      | 0.09   | 2%                                      |
| VA Total                     | 51.40                                      | 100%                                    | 6.00   | 100%                                    |

Data adapted from "Nutrient and Sediment Load Allocation Tables"  
<http://www.naturalresources.virginia.gov/Initiatives/TributaryStrategies/PDFs/AllocationTables.pdf>

The James River is the longest river contained entirely in one state in the United States and is the third largest tributary of the Chesapeake Bay. It receives water flows from 57 counties with more than 2.6 million people. The primary land use is forest area. Agricultural land accounts for only 7 percent, followed by urban land at 5 percent. Non-point pollutant sources, such as runoff from agricultural lands, residential lands, and other urban lands, contribute 59 percent of the nitrogen and 70 percent of the phosphorus loads to the James River. The James accounts for 51 percent of the total Virginia nitrogen loadings into the Chesapeake Bay watershed, and 57 percent of the total Virginia phosphorus loadings. However, because it enters the Bay at its lower portions near the Atlantic Ocean, the nutrient loads from the James are less significant for the overall environmental condition of the Bay. Instead, they are most important for local recreation and other water uses in the James River itself and at the mouth of the River where it enters the Bay.

Agriculture is the largest contributor of pollution in Virginia's Rappahannock River watershed, accounting in 2002 for 4 million pounds of nitrogen and 619 thousand pounds of phosphorus. Similarly, in the tidal York River, about 85 percent of the nitrogen and 81 percent of the phosphorus loads originate from agriculture and other non-point sources.<sup>7</sup>

The Shenandoah River feeds into the middle portion of the Potomac River, and is the most important source of nutrient pollution in Virginia in terms of impact on the Chesapeake. In general, the middle portion of the Potomac is dominated by point sources and urban land use loadings, and the lower portions of the Potomac tend to be influenced more by agriculture, forestry, and other non-point sources of pollution.<sup>8</sup> There are three manure hot spots in the overall Chesapeake Bay watershed – Lancaster County, Pennsylvania, the Delmarva Peninsula, and Rockingham County, Virginia, in the Shenandoah Valley. Together these three sources generate 54 percent of the total nitrogen from manure in the Bay watershed, even though they only represent 23 percent of the land area.<sup>9</sup> The excess manure for animal production regions is shown in Table 3-3 below.

| <b>TABLE 3-3. EXCESS MANURE IN THE CHESAPEAKE BAY WATERSHED UNDER PHOSPHORUS-BASED NUTRIENT MANAGEMENT PLANS</b> |              |
|--|--------------|
| <b>ANIMAL PRODUCTION REGION</b>  | <b>(LBS)</b> |
| Lower Susquehanna (NCRS)   | 286,196      |
| Middle Delmarva (NRCS)   | 257,268      |
| Shenandoah (NCRS)  | 600,070      |
| Total Bay Watershed (ERS)  | 1,500,000    |

Source: CBF, "Manure's Impact on Rivers, Streams and the Chesapeake Bay", July 28, 2004

Rockingham County, located in the Shenandoah Valley and drained by the Shenandoah River, is the largest turkey producer in the nation and the largest dairy and chicken producer in Virginia. Its animal operations have more excess manure than any other county in the nation.<sup>10</sup> Several large poultry processors are located in Harrisonburg or nearby towns, which attract many poultry growers.<sup>11</sup>

### **Nutrient Pollution Programs**

The Virginia Department of Conservation and Recreation (DCR) plays the leading role in the control of the state's non-point sources of pollution. DCR also cooperates with local, state, and federal agencies and other shareholders to identify more effective tools for reduction of non-point source pollution, to coordinate the implementation of the various state non-point source pollution management programs, and to meet the goals of the tributary strategies.

The BMP cost-share program provides financial incentives to Virginia agricultural landowners and operators for implementation of BMPs. The amount of funding varies among different districts and is based partly on the need. Federal and state funds provide up to \$50,000 or 75 percent of the total cost of BMP implementation, while the other 25 percent is borne by the participant. Cost-share assistance is provided only to nutrient management plans that meet local water quality criteria.

Starting from the 1998 tax year, the Virginia Agricultural BMP Tax Credit Program was adopted for non-point pollution control. Activities eligible for the tax credit include implementation of approved conservation plans, adoption of conservation tillage equipment, and usage of conservation equipment, such as manure applicators, tramline adapters, and liquid fertilizers. Since the program's commencement in 1992, it has achieved total reductions of 13,348,080 pounds of nitrogen and 2,545,571 pounds of phosphorus. DCR estimates that an additional 658,945 pounds of nitrogen and 134,245 pounds of phosphorus were prevented from entering Virginia's waters. Until 2004, the cost-share program included 728 farmers, 69,696 acres under implementation, and over \$2.3 million in matching funds.

Established in 1985, the Virginia Conservation Reserve Enhancement Program (CREP) is a supplement to the federal Conservation Reserve Program. The objective of CREP is to improve Virginia's water quality and wildlife habitat by offering financial incentives, such as cost-share and rental payments, to farmers who voluntarily assist environmental conservation.<sup>12</sup> CREP is the most well funded conservation program in Virginia with a core budget of \$91 million from federal and state funds. Up to 25 percent, or \$200 per acre, can be reimbursed by the state to restore buffers or wetlands. Landowners can also receive a 25 percent state income tax credit for out-of-pocket expenses.

In the world of manure fertilizer in Virginia, chicken litter dominates: it is a better fertilizer and it is easier to transport and store than other types of manure.<sup>13</sup> But the high moisture content and associated weight and volume of manure makes transportation over long distances impractical.<sup>14</sup> Virginia started requiring poultry growers to have phosphorus-based nutrient management plans in 2001 and will revise the regulations for other operations by the end of 2005. Maryland, Delaware, and Virginia have started manure transport programs to help move excess manure out of hot spots.<sup>15</sup>

DCR and Virginia's poultry companies jointly fund Virginia's poultry litter application cost-share pilot project. The project requires that poultry litter must be transported from producers in Page or Rockingham counties and applied in Albemarle, Amherst, Botetourt, Clarke, Culpeper, Frederick, Fluvanna, Greene, Louisa, Madison, Nelson, Orange, Rappahannock, Rockbridge, and Warren counties.<sup>16</sup> Transported litter must be used as a land-applied nutrient source. In 2004, the cost-share rate was \$10/acre, and 5,290 tons of manure were transported to cover 3,070 acres, achieving a cost per ton of manure removed of \$5.80.

### Virginia's Tributary Strategy

The State of Virginia was an original signatory to the Chesapeake Bay Agreement in 1983. In 1992, Virginia began developing a statewide tributary strategy. The most recent tributary strategy aims at meeting reduction goals set by the Chesapeake 2000 Agreement. The strategy covers each of the major tributary basins. As shown in Table 3-4, with the full implementation of its tributary strategy, Virginia could achieve complete compliance with the nutrient reduction target.

| TABLE 3-4. VIRGINIA ACTUAL AND PROJECTED LOADS |                |                  |                             |
|--|----------------|------------------|-----------------------------|
| PARAMETER                                      | 2002<br>ACTUAL | 2010 VA STRATEGY | 2010 CAP LOAD<br>ALLOCATION |
| Nitrogen<br>(lbs/yr)                           | 77,804,285     | 49,189,942       | 51,400,843                  |
| Phosphorus<br>(lbs/yr)                         | 9,835,124      | 5,760,395        | 5,996,261                   |
| Sediment<br>(tons/yr)                          | 2,379,018      | 1,509,426        | 1,940,849                   |

*Data are from Virginia Tributary Strategy, page 9*

The total estimated cost for implementing Virginia's agricultural BMPs in its tributary strategy is \$859 million, including capital costs, technical assistance, and operation and maintenance. The cost combines both public and private costs.

A comparative study of costs in Maryland, Pennsylvania, and Virginia allows for better understanding of the most cost-effective BMPs to use, whether there is any possibility of trading pollutant loadings between states, and how to implement BMPs more efficiently. Nine BMPs – conservation tillage, poultry litter alternative use/transported, retirement of highly erodible land, nutrient management, soil conservation and water quality plans, grassed buffers, cover crops (early), animal waste management systems/livestock, and stream protection with fencing – were chosen for analysis in this report. These nine are common among the three original signatory states: Maryland, Pennsylvania, and Virginia.

The total estimated nitrogen reduction in Virginia from the nine BMPs is about 11.57 million pounds. The estimated cost of implementing these BMPs is approximately \$58.21 million per year. Table 3-5 shows the costs and reductions for the selected BMPs in Virginia.

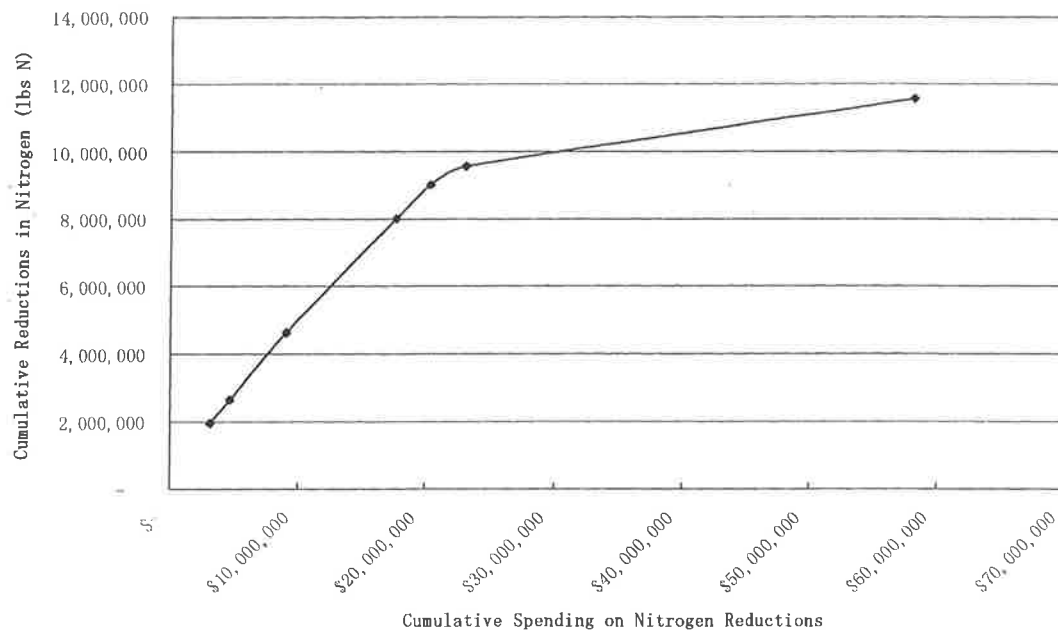


| <b>TABLE 3-5. COST EFFECTIVENESS OF SELECTED BMPS IN VIRGINIA</b> |                                    |                                |
|---|------------------------------------|--------------------------------|
| <b>BMP</b>  | <b>NITROGEN REDUCTION<br/>(LB)</b> | <b>UNIT COST<br/>(\$/LB N)</b> |
| Nutrient Management Plans*  | 1,944,091                          | \$1.60                         |
| 20% Poultry Litter Transport                                      | 694,300                            | \$2.19                         |
| Grass Buffers*  | 1,979,393                          | \$2.22                         |
| Cover Crops (Early-Planting)*                                     | 3,376,445                          | \$2.56                         |
| Animal Waste Management   | 1,007,402                          | \$2.65                         |
| Conservation Plans*   | 565,188                            | \$4.90                         |
| Off-Stream Watering w/ Fencing                                    | 2,006,454                          | \$17.50                        |

Based on the information above, we can further derive a cost curve as shown in Figure 3-1.

**FIGURE 3-1. COST-EFFECTIVENESS OF BMPS IN VIRGINIA**

Graph 3-1. Virginia's Nitrogen Reduction Potential per Dollar Spent on Agricultural BMP Strategies



Virginia's tributary strategy does not include additional conservation tillage because the state achieved the goal for 2010 for this BMP in 2002. But the tributary strategy estimated an additional \$6,894,270 capital cost and \$689,427 for technical assistance that will be needed during the period from 2005 to 2010. Virginia has further agriculture land retirement planned, so no additional cost for land retirement was projected.

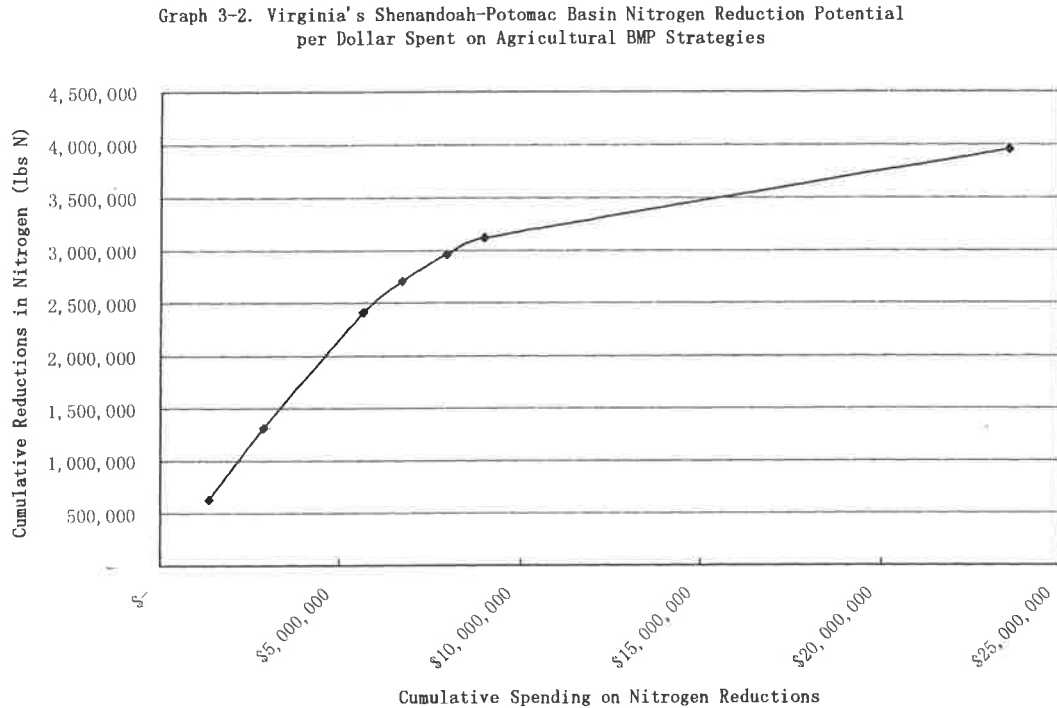
Based on cost-effectiveness analyses of common agricultural BMPs within the three original signatory states, the most promising type of BMP for Virginia is nutrient management planning. This BMP can achieve 16.8 percent of the total nitrogen reduction with only 5.3 percent of the total cost of the BMPs. The five most cost-effective BMPs are: nutrient management planning, poultry litter transport, grass buffers, cover crops, and animal waste management. Together, they can achieve around 9 million pounds of nitrogen reduction during the period from 2005 to 2010. That accounts for 77.8 percent of the total projected reduction from all the BMPs at only \$20.3 million, or 34.9 percent, of the total costs.

According to Virginia's tributary strategy, nutrient management planning should cover 385,000 acres. The Chesapeake Bay Watershed Blue Ribbon Finance Panel estimated that the total cropland area in Virginia is 1.2 million acres. According to the Chesapeake Bay Commission's report, "Cost-Effective Strategies for the Bay," nutrient management plans were prepared for 40 percent of the cropland in Virginia as of 2002. Then, the total feasible cropland area for nutrient management plans could be 720,000 acres – much more than the 385,000 acres designated in Virginia's tributary strategy. It appears that Virginia with the proper incentives could go beyond the existing nutrient management planning goals.

Using the same methodology, a similar analysis can be developed for the most important basin in Virginia – the Shenandoah-Potomac River Basin. Table 3-6 and Figure 3-2 illustrate the cost-effectiveness of various BMPs for this basin.

| <b>TABLE 3-6. BMP COST-EFFECTIVENESS IN THE SHENANDOAH-POTOMAC BASIN</b> |                                    |                                |
|--|------------------------------------|--------------------------------|
| <b>BMP</b>   | <b>NITROGEN REDUCTION<br/>(LB)</b> | <b>UNIT COST<br/>(\$/LB N)</b> |
| 20% Poultry Litter Transport   | 630,398                            | \$2.19                         |
| Grass Buffers*   | 684,872                            | \$2.22                         |
| Cover Crops (Early-Planting)*  | 1,097,177                          | \$2.54                         |
| Nutrient Management Plans*   | 295,665                            | \$3.63                         |
| Conservation Plans*  | 253,534                            | \$4.82                         |
| Animal Waste Management  | 157,482                            | \$6.51                         |
| Off-Stream Watering w/ Fencing   | 833,303                            | \$17.50                        |

**FIGURE 3-2. COST-EFFECTIVENESS OF BMPs IN THE SHENANDOAH-POTOMAC BASIN**



Unlike the statewide estimate, poultry litter transportation is the most cost-effective BMP for the Shenandoah-Potomac basin. The cost for each pound of nitrogen reduced by poultry litter transportation in the Shenandoah-Potomac Basin is \$2.19.

### Existing Obstacles

The strategies provide a helpful tool to assess Virginia's nutrient management programs. However, these strategies do not address some existing problems. The first problem is that the proposed diet and feed adjustments cannot be used for large-scale animal production systems, without consolidating the dairy industry. On a typical dairy farm, 70-80 percent of the nitrogen contained in feed is excreted in manure. A reduction of the nutrient content of dairy manure could lead to significant reductions in total nutrient loads.

The hurdles mainly involve funding. The poultry litter application cost-share pilot project is not guaranteed substantial funding for 2005. In March 2005, Virginia Governor Mark Warner signed eight bills strengthening the protection of Virginia's natural resources. In addition to \$32.4 million in the budget, the bills included \$50 million additional funding in FY2005 for the Chesapeake Bay cleanup. Lawmakers also provided \$4 million to address combined sewer overflows into the James River, \$10 million for land conservation, and nearly \$18 million for operation, maintenance, and capital improvements at state parks.<sup>17</sup> The bills also established a nutrient trading program for the Bay. Less cost-effective polluters could buy credits from more cost-effective dischargers to achieve their state permit limits for nutrient discharges. By doing this, the former (often small dischargers) could avoid upgrading extensively for minor improvements in water quality at high cost. Moreover, the bills sought to stimulate cooperation and environmental stewardship at both private and local levels.

The funding for reducing agricultural pollution to the Chesapeake Bay still remains a core issue for the Virginia part of Bay restoration. A higher level of funding and flexibility is needed to achieve the goal of restoring eleven waterbodies by 2012. Reductions in CWA Section 319(h) funds and other resource limitations constitute a significant problem for implementation.<sup>18</sup> Although the CREP performed well, high legal and technical assistance costs to meet the 9,000-acre goal for permanent CREP easements cannot be ignored.

Another issue is the reliability of the computer model that Virginia uses to project the outcome of implementing agricultural regulations and tributary strategies. Environmental models seek to simulate ecosystems, which may be too large and too complicated for real experiments. The current model – developed by the Chesapeake Bay Program – estimates the delivery of pollutants to the Bay by simulating hydrologic and nutrient cycles. The simulations include atmospheric nutrient deposition, precipitation, fertilizer application, and land cover or land use.<sup>19</sup> Virginia adopted a computer model to allocate nutrient reductions for BMPs. This will require a high reliability of the model, monitoring of implementation, and continuous follow-up of the results.

A second technology hurdle is the availability of the information needed for the computer analysis. Since the size of farms in Virginia is relatively small, accurate data for nutrient pollution from individual farms may be difficult to collect. This may require many assumptions and with the large number of total farms, the deviation from the actual situation could be large.

## **Policy Recommendations**

### ***Find the most cost-effective BMPs.***

From the cost-effectiveness analysis of common agricultural BMPs within the three states, the most cost-effective BMP for Virginia is nutrient management planning. The cost for each pound of nitrogen reduced by this BMP is \$1.60. It alone can yield 1.9 million pounds, or 16.8 percent of the total nitrogen reductions allocated to Virginia, with only \$3.1 million (5.3 percent) of the total costs. The other most cost-effective BMPs include poultry litter transport, grass buffers, cover crops, and animal waste management. With nutrient management planning, these BMPs can achieve around 9 million pounds of nitrogen reduction from 2005 to 2010. That accounts for 77.8 percent of the total projected reduction from all the BMPs with only \$20.3 million or 34.9 percent of the total costs.

It will be important to give the highest priority in funding and other implementation to those BMPs that are most cost-effective.

### ***Strengthen the existing Agricultural Stewardship program.***

Virginia needs to strengthen its existing Agricultural Stewardship Program, designed to educate farm owners and other residents about the significance of pollution reductions in agriculture. The program should create more financial incentives to farmers who voluntarily comply with the agricultural pollution standard.

### ***Buy out farmers on a voluntary basis.***

Buying out existing farmers might be an appropriate step in some circumstances, partly because more than half of Virginia farms are small farms with annual sales of less than \$9,999. If the buyout offers could be made attractive to farmers, it could be a rapid and cost-effective method of nutrient reduction.

### ***Improve the computer model.***

The computer model adopted for allocating pollution reductions and projecting the outcome of regulations should be further refined. Current models are subject to significant potential inaccuracies, which limits their usefulness for policy purposes.

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### Endnotes to Chapter 3

- <sup>1</sup> Virginia Department of Conservation and Recreation
- <sup>2</sup> Virginia farm bureau federation [http://www.vafb.com/abt\\_ag.htm](http://www.vafb.com/abt_ag.htm)
- <sup>3</sup> Virginia Department of Conservation and Recreation, Chesapeake Bay Local Assistance
- <sup>4</sup> Virginia Non-point Source Pollution Management Program, DCR, March 31, 2005
- <sup>5</sup> <http://www.chesapeakebay.net/virginia.htm>
- <sup>6</sup> Virginia Tributary Strategy, Eastern Shore Bay Watershed
- <sup>7</sup> Virginia Tributary Strategy, York River Basin, P14
- <sup>8</sup> Virginia Tributary Strategy, Virginia's Shenandoah and Potomac River Basins, P13
- <sup>9</sup> Chesapeake Bay Foundation, *"Manure's Impact on Rivers, Streams and the Chesapeake Bay"*, July 28, 2004, executive summary
- <sup>10</sup> Ibid
- <sup>11</sup> Virginia Farm Bureau, <http://www.vafb.com/rockingham/rockingham.asp>
- <sup>12</sup> Virginia Department of Conservation & Recreation "Virginia Non-point Source Pollution Management Program 2004 Annual Report", March 31, 2005, p12
- <sup>13</sup> Scott Faber, "Study finds markets for chicken litter much closer to home", Bay Journal, April 2004
- <sup>14</sup> Chesapeake Bay Commission, "Cost-Effective Strategies for the Bay", December 2004
- <sup>15</sup> Chesapeake Bay Foundation, *"Manure's Impact on Rivers, Streams and the Chesapeake Bay"*, July 28, 2004, p9
- <sup>16</sup> Virginia DCR, "Virginia Poultry Litter Application Cost-Share Pilot"
- <sup>17</sup> Virginia Governor press release, March 24, 2005
- <sup>18</sup> Virginia Department of Conservation & Recreation "Virginia Non-point Source Pollution Management Program 2004 Annual Report", March 31, 2005, Executive Summary
- <sup>19</sup> Chesapeake Bay Program: <http://www.chesapeakebay.net/restrtn.htm>



## **Part II – Cost-Effective Urban Nitrogen Reduction**





## CHAPTER 4 – THE URBAN CHALLENGE: GROWTH WITHOUT NITROGEN

While the Chesapeake Bay Program, along with the Bay states, academic institutions, and not-for-profit organizations, struggles to find ways to meet the nutrient reduction goals of the Chesapeake 2000 Agreement (C2K), increasing development in the watershed adds to pollution and threatens to put the C2K goals even further out of reach. By increasing impervious surfaces, cleared land, stormwater and wastewater treatment flows, and motorized transportation, a growing population and associated development means increased nutrient loadings into the Chesapeake Bay. Although a variety of policies at the local and state levels are meant to control development, rapid urban growth persists throughout the Bay watershed. While reducing nutrient pollution, whether from point or non-point sources, is a daunting and technically and politically challenging task, sound development and land use policies are important elements of nutrient pollution policy.

Development pressure in a coastal area is not unique to the Chesapeake Bay region. Between 1998 and 2015, the population of coastal areas nationwide is projected to increase from 139 million to 165 million, or approximately twenty percent.<sup>1</sup> Further, the rate of increase of developed land use for the United States since 1982 is more than twice the rate of population growth over the same period. Increasing populations and development often strain infrastructure and challenge existing land use and zoning policies. Within the Chesapeake Bay watershed, development is managed largely on a local basis. However, on a regional basis, the Chesapeake 2000 Agreement identifies sound land use as one of its strategic focus areas. In 1987, the signatories of the Chesapeake Bay Agreement agreed "there is a clear correlation between population growth and associated development and environmental degradation in the Chesapeake Bay system." In 2000, the signatories made this link more explicit, making it a goal to "develop, promote and achieve sound land use practices which protect and restore watershed resources and water quality, maintain reduced pollutant loadings for the Bay and its tributaries, and restore and preserve aquatic living resources."<sup>2</sup> The twenty-five commitments for sound land use encompass land conservation; land development, redevelopment, and revitalization; public access; and transportation.

Non-point nutrient pollution from urban and mixed open land uses contributes significantly to the excess nutrient loading in the Chesapeake Bay. Urban areas (including suburban, urban, industrial and commercial land uses, and roads) and mixed open areas (land with low levels of development and low population densities that are not in agricultural use) contribute nutrient loads as outlined in Table 4-1.

**TABLE 4-1. NUTRIENT LOADS FROM VARIOUS LAND USES AND TOTAL ACRES OF LAND USES IN THE CHESAPEAKE BAY WATERSHED.<sup>3</sup>**

| LAND USE      | NITROGEN (LBS/ACRE) |       |        | PHOSPHORUS (LBS/ACRE) |      |        | TOTAL ACRES (THOUSANDS) |        |        |
|---------------|---------------------|-------|--------|-----------------------|------|--------|-------------------------|--------|--------|
|               | 1985                | 2002  | CHANGE | 1985                  | 2002 | CHANGE | 1985                    | 2002   | CHANGE |
| Urban         | 9.69                | 7.98  | -17.7% | 1.18                  | 0.82 | -30.4% | 3,152                   | 3,825  | +21.3% |
| Mixed Open    | 4.47                | 4.39  | -1.8%  | 0.54                  | 0.54 | +1.0%  | 3,937                   | 4,155  | +5.6%  |
| Crop          | 15.93               | 13.22 | -17.0% | 1.04                  | 0.88 | -15.8% | 7,018                   | 6,304  | -10.2% |
| Forest/Wooded | 1.69                | 1.75  | +4.1%  | 0.02                  | 0.02 | +4.3%  | 22,970                  | 23,495 | +2.3%  |

Despite the goals and initiatives identified above, as population increases within the watershed, forested and agricultural lands continue to be lost, low-density development continues, traditional stormwater management practices dominate, and wastewater treatment lags behind what is technically feasible. As with most pollutant sources in the watershed, a common complaint associated with controlling pollutants originating from developed and mixed open lands is a lack of funding. The Chesapeake Bay Commission, in its "Cost of a Clean Bay" report, identified an overall budget shortfall of approximately \$1.1 billion dollars for funding the Sound Land Use goals in C2K.<sup>4</sup> This figure includes creating riparian buffers, stormwater retrofits, etc. On a more local level, the report discusses recent analyses by Prince William and Carroll counties that indicate that low-density development often costs municipalities more in infrastructure and other expenditures than the development returns in property taxes. In preparation for the renegotiation of C2K, the Alliance for the Chesapeake Bay found in its stakeholder outreach efforts that managing growth in the watershed was the number one concern of the public.<sup>5</sup>

The remainder of this chapter identifies population and development trends within the watershed that will pose a challenge for policymakers in the achievement of cleanup goals for the Chesapeake Bay. It then describes some methods that might be applied to mitigate these impacts.

### **Population Growth and Land Use Change within the Watershed**

Over the past several decades, the population in the Chesapeake Bay watershed increased rapidly. Table 4-2 presents population estimates and projections for the portions of the Chesapeake Bay states that drain into the Bay.

**TABLE 4-2. POPULATION ESTIMATES AND PROJECTIONS FOR PORTIONS OF STATES WITHIN THE CHESAPEAKE BAY DRAINAGE BASIN.<sup>6</sup>**

| <b>STATE</b>     | <b>1990</b> | <b>2000</b> | <b>2010</b> | <b>2020</b> |
|------------------|-------------|-------------|-------------|-------------|
| Washington, D.C. | 606,900     | 536,750     | 576,924     | 636,380     |
| Delaware         | 68,283      | 82,845      | 92,321      | 99,178      |
| Maryland         | 4,731,408   | 5,256,268   | 5,675,036   | 6,052,542   |
| New York         | 659,981     | 665,129     | 672,319     | 678,014     |
| Pennsylvania     | 3,277,323   | 3,433,056   | 3,537,020   | 3,600,916   |
| Virginia         | 4,749,928   | 5,415,573   | 5,929,948   | 6,457,412   |
| West Virginia    | 180,828     | 204,620     | 225,255     | 242,188     |
| Bay Watershed    | 14,274,651  | 15,594,241  | 16,708,823  | 17,766,630  |

Further, as population increases within the watershed, the demand for housing units increases along with potential pollution loads. Table 4-3 provides population and housing estimates for the Chesapeake Bay watershed based on U.S. Census Bureau projections that were adapted to match the boundaries of the watershed. As shown, the increase in housing units for the entire Bay watershed exceeded the increase in population. This may be due in large part to the decreasing average family size and preferences toward owning multiple housing units. The tributary-specific estimates below also exhibit this pattern.

**TABLE 4-3. POPULATION AND HOUSING ESTIMATES FOR THE CHESAPEAKE BAY WATERSHED**

| STATE  | 1970       | 1980       | 1990       | 2000       | 2010       | 2020       |
|--|------------|------------|------------|------------|------------|------------|
| Population                                     | 11,793,163 | 12,784,860 | 14,274,651 | 15,594,241 | 16,709,043 | 17,766,832 |
| Population Density (persons/mi <sup>2</sup> )  | 177.6      | 192.6      | 215.0      | 234.9      | 251.7      | 267.6      |
| % Change                                       | --         | 8%         | 10%        | 8%         | 7%         | 6%         |
| Housing Units                                  | 5,184,903  | 6,572,412  | 7,740,841  | 8,557,413  | 9,387,263  | 10,223,752 |
| Housing Unit Density (houses/mi <sup>2</sup> ) | 78.10      | 99.0       | 116.6      | 128.9      | 141.4      | 154.0      |
| % Change                                       | --         | 21%        | 15%        | 10%        | 9%         | 8%         |

Note: Data adapted from Chesapeake Bay Program data.<sup>7</sup> Total population projection for the Chesapeake Bay watershed differs slightly from estimates provided above.

Given the diversity of the Chesapeake Bay watershed, the extent of land use and also of population and development pressure vary widely. Table 4-4 below compares the total area, distribution of land cover, and extent of impervious surface for eight major tributaries.

**TABLE 4-4. TOTAL AREA, CURRENT LAND COVER, AND CURRENT EXTENT OF IMPERVIOUS SURFACE IN EIGHT MAIN CHESAPEAKE BAY TRIBUTARIES**

| TRIBUTARY        | AREA (MI <sup>2</sup> ) | LAND COVER (MI <sup>2</sup> ) |             |          | IMPERVIOUS SURFACE |
|------------------|-------------------------|-------------------------------|-------------|----------|--------------------|
|                  |                         | DEVELOPED                     | AGRICULTURE | FORESTED |                    |
| Eastern Shore    | 5,048                   | 105                           | 1,951       | 1,259    | 1.52%              |
| James            | 10,432                  | 472                           | 1,778       | 7,382    | 1.89%              |
| MD Western Shore | 1,670                   | 291                           | 575         | 611      | 8.49%              |
| Patuxent         | 957                     | 102                           | 328         | 405      | 4.41%              |
| Potomac          | 14,679                  | 701                           | 4,663       | 8,451    | 2.21%              |
| Rappahannock     | 2,845                   | 52                            | 880         | 1,619    | 0.66%              |
| Susquehanna      | 27,486                  | 612                           | 8,041       | 18,181   | 1.37%              |
| York             | 3,270                   | 74                            | 680         | 1,992    | 0.95%              |
| CB Watershed     | 66,388                  | 2,409                         | 18,895      | 39,901   | 1.76%              |

Note: Data adapted from Chesapeake Bay Program data.<sup>8</sup> Not all land cover types are identified. Additional land covers include open water, wetland, and barren.

Table 4-5 provides population and housing projections for these watersheds. Sprawl City, a non-profit research organization, analyzed the relationships between population growth and urbanized land cover for the nine major urbanized areas<sup>a</sup> in the Chesapeake Bay watershed from 1970 to 1990.<sup>9</sup> According to this study, average increases in per capita land consumption almost equal the average impact of population growth, both of which contributed to a loss of approximately 1,200 square miles of rural land (although not necessarily crop land) within the Chesapeake Bay watershed. It is important to note, however, that the impact of these two factors may vary considerably between specific urbanized areas.

**TABLE 4-5. POPULATION ESTIMATES FOR EIGHT MAJOR CHESAPEAKE BAY TRIBUTARIES**

| TRIBUTARY        | POPULATION (PERSONS) AND POPULATION DENSITY (PERSONS/MI <sup>2</sup> ) |            |            |            |            |            |
|------------------|--|------------|------------|------------|------------|------------|
|                  | 1970   | 1980       | 1990       | 2000       | 2010       | 2020       |
| Eastern Shore    | 315,615  | 360,654    | 412,179    | 467,542    | 508,323    | 539,867    |
|                  | 65.5   | 71.4       | 81.7       | 92.6       | 100.7      | 106.9      |
| James            | 1,793,109  | 2,010,933  | 2,288,366  | 2,522,583  | 2,739,277  | 2,968,430  |
|                  | 171.9  | 192.8      | 219.4      | 241.8      | 262.6      | 284.5      |
| MD Western Shore | 1,941,827  | 1,979,902  | 2,081,500  | 2,188,148  | 2,261,690  | 2,345,309  |
|                  | 1,163  | 1,186      | 1,247      | 1,310      | 1,354      | 1,404      |
| Patuxent         | 317,752  | 389,357    | 491,006    | 590,769    | 670,543    | 757,135    |
|                  | 332.1  | 407        | 513.3      | 617.5      | 700.9      | 791.4      |
| Potomac          | 3,607,722  | 3,927,938  | 4,667,581  | 5,243,322  | 5,770,639  | 6,259,872  |
|                  | 245.8  | 267.6      | 318        | 357.2      | 393.1      | 426.4      |
| Rappahannock     | 119,421  | 156,939    | 200,241    | 240,754    | 270,897    | 301,037    |
|                  | 42.0   | 55.2       | 70.4       | 84.6       | 95.2       | 105.8      |
| Susquehanna      | 3,474,521  | 3,688,979  | 3,809,742  | 3,968,635  | 4,075,304  | 4,142,929  |
|                  | 126.4  | 134.2      | 138.6      | 144.4      | 148.3      | 150.7      |
| York             | 223,196  | 270,158    | 324,036    | 372,488    | 412,370    | 452,254    |
|                  | 68.3   | 82.6       | 99.1       | 113.9      | 126.1      | 138.3      |
| CB Watershed     | 11,793,163   | 12,784,860 | 14,274,651 | 15,594,241 | 16,709,043 | 17,766,832 |
|                  | 177.6  | 192.6      | 215.0      | 234.9      | 251.7      | 267.6      |

As the population in the Bay watershed continued to grow, demand for housing units increased, often at a rate that exceeded population growth. From 1970 to 2000, the average household size in the Chesapeake Bay watershed decreased from 3.26 persons/household to 2.62 persons/household.<sup>10</sup> As a result of increased population and decreased household size, land use patterns also changed rapidly. In response to housing and infrastructure needs, a pattern of sprawl development emerged, which is also encouraged by federal highway subsidies, personal preferences, and the need for

<sup>a</sup> Baltimore, MD; Hagerstown, MD-PA-WV; Harrisburg, PA; Lynchburg, VA; Norfolk-Virginia Beach, VA; Scranton-Wilkes-Barre, PA; and Washington, DC-MD-VA.

more affordable housing. At the same time, between 1970 and 2000 the average house area increased from 1,500 to 2,265 square feet, lot size increased by 60%, and average household population decreased.<sup>11</sup>

**TABLE 4-6. HOUSING UNIT ESTIMATES FOR EIGHT MAJOR CHESAPEAKE BAY TRIBUTARIES**

| TRIBUTARY        | HOUSING UNITS AND HOUSING UNIT DENSITY (UNITS/MI <sup>2</sup> ) |           |           |           |           |            |
|------------------|---|-----------|-----------|-----------|-----------|------------|
|                  | 1970  | 1980      | 1990      | 2000      | 2010      | 2020       |
| Eastern Shore    | 196,872   | 254,419   | 303,385   | 334,178   | 359,922   | 385,162    |
|                  | 39.0  | 50.4      | 60.1      | 66.2      | 71.3      | 76.3       |
| James            | 1,087,014   | 1,506,381 | 1,818,298 | 2,016,506 | 2,172,986 | 2,326,336  |
|                  | 104.2   | 144.4     | 174.3     | 193.3     | 208.3     | 223.0      |
| MD Western Shore | 291,749   | 491,314   | 562,790   | 610,385   | 657,312   | 703,905    |
|                  | 174.7   | 294.2     | 337       | 365.5     | 393.6     | 421.5      |
| Patuxent         | 83,068  | 141,253   | 196,855   | 245,183   | 294,469   | 346,147    |
|                  | 86.8  | 147.6     | 205.7     | 256.2     | 307.7     | 361.7      |
| Potomac          | 1,463,496   | 1,859,829 | 2,292,860 | 2,611,394 | 2,902,038 | 3,211,765  |
|                  | 99.7  | 126.7     | 156.2     | 177.9     | 197.7     | 218.8      |
| Rappahannock     | 105,834   | 170,985   | 214,229   | 258,895   | 292,182   | 325,468    |
|                  | 37.2  | 60.1      | 75.3      | 91.0      | 102.7     | 114.4      |
| Susquehanna      | 1,759,104   | 2,157,651 | 2,350,053 | 2,451,751 | 2,655,148 | 2,858,544  |
|                  | 64.0  | 78.5      | 85.5      | 89.2      | 96.6      | 104.0      |
| York             | 150,420   | 206,337   | 257,022   | 309,996   | 356,103   | 403,191    |
|                  | 46.0  | 63.1      | 78.6      | 94.8      | 108.9     | 123.3      |
| CB Watershed     | 5,184,903   | 6,572,412 | 7,740,841 | 8,557,413 | 9,387,263 | 10,223,752 |
|                  | 78.10   | 99.0      | 116.6     | 128.9     | 141.4     | 154.0      |

### Environmental Impacts of Development

Developed land contributes to pollution by increasing impervious surfaces (e.g., roads, driveways, rooftops), which increase stormwater runoff to streams and other waterways, by increasing vehicle travel and industrial activity, and by increasing emissions from either septic systems or municipal wastewater treatment plants. These problems are all exacerbated when residential development is sprawling, often defined as low-density, land-consumptive development that separates jobs from homes, encourages reliance on the automobile, and underutilizes existing community facilities and public services.<sup>12</sup> In addition, development also leads to the loss or fragmentation of resource lands, which means a loss of habitat.

Impervious surfaces increase runoff, and when more than ten percent of a watershed is covered by these surfaces (e.g., parking lots, roads, rooftops, etc.), water quality of streams and other water bodies within the watershed is often negatively impacted<sup>13</sup>. Further, land development decreases resource lands (open space and forested area), and often augments pollution from increased transportation. As shown earlier in Table

4-1, developed lands (synonymous with substantial percentages of impervious surfaces) contribute nitrogen and phosphorus to the Chesapeake Bay in an amount less than crop lands, but significantly greater than the land in a natural state. Further, the type of development also determines the extent of imperviousness, and therefore runoff, as indicated in Table 4-7.

**TABLE 4-7. IMPERVIOUSNESS AND RUNOFF ASSOCIATED WITH DIFFERENT DEVELOPMENT TYPES**

| LAND USE                                | PERCENT IMPERVIOUSNESS | PERCENT RUNOFF |
|---|------------------------|----------------|
| Open Areas                              | 0-10                   | 10             |
| Residential,<br>Low Density             | 20-40                  | 20-30          |
| Residential,<br>Medium Density          | 35-45                  | 30             |
| Residential,<br>High Density            | 45-60                  | 30-50          |
| Business District or<br>Shopping Center | 95-100                 | 55             |

*Source: Chesapeake Futures*

In what follows, this chapter presents crude estimates of the nitrogen and phosphorus contributed by additional housing units under a "business as usual" strategy. Although this varies depending on housing type, lot size, and extent of impervious area, these numbers are presented to provide a general idea of the increase in nutrient loading that may result from residential development. This is particularly important considering the diversity in development patterns throughout the watershed. Further, although these estimates pertain to runoff, they do not differentiate the impact relative to the location in the watershed or how significantly water quality may be affected in the Chesapeake Bay, or even an individual tributary.

In an attempt to predict environmental gains from improved development practices, in the *Chesapeake Futures*<sup>14</sup> report, the Chesapeake Bay Program characterizes the recent trend in development as follows:

- Density of new residential development is 0.6-1.1 units/acre.
- Average lot size per new household is 0.91-1.45 acres.
- Impervious cover per new household is 0.21-0.31 acres.
- Commercial/industrial land per household is 0.10 acres.

Also taking into account the current extent of sewer systems and other development patterns, the authors predict that 2 million acres of resource lands will be lost by 2030, and nutrient loading from new development (including non-point, point, and septic sources) will be nearly 35 million pounds of nitrogen and 1.8 million pounds of phosphorus, annually. This is approximately a ten percent increase over current loadings.

However, under a "current objectives scenario," which is framed in order to meet the current C2K goals and which includes increased density, decreased average lot size, and decreased impervious surfaces, relative to the business as usual assumptions, the authors find that only 800,000 acres of resource lands will be lost, increased nitrogen

loadings from non-point sources will be reduced by half, and phosphorus loadings will be significantly reduced. Lastly, by adjusting these development patterns even further to develop a "feasible alternatives" scenario, the authors determine that total nitrogen loads to the Bay from new development drop to less than half of the "recent trends scenario." Note that this report uses a proprietary data set, which includes projections to 2050, different from the analysis below, and also includes additional policy parameters beyond the scope of this chapter.

Depending on the assumption for the development pattern, the future contribution of development to nutrient loading is variable. To crudely estimate the nitrogen and phosphorus runoff from the housing unit projections provided in Table 4-6 above, this chapter assumes a lot size of 0.62 acres,<sup>15</sup> which is the current average lot size in Maryland for both new and old development, with a 40% imperviousness. (40% is a rough approximation of imperviousness of a suburban development with single-family homes at a density of three to five units per acre.<sup>16</sup>) This equates to an annual storm pollutant export estimate for total nitrogen and total phosphorus estimates of 6.7 and 0.87 pounds/acre/yr, respectively.<sup>17</sup> Each housing unit contributes approximately 4.2 pounds nitrogen/year and 0.54 pounds phosphorus/year. It is important to note that these estimates (and presumably the more generous acreage estimate provided by the *Chesapeake Futures* report) also include the per-household sidewalks, driveways, and residential roads.

Extrapolating this estimate to the entire watershed, Table 4-8 provides rough approximations of the increased nutrient runoff associated with the increase in housing units predicted in each tributary. As noted above, this estimate does not account for the nutrients that are managed through existing stormwater management practices, nor does it predict the percentage of the runoff that reaches the Chesapeake Bay or its tributaries, let alone imply the affect on water quality from increased development. This estimate does, however, highlight the increase in nutrient runoff associated with development, presenting a challenge to meeting goals for nutrient reduction generally, but also an opportunity to implement practices that allow development without increasing the overall nutrient pollution.

**TABLE 4-8. ESTIMATED NITROGEN AND PHOSPHORUS (LB/ACRE) EXPORTED BY NEW DEVELOPMENT IN EACH DECADE**

| TRIBUTARY        | 1981-1990  |           | 1991-2000  |           | 2001-2010  |           | 2011-2020  |           |
|------------------|------------|-----------|------------|-----------|------------|-----------|------------|-----------|
|                  | N          | P         | N          | P         | N          | P         | N          | P         |
| Eastern Shore    | 1,118,717  | 145,266   | 703,523    | 91,353    | 588,191    | 76,377    | 576,658    | 74,880    |
| James            | 7,126,363  | 925,364   | 4,528,458  | 91,353    | 3,575,099  | 464,229   | 3,503,597  | 454,945   |
| MD Western Shore | 1,633,012  | 212,048   | 1,087,403  | 141,200   | 1,072,141  | 139,218   | 1,064,510  | 138,227   |
| Patuxent River   | 1,270,332  | 164,954   | 1,104,161  | 143,376   | 1,126,026  | 146,215   | 1,180,687  | 153,313   |
| Potomac River    | 9,893,448  | 1,284,672 | 7,277,553  | 944,996   | 6,640,348  | 862,254   | 7,076,330  | 918,867   |
| Rappahannock     | 987,996    | 128,292   | 1,020,496  | 132,512   | 760,497    | 98,751    | 760,497    | 98,751    |
| Susquehanna      | 4,395,808  | 570,799   | 2,323,499  | 301,708   | 4,646,998  | 136,786   | 4,646,998  | 603,416   |
| York             | 1,158,000  | 150,367   | 1,210,297  | 157,158   | 1,053,407  | 136,786   | 1,075,820  | 139,696   |
| CB Watershed     | 26,695,093 | 3,466,378 | 18,656,230 | 2,422,525 | 18,959,583 | 2,461,916 | 19,111,260 | 2,481,611 |

*Note: As explained above, these estimates assume 40% imperviousness and a per unit acreage of 0.62 acres. See Table 5 for housing unit estimates.*

As mentioned above, the Chesapeake Futures report also accounts for loading from commercial development, estimated at approximately 0.1 acres/housing unit, as well as point source pollution. Commercial and industrial development is assumed to be between 95-100% impervious.<sup>18</sup> Commercial development is considered 95% impervious, exporting 14.8 and 1.92 pounds/acre/year of nitrogen and phosphorus, respectively.<sup>19</sup>

### **Growth Without Nutrients**

Given the substantial increases in housing and population that are almost certain to occur with the Chesapeake Bay watershed within coming decades, it is important to find policy measures to counteract the potential adverse impacts on the water quality of the Chesapeake Bay. This can be accomplished in two basic ways. First, states can encourage new urban development to minimize the nutrient loads that it generates and that might reach the waters of the Bay, through some combination of regulatory requirements and financial incentives. Second, for those remaining loads, states should require new land uses to create compensating offsets from other sources of Bay nutrient pollution. Indeed, if these required offsets exceed the pollution load generated by the new land development, the process of urban growth can even set in motion forces that could accelerate the cleanup of Chesapeake Bay. The large financial resources available to land developers would be directed in part to the cleanup of pollution from other sources with fewer resources. Agriculture within the Bay watershed is likely to be the largest single such source.

### **Stormwater Offsets**

There already exist some limited precedents for the use of offsets within the water quality management system of the Chesapeake Bay. In 1984, the Maryland General Assembly enacted the Chesapeake Bay Critical Area Protection Act to help reverse the



deterioration of the Chesapeake Bay through the regulation of development in specific areas. The Act designated all lands within 1,000 feet of tidal waters or adjacent tidal wetlands as the "Critical Area." Each county, Baltimore City, and certain municipalities surrounding the Bay are required to implement land use and resource management programs to mitigate the damaging impact of water pollution and loss of natural habitat, while at the same time accommodating future growth.

One of the criteria for the Critical Area program specifies that stormwater practices must be capable of reducing stormwater pollutant loads from a development site to a level at least 10% below the load generated by the same site prior to development, known as the 10% rule. In its guidance manual,<sup>20</sup> the Critical Area program states that offsets may be used in the following situations:

- If the use of on-site and off-site best management practices (BMPs) cannot meet the pollutant removal requirement of the 10% Rule;
- If the use of off-site areas draining to on-site BMPs cannot meet the pollutant reduction requirement; or
- If construction of on-site BMPs is not feasible or practical.

In these situations, and only as a last resort, a jurisdiction can allow an applicant to provide an offset, defined as "structures or actions that compensate for undesirable impacts," or pay an offset fee to meet the pollutant reduction requirement.

The criteria dictate that offsets must be located within reasonable proximity to the Chesapeake Bay, Atlantic Coastal Bays, their tributaries and associated tidal wetlands, and preferably within the Critical Area itself, but at a minimum, offsets must be in the same watershed. Examples of offsets include stormwater retrofits, reducing the imperviousness of an existing property, or "innovative options," which include restoring a degraded tidal or non-tidal wetland, restoring a channelized stream, installing a trash inceptor, installing a riparian buffer, over-designing an upcoming project, or upgrading a stormwater pond.

Like the rest of the Critical Area Program, the implementation is at the discretion of a locality, as long as the criteria are met. Local jurisdictions have flexibility in terms of their level of involvement in implementing offsets, ranging from an oversight role, "brokering" the offset, or even taking on responsibility for the offset, leaving the developer only responsible for paying an "offset fee." The manual provides some guidance for setting offset fees, relying largely on a 1997 analysis by Brown and Schueler<sup>21</sup> that evaluated the actual costs for 73 stormwater BMPs in the mid-Atlantic region, and developed cost equations and cost per cubic foot of water quality storage provided. The manual suggests that these data become the basis for setting an offset fee that fully recovers the cost to remove phosphorus from one acre of impervious cover. Based on these data, the guidance suggests that the fee necessary to fully recover the cost to remove phosphorus from one acre of impervious cover ranges from \$22,500 to \$38,400 per pound of phosphorus removed. A nitrogen estimate is not provided, as the guidance considers that phosphorus is a good surrogate for other urban pollutants. Up to the present, however, none of the Maryland counties has implemented taxes or charges to manage development in the Critical Area.

### **Forest Offsets**

Recognizing the ecological importance of forests and providing guidance to ensure their protection and/or replacement, the Critical Area Program criteria state that:

- The total acreage in forest coverage within a jurisdiction in the Critical Area shall be maintained or, preferably, increased.
- All forests that may be cleared or developed shall be replaced in the Critical Area on not less than an equal area basis.

A review of economic approaches to help implement the Critical Area Act found that thirteen of fifteen counties affected by the Critical Area Act use forestation offsets.<sup>22</sup> In its forest mitigation guidance, the Maryland Department of Natural Resources prescribes requirements for when and to what extent a property owner is required to replace cleared trees within the LDA or RCA of the Critical Area.<sup>23</sup> Up to 20% of a forest or developed woodland can be cleared in a LDA or RCA provided the forest is replaced (offset) on not less than an equal basis or 1:1 mitigation. For more than 20%, but less than 30% clearing, then the total surface acreage of the disturbed forest must be replaced on 1.5:1 basis. (These mitigation ratios are based on the percentage of the on-site forest cleared, not the total acreage of the property.) Finally, violations for clearing must replant at three times the areal extent of the cleared forest instead of the above planting ratio.

There are no reforestation provisions for sites designated as Intensely Developed Areas (IDAs). Also, in addition to the mitigation requirements, the criteria state, "If no forest is established on proposed development sites, these sites shall be planted to provide a forest or developed woodland cover of at least 15 percent."

If the size of a property in the Critical Area is too small to reasonably accommodate the amount of mitigation required by the regulation, the criteria allow local jurisdictions to create a "fee in lieu" program providing the fee is adequate to restore or establish an equivalent forest area. This may be more ecologically beneficial for smaller lots in densely populated areas, which may not support the proper scale of planting. Also, in some counties, fees-in-lieu can be used to plant trees and purchase easements in conjunction with the U.S. Department of Agriculture's Conservation Reserve Enhancement Program.

### **Virginia – Chesapeake Bay Preservation Act**

In 1988 the Virginia General Assembly enacted the Chesapeake Bay Preservation Act to establish a cooperative state/local program for reducing non-point source pollution. The resulting program requires wise resource management practices for the use and development of environmentally sensitive land features to improve water quality in the Chesapeake Bay and its tributaries, particularly by using and developing land in ways that minimize impact on water quality. Specifically, the Act requires Virginia Tidewater localities to prepare inventories of environmentally sensitive land features, to designate Chesapeake Bay Preservation Areas based upon these findings, and to amend their local land use management systems (including zoning and subdivision ordinances and comprehensive plans) to protect water quality.

Land use and development are regulated where necessary and in a degree appropriate to the type of landform on which they are located. Similar to the Maryland Critical Area Act, the Chesapeake Bay Preservation Act allows flexibility to meet local needs, both in terms of existing water quality conditions and unique land characteristics and in terms of the existing regulatory system, yet provides uniform standards for use throughout the Tidewater to ensure a basic level of consistency among the various local programs.

In 2001, the Chesapeake Bay Local Assistance Department completed a study<sup>24</sup> that considered expanding the scope of the Act. The study further identified the potential need for changes to the current regulations and identification of financial resources needed for an expansion, in addition to the assessment of environmental benefits and costs to government. The study concluded that legislative action to apply the goals, objectives, and programs associated with the Chesapeake Bay Preservation Act throughout the Chesapeake Bay watershed in the Commonwealth is warranted, but would come at significant costs to local governments. Similar to the Maryland Critical Area Act, economic incentives, as identified below, could be incorporated into this framework to make nutrient management from developed lands more effective.

## **Pennsylvania – Growing Greener Bond**

In 1999 Pennsylvania enacted the Growing Greener Program, which provides the funding necessary to preserve farmland and protect open space; to eliminate the maintenance backlog in state parks; to clean up abandoned mines and restore watersheds; and to provide new and upgraded water and sewer systems across the state. Funded at \$645.9 million over five years (\$105.9 million for the first year and \$135 million a year for the next four), the money will come from about \$473.4 million in new allocations from the General Fund and \$172.5 million in funds redirected from the Recycling and Hazardous Sites Cleanup funds and the Landfill Closure Accounts. On May 17, 2005, the ballot in the primary election included a referendum question that would allow for the borrowing up to \$625 million to fund environmental programs, including “maintenance and protection of the environment, open space and farmland preservation, watershed protection, abandoned mine reclamation, acid mine drainage remediation and other environmental initiatives.” Pennsylvania voters approved this new initiative. The Growing Greener program has directed funds at sewage treatment upgrades and agricultural nutrient management, but does not directly address other sources of nutrients originating from developed lands.

## **Findings and Recommendations**

The growth management policies thus far adopted within the Bay watershed, while marginally successful at regulating development, do not encourage practices that will do much to help meet the goals of the Chesapeake Bay Agreement. Specifically, they are either too limited in scope to effectively limit nutrient pollution from developed land as a whole, or do not establish nutrient management as a primary goal of the policy. Further, as currently written, the policies do not efficiently use government resources, and fail to provide strong incentives to developers and/or landowners.

To help mitigate some of these shortcomings, modifying policies to include economic policy mechanisms may provide the proper incentives to more effectively manage growth within the Chesapeake Bay watershed and meet the land use goals for 2010 of the Chesapeake 2000 Agreement. As currently demonstrated in limited applications under the Critical Area Protection Act, offsets for the negative impacts of development could be used in a number of media, including forests or stormwater management. This report makes the following recommendations:

### ***Improve implementation of Maryland’s Critical Area Protection Act and use it as a model for broader application within the watershed.***

The Chesapeake Bay Critical Area Protection Act is often criticized for being administratively burdensome, and requiring local planning and zoning agencies to develop, implement, and enforce policies that they are not individually equipped to do. The scope of the Act is rather limited, focusing only on land use within the immediate borders of the Chesapeake Bay and its tributaries. Recognizing the impact of land use beyond this area, the Act or its principles could be extended to other environmentally significant areas. This chapter acknowledges that the goals of the Act extend beyond nutrient management on developed land, although specific to that goal, the State of Maryland (or as suggested in this report, other states within the Chesapeake Bay watershed) could provide more stringent criteria, standardized guidance, and technical resources for limiting nutrient runoff from developed lands. With this authority, the more effective implementation of other recommendations in this report, such as Low Impact Development, may be the more feasible, particularly given that the Critical Area Program has existed for over twenty years.

### ***Expand more broadly the use of the offset provisions as now found within the Critical Area Protection Act.***

This Act currently allows developers to offset or even “pay” for an amount of stormwater runoff created by the new activity, or for the number of trees cut down. The

actual offset for additional stormwater loads created by new development can be determined by estimating the specific nutrient load associated with the development project. To expand this practice, projects could be required to meet a higher standard for controlling runoff than currently required, which would in turn increase the required offset. Further, a developer could also offset its pollution across pollutant sources, for instance by obtaining offsets in the agricultural sector or within a different watershed – although this is currently not allowed under the Critical Area Program stormwater offset. This would help prevent the issue that has arisen with the forestation offset program – that the area (over time) lacks suitable mitigation areas. In addition, developers could be required to offset for other sources of nutrients from developed land, including wastewater.

***Supplement an offset program with the collection of additional development fees.***

As is used in the both the stormwater and forest offsets under the Maryland Critical Area Protection Act, instead of physically implementing an offset, a developer could be allowed to pay a fee instead. This money could be used to implement cost-effective nutrient reductions throughout the watershed. Generally, development fees are a form of private charge, with goals similar to subsidies, tax incentives, or tax penalties, and are meant to influence a certain behavior or development pattern.

#### **Endnotes to Chapter 4**

- <sup>1</sup> Beach, D. 2002. Coastal Sprawl: The Effects of Urban Design on Aquatic Ecosystems in the United States. Pew Oceans Commission, Arlington, Virginia. [http://www.pewtrusts.org/pdf/env\\_pew\\_oceans\\_sprawl.pdf](http://www.pewtrusts.org/pdf/env_pew_oceans_sprawl.pdf)
- <sup>2</sup> Chesapeake Bay Agreement, <http://www.chesapeakebay.net/agreement.htm>
- <sup>3</sup> Bay Journal, March 2005.
- <sup>4</sup> Chesapeake Bay Commission, 2003. "Cost of a Clean Bay." Chesapeake Bay Commission, Annapolis, MD.
- <sup>5</sup> Alliance for the Chesapeake Bay, 1999. "Chesapeake Renewal Project Findings." Submitted to the Chesapeake Bay Agreement Planning Committee of the Chesapeake Bay Program.
- <sup>6</sup> Chesapeake Bay Program, 1998, "Population Estimates and Projections for States, Counties and Modeling Segments within the Chesapeake Bay Watershed"
- <sup>7</sup> Chesapeake Bay Program, 2005. Watershed Profiles, [www.chesapeakebay.net](http://www.chesapeakebay.net). Accessed March – May 2005.
- <sup>8</sup> Chesapeake Bay Program, 2005. Watershed Profiles, [www.chesapeakebay.net](http://www.chesapeakebay.net). Accessed March – May 2005.
- <sup>9</sup> Kolankiewicz, L. and R. Beck. 2000. Weighing Sprawl Factors in Large U.S. Cities. Arlington, VA: Sprawlcity.org. <http://www.sprawlcity.org/studyVA/chesapeake.pdf>
- <sup>10</sup> <http://www.chesapeakebay.net/pubs/statustrends/79-data-2002.xls>
- <sup>11</sup> <http://www.chesapeakebay.net/land.htm>
- <sup>12</sup> Chesapeake Bay Program, 1998. "Who pays for Sprawl? The Economic, Social, and Environmental Impacts of Sprawl Development: A Literature Review." April 1998. Chesapeake Bay Program, Annapolis, MD. CBP/TRS 203/98. EPA 903-98-011.
- <sup>13</sup> Beach, D. 2002. Coastal Sprawl: The Effects of Urban Design on Aquatic Ecosystems in the United States. Pew Oceans Commission, Arlington, Virginia.
- <sup>14</sup> Chesapeake Bay Program Science and Technical Advisory Committee. "Chesapeake Futures: Choices for the 21st Century." January 2003. < <http://www.chesapeake.org/stac/futreport.html>>
- <sup>15</sup> <http://www.chesapeakebay.net/status.cfm?sid=79>
- <sup>16</sup> Beach, D. 2002. Coastal Sprawl: The Effects of Urban Design on Aquatic Ecosystems in the United States. Pew Oceans Commission, Arlington, Virginia.
- <sup>17</sup> Maryland Department of the Environment. Maryland Stormwater Design Manual, Effective October 2000.
- <sup>18</sup> Chesapeake Bay Program Science and Technical Advisory Committee. "Chesapeake Futures: Choices for the 21st Century." January 2003. < <http://www.chesapeake.org/stac/futreport.html>>
- <sup>19</sup> Maryland Department of the Environment. Maryland Stormwater Design Manual, Effective October 2000.

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<sup>20</sup> MD Department of Natural Resources, 2003. "Maryland Chesapeake and Atlantic Coastal Bays Critical Area 10% Rule Guidance Manual." Fall 2003. Prepared for Critical Area Commission for the Chesapeake and Atlantic Coastal Bays Prepared by: Center for Watershed Protection 8390 Main Street 2nd Floor Ellicott City, MD 21043 [http://www.dnr.state.md.us/criticalarea/10percent\\_rule.html](http://www.dnr.state.md.us/criticalarea/10percent_rule.html)

<sup>21</sup> Brown, W. and T. Schueler. 1997. The Economics of Stormwater BMPs in the Mid-Atlantic Region. Center for Watershed Protection. Chesapeake Research Consortium. Ellicott City, MD.

<sup>22</sup> Hillyer, S. 2003. An Evaluation of the Maryland Critical Area Program Effects on Conservation of Resource Lands and Patterns of Development. Published by the Abell Foundation. [http://www.abell.org/pubsitems/env\\_critical.area\\_1203.pdf](http://www.abell.org/pubsitems/env_critical.area_1203.pdf)

<sup>23</sup> Batchelder, T. Undated. "Guidance: Information and Analyses for Critical Area Decision Makers: Forest Mitigation." Maryland Department of Natural Resources Critical Area Commission. <http://www.dnr.state.md.us/criticalarea/giaca.html>

<sup>24</sup> Chesapeake Bay Local Assistance Department , HJR 622 Study: Chesapeake Bay Preservation Act – Expansion. For submission to the Joint Legislative Audit and Review Commission, November 2001. <http://www.cblad.virginia.gov/docs/Expanstudy/Expancomb.pdf>



## **CHAPTER 5 – STORMWATER NITROGEN REDUCTIONS BY LOW IMPACT DEVELOPMENT**

Managing stormwater runoff is among the least studied means of reducing nutrients to the Chesapeake Bay. Estimates vary, but urban stormwater contributes approximately 11 to 21 percent (25 to 48 million pounds annually) of the nitrogen<sup>1</sup> pollution and 16 percent to 26 percent (3 million to 5 million pounds annually) of the phosphorous<sup>2</sup> that reaches the Bay. While annual nutrient loadings have been falling in most other management sectors, nutrient loadings from urban stormwater have been rising in recent years. These trends threaten to continue with increases in watershed population and development, as discussed in Chapter 4.

Recent studies of the Chesapeake Bay mainly treat development strategies to mitigate nutrient loadings from urban runoff as impractical. Often this approach stems from a lack of information about and a misunderstanding of innovative stormwater management techniques. The Chesapeake Bay Commission's "Cost-Effective Strategies for the Bay" states that attempts to reduce nutrient loadings from development "are not the best place to spend public money to get timely and efficient results to benefit the Bay."<sup>3</sup> As this chapter suggests, the Commission's conclusion is misleading. Indeed, recent understanding of land use and technology indicates that stormwater controls may offer some of the most promising and cost-effective means of limiting future nutrient flows into the Bay.

Three prevailing myths inhibit wider recognition of the potential for stormwater management in reducing nutrient flows to the Bay:

- Stormwater management is too expensive.
- Stormwater management takes too long to implement.
- Controlling stormwater will have relatively little impact on Bay nutrient levels.

EPA's economic analysis of tributary strategies assembles per acre costs for additional stormwater quality improvements needed to meet tributary goals. Based on six modeling studies, the report estimates average annual costs to achieve water quality goals from new development. The models also estimate retrofit costs generally to be \$150-\$450 per acre (in 2001 dollars).<sup>4</sup> This translates roughly to \$30-\$190 per pound of total nitrogen reduced (again, in 2001 dollars).<sup>5</sup> The same analysis estimates urban retrofits will cost \$287-\$1,164 per acre, translating to \$24-\$97 per pound of nitrogen reduced. Even at the lower estimates, both new development and retrofit costs for traditional technologies compare unfavorably to estimates for many agricultural BMPs and most of the needed wastewater treatment plant upgrades. EPA estimates the cost per household in 2010 to range from \$12 to \$85, depending on the extent of the retrofits.<sup>6</sup> The Chesapeake Bay Commission's "Cost-Effective Strategies for the Bay" also provides high, although vague, estimates of the cost of urban stormwater management at many hundreds of dollars per pound of nitrogen removed, considerably more than other suggested alternatives and thus not a cost-effective approach.

This chapter shows that such estimates are often based on misconceptions and that innovative stormwater management technologies can frequently be utilized in a cost-effective manner.

### **Overview of Urban Stormwater**

Urban stormwater is runoff from the built environment resulting from a precipitation event. In the absence of built surfaces, stormwater is recharged into the ground through pervious surfaces, collected in wetlands and streams, and absorbed by

vegetation. Urban environments characteristically have more impervious surfaces, where built infrastructure prevents stormwater from being absorbed on site. To compensate for this lack of absorptive capacity at individual sites, traditional stormwater management requires a series of conveyance mechanisms to quickly channel stormwater away from buildings and roads. The water is ultimately discharged into a receiving water body, typically without any treatment, except in the case of combined sewer collection systems.

The goal of traditional stormwater management has been to move water as quickly as possible. Most municipal conveyance systems are built with this goal in mind. Only recently have more localities and states begun to consider other important aspects of stormwater management, such as reducing peak flow rates and improving water quality of runoff. In order to reduce nutrient loadings to the Bay from urban stormwater, suitable BMPs for individual sites must be employed. These generally come under the rubric of "low impact development."

### **Why do we care?**

Stormwater may seem relatively harmless but it carries with it a variety of nutrients, trash, and toxics that have been deposited on the ground. Improperly managed stormwater can also lead to increased erosion and sediment loads to the Bay. Nutrient loadings are only one aspect of the urban stormwater problem. Nationwide, EPA estimates that urban stormwater is the second most significant pollutant source for estuaries and bays, following after agriculture.<sup>7</sup>

Nutrients in stormwater runoff come from a variety of sources, some of the most significant being atmospheric deposition of nitrogen, non-agricultural nutrient applications such as fertilization of suburban lawns, and pet and feral animal waste. Specific contributions from each pollutant source for the Chesapeake Bay are not well established in the literature. However, atmospheric deposition and non-agricultural fertilizer application are assumed to be the primary sources for most urban areas.

As the previous chapter described, if current development patterns continue, nutrient loadings to the Bay from urban sources is expected to increase. Development in coastal areas across the nation outpaces growth in all other areas of the country. Coastal counties represent 17 percent of the nation's land and yet are home to 50 percent of the nation's people.<sup>8</sup> Development trends for the mid-Atlantic coastlines show an increase in developed land from 22 percent in 1982 to 30 percent in 1997. Assuming a continuation of these trends, the mid-Atlantic coasts would be 60 percent developed by 2025.<sup>9</sup> In the absence of conservation development incentives, these higher population densities along the coast contribute to higher levels of imperviousness.

Most of the scientific literature finds that when the level of imperviousness in a watershed exceeds 10 percent, ecosystem degradation begins to occur. Species disappear while diversity and resilience begin to decline. Some more sensitive ecosystems experience this decline at even lower levels of imperviousness.<sup>10</sup> Of special concern to the Chesapeake Bay are the high human population densities in these coastal areas. Maryland's Western Shore, an area with a geographically important impact on the Chesapeake Bay, experiences tributary-wide imperviousness of 8.5 percent. As this is an average, there are many smaller areas of this basin directly bordering the Bay that have much higher levels of imperviousness, adversely impacting water quality of the Bay.

### **Stormwater Costs**

Cost estimates of BMPs to improve stormwater quality vary considerably, depending on the group creating the estimates. The focus of much stormwater discussion centers on older tried-and-true stormwater BMPs to address runoff and pollutant concentrations. New low impact development and green infrastructure techniques that frequently cost less than traditional BMPs exist, however, and they are often more effective at improving stormwater quality while providing a host of ancillary benefits beyond stormwater



management. Monitoring data on the costs and effectiveness of these water quality BMPs are only beginning to be developed, since most demonstration projects have been in the ground a few years at most. Many Bay reports have shied away from the inclusion of stormwater management as a cost-effective solution because of the uncertainties of these data.

### **New Site Development Solutions**

New ideas and options to manage stormwater on site are catching on throughout the Chesapeake watershed. Low impact development (LID), often called conservation development or environmental site design, is defined as a "new, comprehensive land planning and engineering design approach with a goal of maintaining and enhancing the pre-development hydrologic regime of urban and developing watersheds."<sup>11</sup> Typical LID applications include bioretention, permeable pavements, green roofs, and other techniques to reduce impervious surfaces on a developed site. The types of techniques appropriate for each site depend on the specific hydrology, geographic location, and site use. Many of the technologies are relatively new but several demonstration projects exist.

Where these techniques have been used in large new residential developments, the developers have realized significant cost savings over traditional stormwater management technologies. LID designs are typically superior for improving water quality, improving peak flow attenuations and often, when designed comprehensively, can improve on-site storage capacity.

Most discussions of LID acknowledge the cost savings that can be achieved for new development by designing a sustainable stormwater management system. However, implementation on a large scale has been slow, partly because significant local subdivision control, zoning, and other regulatory hurdles remain. Most studies are reluctant to determine average cost curves on the basis of the small number of developments that have implemented LID. Data are therefore anecdotal, but on nearly every demonstration site, a significant overall cost savings is seen. Often these new techniques are left out of Bay discussions because of this lack of well-established and quantifiable cost projections. However, this reluctance threatens to become a self-fulfilling prophecy – until there is wider acceptance of the potential large gains from LID methods, it will be difficult to put these gains into practice on a wide basis and to include them as an element of tributary strategies.

Better cost data exist at present for individual stormwater BMPs and small-scale demonstration projects. Often these technologies can cost more on a storage volume basis than traditional techniques. This specific cost differential can be misleading, however, when comparing the technologies. Although some of the applications can be more expensive, developers see a cost savings in other areas such as landscaping and, most significantly, in the form of avoided conveyance structures. On new residential sites, detention facilities and conveyance structures to move stormwater represent a large portion of total capital costs. Controlling stormwater at the source and retaining it on site eliminates the need for expensive culverts, pipelines, and other structures. EPA's recent economic analysis for the tributary strategies calculates the net costs of environmental site design as \$0/acre, claiming that these savings offset implementation costs.<sup>12</sup>

### **Demonstration Projects**

Pembroke Woods, a ½ acre lot residential subdivision in Frederick County, Maryland, is one the first residential LID demonstration sites. The developers attempted to reduce and disconnect impervious areas, minimize development impact through site fingerprinting, and mitigate runoff impacts. Approximately 50 percent of the original wooded areas on the site were retained. The site provides volume control for a 2-year storm and peak discharge control for up to a 100-year storm.

The development saw a cost savings in several areas. Two stormwater ponds were eliminated, saving \$200,000; area not used for the ponds allowed for preservation of 2 ½ acres of open space and wetlands. The comprehensive design allowed for two additional lots, adding \$90,000 in value; and converting a portion of the road from urban to rural design using grassed swales and bioretention saved \$60,000 in curb and gutter costs and 17 percent in paving expenses. The homes in Pembroke Woods sold 60 percent faster than in surrounding developments.<sup>13</sup>

Somerset, a residential development in Prince George's County, Maryland, saved a total of \$900,000 or \$4,500 per lot by eliminating ponds and conveyance structures. Instead the developer installed several rain gardens throughout the development. The early, prototype LID site is predicted to have much lower maintenance costs since the rain gardens only need routine landscaping instead of the expensive dam repairs and dredging required for a pond.<sup>14</sup> Compared to the control portions of the subdivision, this LID site had a 40 percent smaller average annual runoff per unit area and a smaller peak flow per unit area.<sup>15</sup>

Mill Creek, a large residential subdivision in Kane County, Illinois, was examined as part of a study to determine specific costs for conservation development, which includes the clustering of houses as well as LID techniques. The site was directly compared to a nearby development under construction at the same time. Mill Creek saved \$3,700 on a per lot basis; 53 percent of the savings came from stormwater management construction costs and 21 percent came from site preparation costs. Savings were seen for topsoil removal, site paving, and stormwater sewer pipes.<sup>16</sup>

Prairie Crossing, a 678-acre subdivision in Grayslake, Illinois, is one of the oldest conservation development demonstration projects. Net saving from innovative site design was \$1,375,000 (\$3,800 per lot or \$2,000 per acre). Stormwater conveyance structures avoided accounted for \$210,000; alternative street edge treatments accounted for \$339,000; and reduced street width accounted for \$178,000.<sup>17</sup>

### **Cost-Effectiveness**

Demonstration projects across the country have repeatedly found similar savings in reduced construction, paving, and grading costs. Some of the stormwater BMPs viewed in isolation may seem more expensive than traditional stormwater management technologies, but savings gained across a site from avoided conveyance structures typically far outweighs the scale of these smaller differences. Conservation development, LID, and, ESD used in conjunction with growth policies are clearly a cost-effective way to mitigate some of the effects of new development on the Chesapeake Bay.

Based on the available data, we can attempt to make some rough back-of-the-envelope calculations for the cost-effectiveness of low impact site design to reduce nitrogen loadings to the Chesapeake and its tributaries. By creating a simple engineering model and making several assumptions, we can come up with some rough idea as to how much these techniques might cost for new development.

First, we assume two 500-acre new residential developments, one conventional (or "business as usual") and the other with basic LID technologies. For the purposes of the estimation we assume that both sites have 40 percent imperviousness (an average for new residential development on ¼ acre lots) and all runoff is assumed to come from these impervious surfaces. Typically, a feature of LID design is to reduce the site imperviousness and, in fact, reduced paving costs are where much of the cost savings lie. However, reducing site imperviousness of the LID development in the model creates a zero runoff reading. While in reality LID can potentially capture 100 percent of runoff, it is not likely the technologies would be designed to this extent in each and every future development. Also, the effectiveness of the LID devices to retain runoff volumes depends on the frequency and volume of rain events. On paper the LID devices may release no runoff, but an actual project could release small amounts of runoff if the biota is saturated. Therefore, an equivalent imperviousness was forced for the purposes of

the model explicitly to err on the side of caution and not oversell the potential of the design strategy. The model assumes a somewhat incomplete implementation of LID strategies, basically replacing curb and gutter infrastructure with swales and rain gardens.

With these caveats, the LID design generates 80 percent less runoff than the conventional design, based on 2004 Ronald Reagan Washington National airport rainfall data. Total nitrogen sequestered by the LID technologies varies among different studies; if we make the conservative assumption that the only way to remove total nitrogen from runoff is to retain stormwater on site, we can say that the LID design prevents 80 percent of total nitrogen (2,000 pounds for a 500 acre development) from leaving the site. Partial implementation of LID could mitigate a minimum of 80 percent of nitrogen loadings from new residential development. For this particular development this translates to 4.1lbs of nitrogen/year removed.

Costs are a bit more complicated and vary based on the type of development strategies employed. However, EPA estimated capital costs for LID and conventional stormwater management for a 7.5-acre development in a 2001 draft report on proposed construction guidelines. The numbers are also necessarily rough but EPA calculates a cost savings of \$8,500 per acre (in 2001 dollars) for "hydrologically functional" management (LID) over conventional stormwater baselines. However, these savings include reduced paving costs not modeled in our reduction estimates. Accounting only for the savings for LID stormwater infrastructure, the development would see a savings of \$5,300/acre. This amounts roughly to a "negative cost-effectiveness" (a project savings) of -\$1300/lb for the first 80 percent of total nitrogen removed. This is a one-time savings in project capital costs but the nutrient benefits would be received annually.

Determining costs for the remaining 20 percent of total nitrogen is much less certain. If a developer fully implements environmental site design, typically the site will have little to no runoff. Reducing the imperviousness of the site saves on paving costs and reduces the quantity of runoff produced. Reducing impervious surfaces would largely mitigate the final 1.1lbs/acre per year of our hypothetical modeled site; however some runoff would still be expected during periods of extended rain events. Based on EPA's estimates, reduced paving costs would involve savings of approximately \$3,250/acre, assuming a 25 percent reduction in driveway surfaces, a 50 percent reduction in impermeable sidewalk surfaces, and a 12 percent reduction in road surfaces. This can be accomplished through minimizing pavement widths, the use of permeable pavements, or clustering design. Clearly the cost-effectiveness of the remaining 1.1lbs/acre would be quite favorable at a savings of almost \$3,000/lb of total nitrogen reduced. However, this component of LID could be challenging to developers as the project may begin to look slightly different than surrounding developments. To date, however, the emphasis on environmental design has been a selling point rather than a deterrent.

In sum, LID designs can, on average, mitigate all but a small fraction of the nitrogen loadings to the Chesapeake Bay from new residential development at zero cost to developers (or in fact often substantial net savings). Assuming LID permitting processes become smoother and the technical knowledge exists in a community, these designs present a cost savings to the developer and the local stormwater authority while mitigating adverse impacts of development on the Bay.

### **Urban Retrofits**

Applying LID methods is easiest and least expensive for new projects where innovative stormwater management can be worked into the initial project design. Solutions for stormwater management on existing developed sites are often more complicated and potentially much more expensive. Urban retrofits vary greatly in cost and each site may have many different needs, depending on current site structures and usage. For urban retrofits, determining a standard cost per pound of nutrients removed across the watershed is nearly impossible. When these calculations are made, they often include a subset of the most expensive retrofits that skew the calculations.

Instead of trying to create a cost per pound figure for nutrients removed from urban retrofits, it may be more fruitful to explore opportunities where stormwater retrofits can be accomplished cheaply. Often these techniques provide a host of benefits beyond nutrient management, including flood reduction, toxics and sediment removal, aesthetic landscaping, energy conservation, water conservation, and urban heat island mitigation (which consequently leads to air quality improvement). Nutrient management is just one small part of the overall stormwater management picture.

Another important consideration for urban retrofits is the desirable timeframe for implementation. The rate at which implementation is expected to take place is critical when determining the costs of urban retrofits. If retrofit installation is expected to occur on a relatively quick time frame of a few years, costs soar. If, however, retrofits are allowed to occur at the rate of ongoing project maintenance and redevelopment, they can often be less expensive than traditional site designs and structures. The original structures will eventually have to be worked and upgraded. In that process, the costs of LID at existing sites may more closely resemble the low costs in brand new projects. Once installed, most technologies provide immediate benefits (although some vegetated technologies may take a year or more to reach their full potential).

A final consideration for retrofit costs is the cost of flood control and combined sewer overflow mitigation, ignoring general water quality improvements. Many cities and counties struggle with funding gaps for traditional stormwater conveyance and treatment systems. The District of Columbia spends over \$1 million annually on repair of trunk sewers alone.<sup>18</sup> The total spending specifically disbursed for stormwater in D.C. ranges from about \$2 million to \$7 million, excluding the much more expensive combined sewer costs of \$12 million to \$86 million annually.<sup>19</sup> Stormwater infrastructure costs can be one of the most significant expenses a municipality faces. By utilizing some of the decentralized and green technologies to manage this burden, government entities can receive greater ancillary benefits, such as landscaping and water quality, from strategies that have to be imposed anyway. Also, because many of these technologies are on site and decentralized, government entities can shift some of this cost to the private sector, alleviating the funding gap for capital projects and maintenance.

Working under the assumption that the urban problem will ultimately need to be addressed, where should we begin? Impervious surfaces currently cover about 9 percent of the Chesapeake Bay watershed. By 2020, this number is expected to rise to 12 percent of the watershed area.<sup>20</sup> Approximately, one third of this area is attributable to rooftops and approximately two-thirds can be attributed to paved surfaces like roads, parking lots, and driveways.<sup>21</sup> If we want to reduce the stormwater impacts on the Chesapeake Bay through retrofitting in a cost-effective manner, it seems that roadways and rooftops would be an excellent place to start the discussion.

## **Roadways**

Paved surfaces, roadways especially, provide an excellent opportunity for urban retrofits. Roadways act as a conduit for stormwater and collect a variety of urban toxics. Most roads need frequent maintenance and replacement. A variety of technologies exist to mitigate these impacts from both local streets and highways. Local streets can benefit from the use of permeable pavers for smaller alleys and parking lots, as well as vegetated curb extensions and reduced street widths for ultra urban areas. Highway reconstruction can include large swales and bioretention facilities. The costs of highway reconstruction are orders of magnitude larger than the cost of the bioretention facilities; therefore these costs could be easily worked into the cost of these massive projects.

## **Demonstration Projects**

The Siskiyou green street in Portland, Oregon, is a good example of retrofitting an existing street using innovative stormwater management techniques. The city added vegetated curb extensions to filter stormwater and reduce total runoff into the city's combined sewer system. Portland's Bureau of Environmental Services claims the project cost \$15,000 and took two weeks to construct.<sup>22</sup> Flow tests for a 25-year storm

equivalent show peak flow reductions of up to 88 percent and total volume reduction of 84 percent.<sup>23</sup>

Two widely noted examples of roadway retrofits are Seattle's Street Edge Alternative (SEA) design and the Viewlands Cascade Installation. Monitoring results of the SEA streets, characterized by open bioswales and narrower paved areas, show reductions in the amount of stormwater leaving the catchment area by 98 percent for a two-year storm.<sup>24</sup> The site has not discharged at all since December 2002. Viewlands has a lower efficiency, capturing an average of half of the runoff from smaller storms and reducing peak flow rates by 60 percent. The Viewlands project attempts to capture stormwater runoff from a much larger area; in essence it is an end-of-pipe technology. Despite Viewland's lower efficiency in terms of volume per unit area, it actually turns out to be the more cost effective of the two installations.<sup>25</sup> The projects are intended to illustrate a choice of different management options, depending on the needs of the site. The SEA street project exceeded the cost of a typical street remodel because of an extensive outreach budget; Seattle expects that future SEA streets will cost less than traditional street improvements.<sup>26</sup> Looking solely at construction costs, the SEA streets cost \$217,300 less than a traditional street with the same drainage area. This translates to a construction savings of \$329 per foot.<sup>27</sup>

### **Rooftops**

Since rooftops account for nearly a third of watershed imperviousness, they cannot be ignored in discussions of runoff mitigation. Many rooftops in the watershed could support a green roof, which is a rooftop with vegetation, a growing medium, and a waterproof layer. Green roofs come in all shapes and varieties and are especially popular in Europe. Roofs typically cost between \$15 and \$20 per square foot, but extend the life of a roof around 20 years because of decreased weatherization.<sup>28</sup> In Europe, where green roof markets exist, relative costs are about \$8 to \$15 per square foot.<sup>29</sup>

Green roof demonstration projects across North America show significant stormwater volume reduction, peak flow reduction, and nutrient capture. A recent study estimated that by greening 6 percent of Toronto's rooftops, the city would see a reduction of stormwater runoff by 1 billion gallons per year.<sup>30</sup>

Chicago's City Hall has a 20,300 square foot semi-extensive green roof as part of the city's initiative to promote green building practices. Roof monitoring indicates the installation retains 75 percent of the volume of a one-inch storm. Chicago has also pursued green roof technologies to mitigate urban heat island effects. The city's monitoring shows green roof temperatures are typically 10-15 degrees Celsius lower than on surrounding rooftops. Also, estimates show the insulating effect of the roof garden provides an energy savings for the building as a whole. The roof contributes to a savings of around 9,272 kilowatt-hours and \$3,600 per year.<sup>31</sup>

### **Policy Recommendations**

Urban retrofits will take time. Therefore, it is critical to accelerate the learning curve and create new markets for stormwater management in the Chesapeake watershed. Many of these techniques were created in the Chesapeake area and local knowledge of how the technologies work is greater than in most other areas of the country. However, the Chesapeake area lags behind some of the more innovative areas for sustainable building in general. Below are five major policy recommendations to encourage innovative stormwater management to achieve nutrient reductions for the Bay.

Urban stormwater runoff is a major contributor to Bay nutrient loadings. These loadings will continue to rise as development increases within the watershed. Low-cost decentralized management could mitigate much of the urban stormwater problem. These solutions can be cheaply implemented at the time of new construction or as part

of major reconstruction projects. Often, the costs of stormwater management can be shifted from the municipality to the developer or landowner.

#### ***Remove regulatory impediments.***

The most important policy action to encourage innovative stormwater management is simply to remove the current regulatory impediments to installation. Often municipalities will have zoning requirements that prevent the implementation of LID techniques. On-site stormwater management can include the redirection of residential downspouts from the municipal sewer system to on-site rain barrels or bioretention areas. Municipal regulations that require downspout connections are an obvious impediment to this practice. Requirements for roadways, driveways, and parking lots are also significant as they can require larger areas of impervious surfaces than typical LID design strategies. Several municipalities across the country have assessed their zoning regulations to remove these specific impediments.

Another critical obstacle to innovative stormwater management is the length of the permitting process for the integrated site designs. Because many of the technologies are innovative, permitting is slow at this point. A designer from the Somerset subdivision claims the permitting process for similar developments would take six to twelve months more than a traditional development.<sup>32</sup> It is unlikely that most developers would be willing to wait an additional year to complete a project, even if they could foresee a cost savings from using the conservation development techniques. Planning departments and municipalities could overcome this obstacle by implementing an expedited permitting process for green development. In April 2005, Chicago introduced the Environmental Agenda: Building the Sustainable City, which highlights the city's commitment to developing a fast-track permitting process for green projects.<sup>33</sup>

#### ***Amend stormwater regulation.***

Stormwater management is already regulated, but often not for water quality results. Each municipality, county, state, and stormwater district has specific regulations for site design. More stringent water quality requirements could be written into stormwater manuals. Since 2000, Maryland has required redevelopment sites to reduce existing imperviousness by 20 percent or provide equivalent water quality treatment. The state's design manual also allows a developer to implement offsite alternatives or pay a fee if the regulation is infeasible at the site.<sup>34</sup> Some regulatory entities go even further to require 100 percent on-site stormwater management. Portland requires most new development to manage stormwater on site, shifting the burden of stormwater management from the municipality to the developer. Requiring 100 percent equivalent management could provide a strong regulatory cap for a potential nutrient trading system throughout the Bay watershed.

#### ***Provide incentives.***

Incentives may be an appropriate expenditure, even for municipalities struggling to upgrade their storm sewer systems. Offering some small incentive can help build the local markets for new technologies and assist homeowners with residential retrofits. Several cities have provided a variety of incentives from free rain barrels to instructional workshops. Chicago offers density bonuses to buildings that feature a green roof and Portland has begun offering a reduction in stormwater utility fees based on site imperviousness.

Another set of incentives would be direct funding for installations. Portland offers this supplemental funding as well. The city's wet weather grant program is funded jointly with EPA and provides \$3 million in grants to stormwater projects focusing on improving water quality.<sup>35</sup>

#### ***Build local markets.***

Along with zoning and monetary incentives, government entities should be creative in their approach to facilitating green development in the region. Requiring on-site stormwater management for new schools and municipal buildings could provide a critical

number of installation projects in the region. Chicago has created "The Chicago Standard," a checklist to guide the design of new municipal buildings. The specific goal was to create a number of demonstration sites and to "build a base of architects and contractors experienced in sustainable design and construction."<sup>36</sup> In 2001 the Chesapeake Executive Council issued a stormwater directive to lead by example on government owned properties; the directive called for the implementation of 60 new stormwater demonstration projects in the Chesapeake watershed.<sup>37</sup> Government entities in the watershed have committed to a good start, but progress is slow and more aggressive action is needed.

#### **Create stormwater utilities.**

Some municipalities in the Chesapeake watershed have already created stormwater utilities to fund and maintain local stormwater systems. The City of Takoma Park, MD, receives approximately \$230,000 annually from local stormwater fees.<sup>38</sup> Single-family homes are billed at a flat rate and commercial units are charged based on the site level of impervious surfaces. These fees are used for maintenance and to provide sediment control on large construction projects.<sup>39</sup> Virginia Beach, Virginia, collects stormwater utility fees along with sewer and water bills to fund BMP inspections and a variety of stormwater education programs. Assessed fees for fiscal year 2003-04 totaled over \$12.7 million.

#### **Employ creative financing.**

Local financing must be as creative as possible to make the best use of allocations. One way to fund partially new projects and retrofits is through "piggybacking." Often the major costs of a stormwater installation are already included in a major construction project (e.g., a road). Adding the stormwater technology may be an incremental cost and worthwhile to include as part of the total project cost. Also, large habitat restoration efforts can provide the ideal circumstances to retrofit some surrounding areas.

Because many LID technologies have ancillary benefits beyond stormwater management, funding can also be secured through other, non-stormwater programs. Chicago funded many of its green roofs through EPA's Urban Heat Island Mitigation Program. Pittsburgh funded a major stream restoration effort that will provide important stormwater benefits through Section 206 of the Water Resources Development Act. The Chesapeake watershed could fund at least some urban retrofits through these types of financing options.

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## **Endnotes to Chapter 5**

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<sup>3</sup> Chesapeake Bay Commission, *Cost-Effective Strategies for the Bay*, December 2004.

<sup>4</sup> Environmental Protection Agency, *Chesapeake Bay Program, Economic Analyses of Nutrient and Sediment Reduction Actions to Restore Chesapeake Bay Water Quality*, September 2003.

<sup>5</sup> Estimates determined by dividing the per acre costs by estimated annual storm pollutant export. A rural estimation was used for the lowest cost, and older urban neighborhood estimations were used for the highest cost. Loadings determined from Schueler, Thomas. "Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs." Metropolitan Washington Council of Governments. July 1987.

<sup>6</sup> Environmental Protection Agency, *Chesapeake Bay Program, Economic Analyses of Nutrient and Sediment Reduction Actions to Restore Chesapeake Bay Water Quality*, September 2003.

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- <sup>20</sup> Envirocast. <http://www.stormcenter.com/envirocast/2003-02-01/envirocast-article1.php>
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<sup>33</sup> City of Chicago, Department of Environment, "Mayor Daley Announces Environmental Agenda," [http://egov.cityofchicago.org/city/webportal/portalContentItemAction.do?BV\\_SessionID=@@@@0706216885.1114313534@@@@&BV\\_EngineID=cccdaddehegmiflcefecelldffhdfgn.0&contentOID=536925479&contentTypeName=COC\\_EDITORIAL&topChannelName=Dept&blockName=Environment%2FI+Want+To&context=dept&channelId=0&programId=0&entityName=Environment&deptMainCategoryOID=](http://egov.cityofchicago.org/city/webportal/portalContentItemAction.do?BV_SessionID=@@@@0706216885.1114313534@@@@&BV_EngineID=cccdaddehegmiflcefecelldffhdfgn.0&contentOID=536925479&contentTypeName=COC_EDITORIAL&topChannelName=Dept&blockName=Environment%2FI+Want+To&context=dept&channelId=0&programId=0&entityName=Environment&deptMainCategoryOID=) (Accessed May 10, 2005).

<sup>34</sup> Maryland Department of the Environment. Maryland Stormwater Design Manual, Effective October 2000.

<sup>35</sup> City of Portland Bureau of Environmental Services, Environmental Assessment: Innovative Wet Weather Program. April 2004.

<sup>36</sup> City of Chicago, Department of Environment, "The Chicago Standard," [http://egov.cityofchicago.org/city/webportal/portalContentItemAction.do?BV\\_SessionID=@@@@1285598079.1114315067@@@@&BV\\_EngineID=ccceaddehegmfmfcfecelldffhdfhg.0&contentOID=536910321&contentTypeName=COC\\_EDITORIAL&topChannelName=Dept&blockName=Environment%2FGreen+Building%2FI+Want+To&context=dept&channelId=0&programId=0&entityName=Environment&deptMainCategoryOID=-536887205](http://egov.cityofchicago.org/city/webportal/portalContentItemAction.do?BV_SessionID=@@@@1285598079.1114315067@@@@&BV_EngineID=ccceaddehegmfmfcfecelldffhdfhg.0&contentOID=536910321&contentTypeName=COC_EDITORIAL&topChannelName=Dept&blockName=Environment%2FGreen+Building%2FI+Want+To&context=dept&channelId=0&programId=0&entityName=Environment&deptMainCategoryOID=-536887205) (Accessed May 10, 2005).

<sup>37</sup> Blankenship, Karl. "Developing a Better Watershed," *Bay Journal*, Vol. 11, No. 10. January-February 2002.

<sup>38</sup> Chesapeake Bay Watershed Blue Ribbon Finance Panel, Background Information for Developed Land and Air Case Studies, August 3, 2004.

<sup>39</sup> City of Takoma Park, Finance Department, "Stormwater Utility: Questions and Answers," <http://207.176.67.2/finance/documents/swques.html> (Accessed April 30, 2005.)



## **CHAPTER 6 – WASTEWATER TREATMENT PLANT UPGRADES**

Point sources have a significant overall impact on nutrient loadings to the Chesapeake Bay. Wastewater treatment plants (WWTPs) and industrial dischargers account for an estimated 21% of the nitrogen loadings and 22% of the phosphorous loadings entering the Bay.<sup>1</sup> These point sources have been the target of many nutrient reduction measures because reducing loadings from point sources is perhaps the easiest way to achieve quantifiable nutrient reductions. Unlike most non-point sources, federal and state governments have clear regulatory authority under the Clean Water Act to set wastewater treatment plant standards and technology requirements.

The centralized nature of the WWTP provides a choke point where nutrients from large urban areas can be treated in one place before effluents enter the Bay. Technologies to reduce both nitrogen and phosphorous during the treatment process are well known and have been decreasing rapidly in cost. Reductions are immediate and concentrations in effluent can be measured at exactly the point where the discharges enter the Bay. From 1995 through 2004, point sources have achieved a 32% reduction in annual loadings of nitrogen delivered to the Bay (26 million pounds annually).<sup>2</sup>

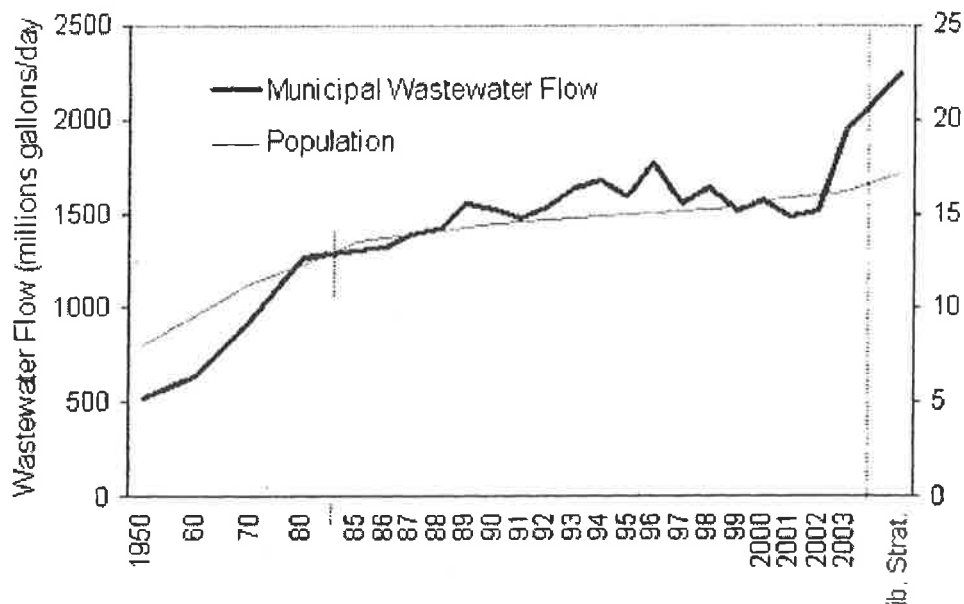
While point sources present a continuing opportunity to reduce nutrient loadings, overall costs of plant upgrades can be quite high. Most troublesome are smaller plants in towns that are not able to fund improvements. Often the municipality lacks the resources to upgrade a plant, or has little motivation to assess a heavy user fee on residents, especially if the perceived benefits are Bay-wide and not predominantly local. Some of these plants are prohibitively expensive to upgrade and would provide little benefit to the Bay. Bay cleanup strategies should stress the need to focus upgrade efforts in a cost-effective manner, while not ignoring local impacts.

Approximately 322 municipal and 68 industrial treatment plants are considered significant because of their size or location; these plants account for 95% of wastewater flows into the Bay.<sup>3</sup> Most strategies have focused most heavily on these plants where the “bang for the buck” is highest. The average (2003) concentration of nitrogen in effluent from WWTPs is 9mg/L<sup>4</sup>. The most recent Bay strategies aim to reduce that number in the future to as close as financially possible to the economically and technically feasible limit of 3mg/L – thus achieving a 66 percent nitrogen reduction – although this varies considerably by tributary and state.

### **A Note on Growth**

An important consideration when planning nutrient reductions for the Chesapeake is to assess moving targets. Municipal wastewater flow is a moving target that grows with the population and development in the watershed. Lower effluent concentrations may not necessarily prevent increases in aggregate nutrient loadings in the future. An increased volume of wastewater could increase nutrient loadings even if concentrations are falling. Therefore, point source strategies should be designed with some flexibility that will allow for the mitigation of future increases in flows. The tributary strategies are designed for loading reductions in 2010; beyond that more aggressive or creative action may be needed.

**FIGURE 6-1. INCREASE IN WASTEWATER FLOW AND POPULATION IN THE CHESAPEAKE WATERSHED**



Source: Chesapeake Bay Program<sup>5</sup>

### Cost to Reduce

The Chesapeake Blue Ribbon Finance Panel estimates \$6 billion is needed to pay for the point source upgrades outlined in the state tributary strategies. Roughly half of these aggregate costs are for the Blue Plains treatment plant and Combined Sewer Overflow (CSO) upgrades for Washington, D.C., area. The panel estimates that, as of May 2004, this represents a Bay-wide funding gap of \$4 billion.<sup>6</sup> Although recent funding increases and appropriations may have alleviated some of this burden, funding gaps are still a significant impediment to upgrading WWTPs in the Bay watershed. It is questionable, however, whether CSO-related measures should be included in the costs of the Bay cleanup. These measures are designed in significant part as elements of the cleanup strategy for the Potomac River, and are required for that purpose under the provisions of the Clean Water Act, independent of any impacts on Chesapeake Bay cleanup.

Another estimate, from EPA's Chesapeake Bay Program, indicates that upgrading all WWTPs to the technologically feasible limit of 3mg/L for total nitrogen effluent would achieve 37% of the required annual reductions of nitrogen Bay-wide. The Program cites total cost estimates of \$4.7 billion to achieve this 40.6 million pound annual reduction. Assuming this figure includes both capital and O&M costs, (which may not necessarily be true) this translates to approximately \$7 per pound of nitrogen reduced.<sup>a</sup> The Program calculates that plants with some form of nutrient reduction technology would be able to make the reductions to the 3mg/L standard for less than \$4 per pound of total nitrogen; plants with no nutrient reduction technology could upgrade at costs less than \$10/lb. The Program also claims that these costs are likely overestimated, possibly by as much as 30%, based on recent engineering studies that show costs for individual plants to be less than expected.<sup>7</sup>

The Chesapeake Bay Commission estimates that these reductions can be undertaken selectively in order to increase overall cost-effectiveness. It would be unduly expensive for all of the point sources in the Bay watershed to improve their effluent streams to the

<sup>a</sup> Assuming 20 years at 2.5% rates.

3mg/L limit. Instead, the Commission claims that most of the nitrogen reduction, 35 million pounds (one third of the total Bay goal from all sources), could be accomplished at a cost of \$8.56 per pound by eliminating the most expensive WWTP upgrades from consideration. The Commission states that they derived this cost by selecting the cheapest reductions and assuming some sort of trading opportunity.<sup>8</sup> Using the Chesapeake Bay Program's total cost estimate of \$4.7 billion, the remaining 5.6 million pounds to achieve Bay reductions would cost a rough average of \$790 per pound – clearly a cost-ineffective expenditure of funds.

## **State Tributary Strategies for Point Sources**

### **Pennsylvania**

According to Pennsylvania's tributary strategy documents, point sources account for 11% of the state's nitrogen loadings and 18% of its phosphorous loadings to the Bay. Pennsylvania will require reductions from "significant sources" – plants with flows larger than 0.4 million gallons per day. Significant sources account for 95% of total point source loadings. Based on 2010 flows, the new effluent concentration standard for point sources will be 8 mg/L for nitrogen and 1 mg/L for phosphorous.

Full implementation of the state tributary strategy would achieve a 3.1 million-pound annual reduction in total point source nitrogen and a 745,000-pound annual reduction in total point source phosphorous. With estimated annualized capital costs of \$24 million and O&M costs of \$9.8 million annually, Pennsylvania's figures point to a per pound reduction of nitrogen of \$11.

Note that these figures combine costs for both nitrogen and phosphorous point source reductions, as most tributary documents report one figure for total point source upgrade costs. In essence, as calculated elsewhere in this report, all the new burden of costs is being assigned to nitrogen. This conservative calculation is primarily useful for pointing out the disparity in costs or, more likely, methodologies between the tributary strategies. This number may be useful when comparing upgrade costs between states, but may be less so when looking at cost-effectiveness figures for non-point source BMPs based strictly on nitrogen reductions.

Pennsylvania's reductions are based on actual flows, not design flows; its tributary strategy claims this compares favorably to smaller concentrations from other states that are based specifically on design flows. Because WWTP in Pennsylvania can more cost-effectively reduce phosphorous than agricultural and other non-point sources, the state has required more phosphorous reductions from point sources in exchange for less stringent nitrogen reductions.

### **Maryland**

Maryland's tributary strategy calls for a 5.14 million-pound annual reduction in WWTP nitrogen loadings and a 0.73 million-pound annual reduction in phosphorous loadings. Overall, point sources account for 26% of Maryland's total nitrogen loads and 20% of the state's total phosphorous loads (for 2002). Maryland's Enhanced Nutrient Removal (ENR) strategy calls for an average annual concentration of 3mg/L for nitrogen for all major plants and 0.3mg/L for total phosphorous. An annual load cap on each plant will be based on 4mg/L total nitrogen and again, 0.3mg/L total phosphorous. Initial estimates indicate the total cost of the upgrades to be approximately \$1.1 billion. Assuming O&M will not be an additional cost, and annualizing over 20 years at a 2.5% rate, Maryland's point source upgrades can be achieved at a cost of \$14 per pound of nutrients reduced. More clarity about how Maryland's O&M costs estimates were included in total cost figures could refine this calculation.

## **West Virginia**

West Virginia tributary goals include a 72%, 2.5 million-pound reduction in point source annual loadings of total nitrogen and an 89%, 850,000-pound reduction in annual total phosphorous loadings. The state estimates the cost for both municipal and industrial upgrades to achieve this objective will be approximately \$120 million in capital costs and \$2.4 million in annual O&M. Using the same 20-year, 2.5% assumption, this translates to a cost of \$3 per pound of nutrients removed. The cost of the upgrades will likely be borne by wastewater ratepayers who will add an estimated \$7-17 per month to the average sewage bill.

## **Funding Strategies**

### **Maryland: Bay Restoration Fund**

In May 2004, Maryland implemented Senate Bill 320, more commonly known as the "flush tax." The wastewater treatment portion of the Fund comes from a \$2.50 per month charge on residential sewer bills. Commercial users are charged based on equivalent dwelling units. This user fee will raise approximately \$60 million annually, which could leverage \$1 billion for upgrades at Maryland's most significant treatment plants.<sup>9</sup> Funds will be targeted to Maryland's 66 major plants; other facilities may be considered based on criteria of cost-effectiveness, readiness to implement, and potential water quality benefits.<sup>10</sup>

### **Virginia: Legislative Appropriation**

In February 2005, the Virginia General Assembly approved a \$50 million appropriation from the state's general fund to upgrade nutrient removal technologies at publicly owned treatment works. The state also created a committee to determine long-term funding sources for nutrient reductions.<sup>11</sup>

### **Pennsylvania: Growing Greener Fund**

Pennsylvania has also attempted to address its funding shortfalls by legislative appropriation to its general environmental and infrastructure program, the Growing Greener Fund. Approximately 10% of Growing Greener grants (\$4 million) are set aside for water and sewage infrastructure.<sup>12</sup> Act 218, passed by the state legislature in 2004, sets aside \$250 million for economic development; \$50 million of these funds are specifically set aside for point source upgrades. Note that the remaining \$150 million is not directly designated for point source upgrades, but point sources can apply for this funding and are expected to be the primary users. In addition, the Growing Greener Bond II Initiative, approved in May 2005, is expected to provide \$80 million over a four-year period.

## **Other Funding Strategies**

*Clean Water State Revolving Loan Fund:* This program is currently one of the most important sources of federal funding for municipal water and wastewater infrastructure. In fiscal year 2002, the fund disbursed \$300 million to Chesapeake Bay states.<sup>13</sup>

*Municipal Bonds:* Municipalities have also used local bonds to fund wastewater treatment plant upgrades. Typically this is combined with some sort of federal assistance. This requires a willingness to take on significant long-term debt.

*Local User Fees:* Local user fees can also be used to assist with funding wastewater plant upgrades. This would be analogous to Maryland's flush tax but at a smaller scale. However, this is only feasible if the cost upgrades are minor or the local utility has a large base from which to draw funds. This option is limited as municipalities with smaller populations may not be able to support significant upgrades.

*Trading Program:* Instead of requiring uniform standards between plants, permitting authorities would allow point sources to purchase offsets to achieve equivalent or improved nutrient reductions. It would also be possible in some cases for trading to occur between point and non-point sources. For example, if an existing urban development is required to offset some part of its nitrogen nutrient loadings from stormwater and sewage, it might be cheapest to purchase the offsets by paying for WWTP upgrades elsewhere in the state or in the Bay region.

### **Combined Sewer Overflows**

The Chesapeake Bay tributary strategies create confusion about stormwater and sewage treatment costs by including expenses for projects not explicitly designed to reduce nutrient loads to the Chesapeake Bay. Rather, many of the costs in the tributary strategies come from baseline activities already required under EPA guidelines, such as combined sewer overflow (CSO) mitigation and current National Pollutant Discharge Elimination System (NPDES) requirements. For instance, the Chesapeake Bay plans include over \$1.2 billion to mitigate CSOs in the District of Columbia. While efforts such as CSO mitigation will ultimately reduce nutrients to the Bay, CSO plans are already required under EPA's Combined Sewer Overflow Control Policy. The most important benefits of D.C.'s costly CSO plan are improved water quality and reduced bacteria in the Anacostia River, the Potomac, and other local waterways. Although cleaner tributaries do lead to a cleaner Bay, including these types of programs as specific costs to Bay cleanup efforts is misleading.

A combined sewer system (CSS) is a stormwater and sewage collection system where both stormwater and sewage travel through many of the same collector pipes on their way to a wastewater treatment plant. In a combined sewer system under normal conditions, both sewage and stormwater runoff receive treatment before being released into local waterways. These systems are typically seen in parts of older urban communities where the land development occurred prior to the 1920s. After that, most local governments built separate conveyance systems for sewage and for stormwater.

Several municipalities within the Chesapeake Bay watershed have at least partially combined sewer systems, most notably Washington, D.C.; Baltimore, MD; Richmond, VA; and several Pennsylvania cities along the Susquehanna. Combined systems pose two major challenges for municipalities. First, they are typically part of aging infrastructure and, if not maintained properly, can begin to fail like all sewer systems. The other critical challenge is that these systems often exceed capacity during periods of rainfall. Development and levels of imperviousness in these CSS cities have increased from the time when many of these systems were originally designed, increasing pressures on capacity. The amount of stormwater runoff entering these systems grows along with this development. Excess stormwater during wet weather events can overload the capacity of the system and cause a combined sewer overflow (CSO). These overflows discharge both stormwater and raw sewage into local rivers and streams. These overflows carry pathogens, floatables, sewage debris, and toxics from industrial dischargers as well as nutrients and sediments. Locally, these overflows occur in the Potomac River, Rock Creek, and the Anacostia River.

While the CSOs are ultimately created by non-point stormwater discharges, the outfalls themselves are considered point source discharges under the Clean Water Act. Each outfall is permitted under the NPDES as part of EPA's 1994 Combined Sewer Overflow Control Policy. This policy requires nine minimum controls for combined sewer systems, including public notification of CSO events and proper maintenance of the system.

Washington, D.C., has been among the most proactive in presenting its CSO control plan to the public. D.C. plans to reduce the volume of CSO discharges by 96% over the span of 40 years without additional federal assistance. The plan is expected to accelerate if D.C. receives expected federal appropriations for the remediation. Total

capital costs for the entire plan are estimated at \$1.3 billion in FY2001 dollars, or \$2.6 billion in inflated dollars at a 40-year implementation.<sup>14</sup>

DC's Water and Sewer Authority estimates the current system creates an average of 2.5 billion gallons of combined sewer and stormwater overflow annually. Mitigating 96% of this estimated flow would prevent a net estimate of 32,000 to 290,000 pounds of total nitrogen from reaching the Bay each year.<sup>b</sup> The primary benefits would be local, but the Bay would see fewer total nitrogen loadings as a result.

Because of the significant costs and extensive planning required for these long-term control plans, progress is slow. Both D.C. and Baltimore have been under a legal consent decree to develop and begin implementation of these control strategies. Baltimore is now planning a \$460 to \$650 million 12-year rehabilitation effort to eliminate both CSOs and sanitary sewer overflows. The city has been less visible than D.C. in publicizing the extent of the problem and possible remedies.

Pennsylvania has faced many problems statewide dealing with its combined sewer systems. Pennsylvania water authority management is particularly fragmented, and until recently, funding to upgrade systems has been difficult to come by. Several recent initiatives at the state level make some amelioration possible but the extent of Pennsylvania's sewage problems indicates that combined sewer cities along the Susquehanna will continue to discharge into the river for the short to medium term.

### **Policy Recommendations**

Wastewater treatment plants and industrial point sources present an obvious opportunity to reduce nutrient pollution in the Chesapeake Bay. Loadings from these sources are easily quantified and monitored, and advanced technologies are readily available to implement. Point sources are one of the largest sources of nutrients to the Bay and to date they have also been the largest contributor of nutrient reductions. There are still available reductions to make in this sector; however, these reductions are becoming increasingly costly. A significant financial investment in the Chesapeake Bay region will be required to achieve remaining planned nutrient reductions. This report makes the following recommendations.

#### ***Enhance funding for cost-effective plant upgrades.***

All municipal and state sources of funding mentioned above should at least be considered in the financing calculus of municipal point source upgrades. The spending of available funds should be prioritized to take account of widely varying cost-effectiveness of WWTP upgrades.

#### ***Implement offset or trading programs for the most expensive upgrades.***

Some upgrades may be too expensive to justify for their nutrient reduction potential alone. In these cases, where upgrades are expensive and nutrient discharges do not provide significant local pollution effects, states should consider offset programs considered to achieve Bay reductions. This could be achieved through a trading system or through direct purchase of a nutrient reducing strategy at an alternate location. For many dischargers, offsets will be an attractive alternative to the enormous capital costs they face. In the aggregate, more nutrient reductions could be achieved at a lower cost by directing some of these efforts to other pollution sectors.

#### ***Seek additional funding sources.***

Municipalities and states should continue to be creative in seeking out funds to continue progress in point source reductions. They should strongly consider initiatives that bring in funds from non-governmental funding sources, such as user fees or development assessments. Existing housing development might be required to purchase

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<sup>b</sup> Assumptions: CSO is 80% stormwater, 20% sewage; Concentration of total nitrogen in urban stormwater is 2mg/L; Concentration of total nitrogen in sewage is 20-85 mg/L; All flows will be treated at the WWTP and released as 4mg/L total nitrogen.



at least partial offsets for its stormwater and sewage flows, some of which might be obtained from WWTPs.

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## Endnotes to Chapter 6

- <sup>1</sup> Chesapeake Bay Program Watershed Model. As displayed in *Saving a National Treasure: Financing the Cleanup of Chesapeake Bay*, a report from the Chesapeake Bay Watershed Blue Ribbon Finance Panel.
- <sup>2</sup> "What's the Status of Point Source Nitrogen Reduction in the Chesapeake Bay Watershed?" January 2004. [http://www.chesapeakebay.net/pubs/waterqualitycriteria/doc-pointsource\\_for\\_tribtools.pdf](http://www.chesapeakebay.net/pubs/waterqualitycriteria/doc-pointsource_for_tribtools.pdf)
- <sup>3</sup> Chesapeake Bay Program Watershed Model. As displayed in *Saving a National Treasure: Financing the Cleanup of Chesapeake Bay*, a report from the Chesapeake Bay Watershed Blue Ribbon Finance Panel.
- <sup>4</sup> Chesapeake Bay Watershed Blue Ribbon Finance Panel, Background Information for Municipal and Industrial Wastewater Treatment. May 5, 2004.
- <sup>5</sup> Chesapeake Bay Program, "Bay Trends and Indicators," <http://www.chesapeakebay.net/status.cfm?sid=133> (Accessed May 10, 2005).
- <sup>6</sup> Chesapeake Bay Watershed Blue Ribbon Finance Panel, *Saving a National Treasure: Financing the Cleanup of the Chesapeake Bay*, Date unknown.
- <sup>7</sup> Chesapeake Bay Program, *What's the Status of Point Source Nitrogen Reduction in the Chesapeake Bay Watershed?* January 2004. [http://www.chesapeakebay.net/pubs/waterqualitycriteria/doc-pointsource\\_for\\_tribtools.pdf](http://www.chesapeakebay.net/pubs/waterqualitycriteria/doc-pointsource_for_tribtools.pdf) (Accessed May 10, 2005).
- <sup>8</sup> Chesapeake Bay Commission. Cost Effective Strategies for the Bay: 6 Smart Investments for Nutrient and Sediment Reduction. December 2004.
- <sup>9</sup> Chesapeake Bay Watershed Blue Ribbon Finance Panel, *Saving a National Treasure: Financing the Cleanup of the Chesapeake Bay*, Date unknown.
- <sup>10</sup> Maryland Department of Environment, *Governor Ehrlich's Bay Restoration Fund*, <http://textonly.mde.state.md.us/assets/document/Bay%20Restoration.pdf> (Accessed May 10, 2005).
- <sup>11</sup> Blankenship, Karl, "General Assembly Highlights for Maryland and Virginia," Bay Journal, May 2005.
- <sup>12</sup> Pennsylvania Department of Environmental Protection. *Pennsylvania's Chesapeake Bay Tributary Strategy*. December 2004.
- <sup>13</sup> Chesapeake Bay Foundation, "U.S. Environmental Protection Agency FY2004 Budget," Fact Sheet. [http://www.cbf.org/site/PageServer?pagename=resources\\_facts\\_epa\\_budget](http://www.cbf.org/site/PageServer?pagename=resources_facts_epa_budget) (Accessed May 17, 2005).
- <sup>14</sup> District of Columbia Water and Sewer Authority, "Combined Sewer Service Area," <http://www.dcwasa.com/about/cip/cso.cfm> (Accessed May 10, 2005)



## **CHAPTER 7 – REDUCING AIRBORNE NITROGEN DEPOSITION**

Although nitrogen is found naturally in the air, during the last century human activities have doubled the annual additions of nitrogen to the atmosphere.<sup>1</sup> Over the past century, atmospheric nitrogen deposition increased such that it now accounts for 20 to 40 percent of the total anthropogenic nitrogen loading to estuarine and coastal waters on the East Coast.<sup>2</sup> As with other such waters, atmospheric deposition of nitrogen contributes significantly to the nutrient problem in the Chesapeake Bay.

Like many elements of the Bay's pollution problem, atmospheric deposition of nitrogen is characterized by scientific uncertainty; complex legal frameworks; lack of political will; and funding issues. Although atmospheric deposition of nitrogen is neither fully understood nor addressed by current policies and programs, it is clearly an important future issue for Bay policymakers.

### **Overview of the Problem**

In 1988, the Environmental Defense Fund (EDF) studied the role of atmospheric transport and deposition of pollutants in the overall decline of coastal ecosystems. The analysis traced 20 to 30 percent of the nitrogen pollution entering the Chesapeake Bay to atmospheric deposition. Despite initial skepticism, subsequent studies yielded similar results.<sup>3</sup> It is now widely accepted that between 25 to 32 percent of the total nitrogen load to the Chesapeake Bay comes from atmospheric deposition.<sup>4</sup> Atmospheric deposition of nitrogen within the Chesapeake watershed is, on average, about 10.3 pounds/acre.<sup>5</sup>

Atmospheric deposition occurs in two forms. Wet deposition is the process by which pollutants are carried to the Earth's surface in rain, snow, and sleet. This form of deposition is relatively easy to measure. Dry deposition is the process by which pollutants fall to the Earth's surface in the absence of precipitation. This form is more difficult to quantify and depends greatly on the characteristics of the underlying lands.

Twenty-five percent of the airborne nitrogen reaching the Chesapeake Bay lands on open water, and thus reaches the Bay directly. The other three-quarters initially lands on the ground, and then washes into streams and then reaches the Bay. However, as discussed in a previous chapter, stormwater flows can be influenced by policy changes. In addition, increasing adoption of LID techniques by developers may result in future reductions in stormwater flows – and thus may also reduce the percent of airborne nitrogen deposition that runs off into the Bay. Moreover, if airborne nitrogen falls on a meadow, forest, or farm, it is often trapped and stored within soils and vegetation and released much more slowly.

### **The Bay's Watershed and Airshed**

The boundaries of the Chesapeake Bay's airshed are defined as the set of locations in the United States from which 70 percent of a particular airborne chemical would drop on the Bay or its watershed.<sup>6</sup> Computer models estimate that the primary nitrogen oxide (NO<sub>x</sub>) airshed for the Chesapeake Bay is approximately 418,000 square miles, roughly six and a half times larger than the Bay's watershed. The Bay's NO<sub>x</sub> airshed extends west to Michigan and south to South Carolina. Figure 8-1 illustrates the relative contribution of nitrogen from different parts of the airshed. The closest states contribute 49 percent of the total nitrate deposition to the Chesapeake Bay. More distant states contribute 27 percent, and those farthest away contribute 24 percent of the total nitrate deposition to the Bay.

**FIGURE 7-1. CONTRIBUTION OF NITRATE DEPOSITION FROM CHESAPEAKE BAY AIRSHED<sup>7</sup>**

Areas of NO<sub>x</sub> Emissions that Contribute Nitrogen Deposition to the Chesapeake Bay and its Watershed



During winter and spring, the prevailing wind direction across much of the Bay watershed is from the west/northwest. These winds carry the many pollutants emitted by power plants in the Ohio Valley. During the summer, the Bay is most impacted by winds out of the south/southwest, bringing pollutants from the urban areas of the Southeast.

#### **Sources of Atmospheric NO<sub>x</sub>**

The largest source of nitrogen deposition to the Chesapeake Bay is cars and trucks. Mobile sources contributed an estimated 39 percent of NO<sub>x</sub> emissions across the total Bay airshed. The burning of fossil fuels by power electric generating units is the second largest source, contributing approximately 27 percent of the nitrogen emissions.

The Chesapeake Bay Program uses air deposition models in conjunction with a Bay water quality and watershed model to estimate the impact of atmospheric nitrogen deposition on water quality. These models indicate that land use and implementation of best management practices play a significant role in determining how much atmospheric nitrogen will actually reach the Bay.<sup>8</sup> The watershed model shows that the forest land surrounding the Chesapeake Bay's watershed can absorb about 76 percent of the atmospheric nitrogen reaching it, while urban areas with high levels of impervious surfaces absorb only about 20 percent – and thus 80 percent of atmospheric nitrogen is carried to the Bay's waters.

#### **The Bay Agreements and Atmospheric Deposition**

The 1987 Bay Agreement called upon signatory states to "quantify the impacts and identify the sources of atmospheric inputs on the Bay system."<sup>9</sup> The 2000 Bay Agreement mandated the states to "assess the effects of airborne nitrogen compounds and chemical contaminants on the Bay ecosystem and help establish reduction goals for these contaminants."<sup>10</sup> However, states have failed to accomplish much in terms of curbing atmospheric nitrogen deposition. This is partly due to gaps in scientific

understanding. Moreover, the politics of atmospheric nitrogen deposition and the fragmented structure of environmental laws and policies further complicate the development of policy solutions. The Clean Air Act largely influences levels of atmospheric deposition of nitrogen, but this law has been shaped and administered in light of air quality considerations. The water quality impacts of airborne pollutants up to now have played little role in the federal or state implementation of the Clean Air Act. Any beneficial reductions in airborne nitrogen reaching the Bay have been largely a byproduct of actions taken for other air quality reasons.

### Clean Air Act

The Clean Air Act (CAA) requires EPA to set national ambient air quality standards (NAAQS) for six criteria pollutants and establish two types of standards. The primary standards set limits to protect public health. The secondary standards set limits to protect other elements of public welfare, including "protection against decreased visibility, damage to animals, crops, vegetation, and buildings."<sup>11</sup> As required by CAA, states develop State Implementation Plans (SIPs) to achieve and maintain NAAQS by limiting the amount of pollutants emitted by sources within their jurisdictions. In the past, EPA mainly focused on the human health consequences of air pollution, largely ignoring impacts on non-human health factors. Thus, the secondary standards were in most cases simply set equal to the primary standards.

One part of the CAA that seeks to control atmospheric deposition of nitrogen is Title IV – Acid Deposition, as incorporated into the 1990 Amendments to the Act. Title IV provisions focus on coal-fired electric utility sources for both SO<sub>2</sub> and NO<sub>x</sub> under the NO<sub>x</sub> reduction strategies of the Acid Rain Program. However, the acid rain regulations primarily focused on sulfur. Unlike mandated sulfur reductions, Congress did not set a cap in the 1990 legislation on NO<sub>x</sub> emissions nor did it require any allowance trading programs. Still, significant reductions in airborne nitrogen under the CAA that will eventually benefit the Bay are gradually being achieved. From the viewpoint of the Chesapeake Bay Program, these will be "costless" reductions in nitrogen loadings.

In 2001, air experts at the Chesapeake Bay Program developed "Clean Air Act NO<sub>x</sub> Scenarios." Of the potential model scenarios for the Bay, two are based on current regulations expected to achieve further NO<sub>x</sub> reductions. Other scenarios modeled hypothetical, aggressive regulatory actions, as well as the potential of including voluntary or incentive-based controls in addition to federal regulations.<sup>12</sup> Figure 7-2 outlines the two likely scenarios.

**FIGURE 7-2. 2001 CLEAN AIR ACT NO<sub>x</sub> SCENARIOS**<sup>13</sup>

**Scenario 1, 2007/2010 Base with NO<sub>x</sub> SIP**

This model run is the Basic 1990 Clean Air Act projected for the year 2010. This scenario includes regulations that have passed.

- 2007 non-utility and area source emissions.
- 2007 mobile source with Tier II tail-pipe standards on light duty vehicles.
- 2010 utility emissions: Title IV (Acid Rain Program) fully implemented; the 20-state NO<sub>x</sub> SIP call reductions.

**Scenario 2, 2020 CAA: With Tier II & Heavy Duty Diesel Regulations**

This model run includes Scenario 1, PLUS new heavy-duty diesel regulations.

- 2020 non-utility and area source emissions (no additional controls).
- 2020 mobile source with Tier II tail pipe standards on light duty vehicles (which are now more effective), and heavy-duty diesel standards to further reduce NO<sub>x</sub> emissions.
- 2020 utility emissions described in Scenario 1.

Each scenario for controlling NO<sub>x</sub> air emissions was based on 2000 land uses, fertilizer applications, point sources, septic sources, and BMP implementation. The purpose of creating these scenarios was to assess the impacts of the current targets and timetables for CAA implementation in meeting the 2010 Bay water quality objectives. Scenario 1 represents the impact of CAA regulations already scheduled to be implemented before 2010. Scenario Two includes these impacts plus the addition of Tier II and Heavy Duty Diesel Regulations.

Based on the air model runs at that time, and holding all other non-air source controls constant, Scenario 1 was estimated to provide an 11 million pound nitrogen reduction in loadings to the Bay by 2010. By 2020, these two scenarios were estimated to reduce nitrogen loads to the Bay by 18 million pounds.<sup>14</sup>

### **The Ozone Transport Commission**

The Ozone Transport Commission (OTC) was established under the 1990 CAA Amendments (CAAA) to help states in the Northeast and Mid-Atlantic region meet the NAAQS for ground-level ozone – formed from the mixing in the atmosphere of “volatile organic compounds” (VOCs) in combination with nitrogen oxides. The states included Maine, New Hampshire, Vermont, Massachusetts, Connecticut, Rhode Island, New York, New Jersey, Pennsylvania, Maryland, Delaware, the northern counties of Virginia, and the District of Columbia. OTC sought consensus among the states for a coordinated effort to reduce ground-level ozone in the eastern United States. By 1994, all of the OTC states (except Virginia) entered into a “memorandum of understanding” to control NO<sub>x</sub> emissions from regional power plants. Employing a system of emissions trading, OTC agreed to a region-wide cap within the framework of the “OTC NO<sub>x</sub> Budget Program.” This program was in place from 1999 until 2002, when it was replaced by the “NO<sub>x</sub> SIP Call.”

### **NO<sub>x</sub> SIP Call/NO<sub>x</sub> Budget Trading Program**

In 1998, EPA determined that SIPs in 22 eastern states and the District of Columbia were not sufficient to prevent elevated ozone and NO<sub>x</sub> levels in downwind states. EPA found that upwind sources of NO<sub>x</sub> in the Midwest and South contributed significantly to downwind noncompliance with ozone NAAQS in areas such as the Chesapeake Bay watershed, triggering the upwind state’s duty to amend each state’s implementation plan to address the NO<sub>x</sub> emissions. Under Section 110 of CAAA, EPA in 1998 required these states to establish additional nitrogen emission reduction requirements in a rulemaking known as the “NO<sub>x</sub> SIP Call.” Under court revision, EPA required 19 states and the District of Columbia to submit revisions to their SIPs with specific strategies for complying with state-level summertime emissions budgets. The NO<sub>x</sub> SIP Call did not mandate which sources must reduce emissions; instead it gave states the flexibility to reduce emissions through various means within a total cap for each state. For the states interested in using a trading scheme to meet the obligations of the NO<sub>x</sub> SIP Call, EPA included a model NO<sub>x</sub> Budget Trading Program (NBP) rule.<sup>15</sup> All the participating states did agree to work within the framework of the “cap and trade” program of the NBP.

Eight northeastern states and the District of Columbia implemented the NBP in 2003. As a result of the NBP, NO<sub>x</sub> emissions have been reduced by more than 30 percent from 2002 levels during peak ozone season. Alabama, Illinois, Indiana, Kentucky, Michigan, North Carolina, Ohio, South Carolina, Tennessee, Virginia, and West Virginia joined the program in 2004. Additional significant reductions are expected in future years. EPA estimates that nationally the NO<sub>x</sub> SIP Call will provide a 22 percent reduction in NO<sub>x</sub> emissions; in the SIP Call region, the program will lead to a 34% reduction in emissions.<sup>16</sup> These reductions will mainly come from coal-fired power plants. Substantial reductions, potentially considerably larger than the previous calculation of 11 million pounds per year, thus may be achieved in the levels of airborne nitrogen reaching Chesapeake Bay in the next few years.

### **Clear Skies Initiative**

On February 14, 2002, President Bush proposed the Clear Skies Initiative, a mandatory program to control NO<sub>x</sub> and other air pollutants from the electricity generation sector. Clear Skies would cap the total amount of pollution allowed from the nation's electricity producing power plants. Individual plants could either install new pollution control technology, or purchase credits from those that exceed their pollution control goals. Under the Clear Skies Initiative, Maryland sources would achieve an estimated 79 percent reduction in their emissions of NO<sub>x</sub> by 2020.

According to the design, Clear Skies would bring all remaining non-attainment counties into attainment with NAAQS by 2020. Based on preliminary model runs assessing the benefits of the Clear Skies initiative, the CBP found that the Initiative provides an additional 8 million pound reduction in the annual nitrogen load to the Bay by 2010, and an additional 10 million pounds by 2020, beyond the controls already in place. Clear Skies, however, has not been passed by Congress.

### **Clean Air Interstate Rule**

On March 10, 2005, EPA issued the Clean Air Interstate Rule (CAIR) by administrative action. The rule reduces emissions of NO<sub>x</sub> in 29 eastern states and the District of Columbia by over 60 percent from 2003 levels through a permanent cap reached in two phases.<sup>17</sup> EPA is currently analyzing CAIR's impacts on the Bay, and is expecting computer-modeling results to be available in Fall 2005. While the benefits to the Bay have yet to be quantified, CAIR is expected to yield significant nitrogen reductions for Bay states.<sup>18</sup>

### **Washington, D.C., and Baltimore, MD, Ozone Non-Attainment Status**

EPA designates the Baltimore metropolitan region and Cecil County as severe ground-level ozone "non-attainment areas." This means that, during the summer, this region fails to meet the federal health-based standard for ground level ozone pollution. The Baltimore metropolitan airshed includes the counties of Anne Arundel, Baltimore, Carroll, Harford, and Howard, plus Baltimore City. EPA also designates the Washington metropolitan region as a severe ground-level ozone non-attainment area. The Washington airshed includes the Maryland counties of Calvert, Charles, Frederick, Montgomery, and Prince George's, as well as the District of Columbia and several Northern Virginia counties. Future CAA-required actions within this region to address the Washington and Baltimore airshed non-attainment status may also have impacts on future levels of airborne nitrogen deposition reaching Chesapeake Bay.

## **Air Policy Alternatives**

Policymakers in the Chesapeake Bay region have thus far generally regarded the levels of atmospheric deposition as a by-product of air quality policy. However, given the growing recognition of the significant impacts of airborne nitrogen on Bay water quality, they should consider atmospheric deposition in the future formulation of national and regional air quality requirements. There are various steps that might be taken in air policymaking to reduce the future levels of airborne nitrogen within the Bay watershed.

### ***Formulate new CAA secondary standards.***

EPA's efforts to meet the primary standards of the Clean Air Act, which protect against adverse human health effects, have sustained and achieved many successes over the years. These NAAQS were set in the 1970s, and the CAA requires that they be "updated from time to time" and reflect the "latest scientific knowledge." The Act also requires EPA to set secondary ambient air quality standards, which are pollution limits based on non-human-health-related environmental effects, such as damage to property, plants, visibility, etc. EPA has always operated under the assumption that the secondary standards would be met if policies targeted to meet the primary standards were met.

As the case of the Chesapeake Bay shows, however, airborne pollutants may have large environmental impacts that are not directly correlated with human health impacts. Seeking to reduce negative environmental impacts of pollutants solely through enforcement of the primary standards fails to comply with the requirements of the CAA, which directs EPA to set and then take into account appropriate secondary standards as well in developing air quality policies.

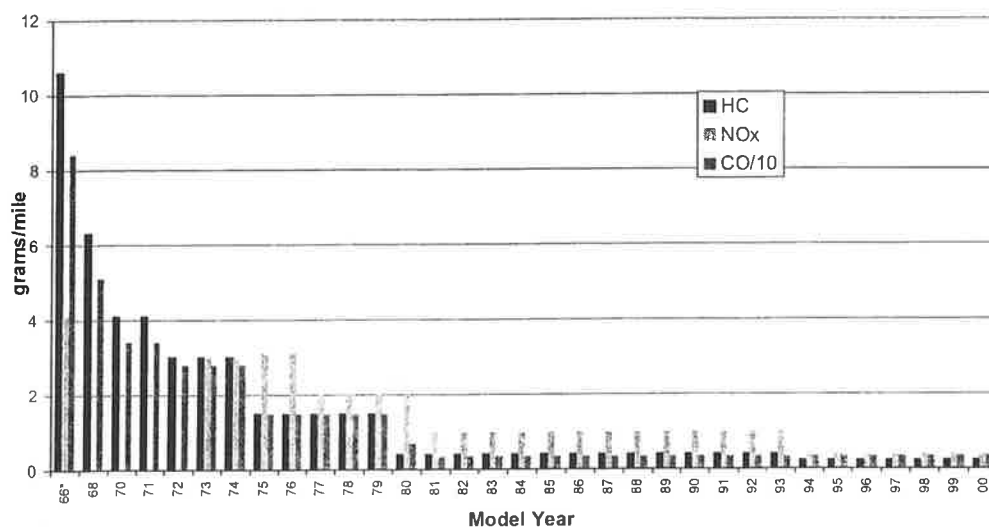
#### ***Provide vehicle incentives.***

The largest source of atmospheric deposition of nitrogen comes from emissions from cars and trucks. According to EPA, NO<sub>x</sub> emissions from vehicles are cheaper to control before they are released into the air. The cost differential is estimated to be about \$2 to \$3 per pound to control at the tailpipe, versus \$150 per pound once it becomes runoff.<sup>19</sup> Therefore, policymakers should also consider water quality impacts in adopting measures that encourage greater fuel efficiency and cleaner technology in future vehicles. There are a host of options to consider: increasing tax cuts for the purchase of hybrid or alternative fuel vehicles; offering subsidies to consumers willing to trade in gas-guzzlers for more energy-efficient vehicles; increasing the vehicle license fee; and improving the quality of public transportation are all possible policy tools to reduce the atmospheric deposition of nitrogen from vehicles that reaches the Chesapeake Bay watershed.

#### ***Establish buy-back and rebate programs.***

EPA studies show that new cars today emit more than 95 percent less pollution for each mile driven than cars in 1970.<sup>20</sup> In 2001, Congress asked the National Research Council (NRC) of the National Academy of Science to determine the most effective option for reducing vehicle emissions. NRC found that, while older and malfunctioning vehicles only account for 10 percent of the vehicles driven in the United States, they emit 50 percent of the pollution from motor vehicles.<sup>21</sup> In fact, the pollution from one poorly maintained vehicle can be equal to that of 25 properly functioning cars.<sup>22</sup> Figure 8-5 illustrates the role that age plays in vehicle emissions of NO<sub>x</sub>. This is also becoming a more significant factor because cars are being driven longer. From the 1970s to the present, the average age of a vehicle on the road has increased from around 5 years to 8 years.

**FIGURE 7-4. VEHICLE AGE AND NOX EMISSIONS.<sup>23</sup>**



Some states have created buy-back programs, which pay citizens to turn in their old heavily polluting cars for cash. The old car is scrapped, and usable parts donated to repair shops or local inspection and maintenance programs. Options for buy-back



programs include paying a flat rate for each car, or estimating a price based on the age of the car. The former may be preferable because it avoids any incentives for either delayed or premature retirement. The biggest obstacle to buying back old cars is the cost – policymakers must find the money to purchase them. However, car buy-backs could be considered in conjunction with required purchases of offsets (see below).

On the West Coast, the retirement concept was introduced by Unocal in 1990, and in seven years led to the scrapping of more than 17,000 high-polluting vehicles from the roads in Southern California and Phoenix, Arizona.<sup>24</sup> Some states have implemented rebate programs, which offer owners a rebate for retiring their old car and purchasing a cleaner vehicle. According to one study, a \$500 million buyback program would have the potential to generate roughly 20 tons of NO<sub>x</sub> reductions per day.<sup>25</sup> In the context of an old vehicle retirement program, it would cost \$1.00 to \$3.50 for every pound of NO<sub>x</sub> reduced.<sup>26</sup>

#### ***Create NO<sub>x</sub> tax.***

Vehicles account for 20 percent of all CO<sub>2</sub> emissions in the United Kingdom. In order to reduce these emissions, the UK government implemented a car tax based on CO<sub>2</sub> emissions known as the Vehicle Excise Duty (VED) in 2001. The tax is structured to encourage the use of fuel-efficient cars that cause less damage to the environment. Implemented on a sliding scale, this tax affects the largest polluters the most, and the least polluting cars the least. For cars registered on or after March 1, 2001, the VED is based upon a calculation of their CO<sub>2</sub> emissions and their fuel type; for those registered before March 2001, the tax is based on engine size. The tax is reduced further for cars that run on alternative fuels. If a similar tax on NO<sub>x</sub> were introduced in the Chesapeake Bay watershed, policymakers would create a price incentive that would send a signal to vehicle manufacturers and consumers about the environmental impacts of the cars they make and use, and encourage the use of more fuel-efficient cars.

#### ***Establish a new car NO<sub>x</sub> offset program.***

Another innovative policy option to reduce vehicle emissions of NO<sub>x</sub> is to require new car buyers seeking to register their cars in the Chesapeake Bay states to purchase an offset for the car's NO<sub>x</sub> emissions. The offset would be determined by estimating the pounds of nitrogen the car will produce that will actually reach the Bay over an average lifetime for that car. Such an offset program would keep the level of car-associated NO<sub>x</sub> reaching the Bay at a constant. It could also be flexible to respond to changes in technology and policies regulating the total nitrogen load to the Bay. This kind of offset program targets new car buyers, who represent a wealthier niche of the car-buying market. Therefore, the equity issues involved in a fee based on annual mileage, or a fee based on total annual NO<sub>x</sub> emissions for all cars, is addressed.

#### ***Institute transportation control measures.***

As air quality non-attainment areas, the D.C. and Baltimore metropolitan regions are eligible to receive special funding to achieve compliance with NAAQS. The Congestion Mitigation and Air Quality Improvement Program (CMAQ) was created after the CAA was enacted in order to fund transportation projects that reduce emissions in non-attainment areas. Projects funded under the CMAQ program must result in tangible reductions in carbon monoxide, ozone precursor emissions (NO<sub>x</sub>), or particulate matter pollution (PM<sub>10</sub>). The Federal Highway Administration and Federal Transit Administration encourage state and local governments to use CMAQ funds for their primary purpose: assisting non-attainment and maintenance areas to reduce transportation-related emissions. To further this goal, transportation activities in approved SIPs and maintenance plans are given the highest priority for CMAQ funding. CMAQ funding stipulates that the transportation improvement must contribute to the specific emission reductions necessary to bring the area into attainment.<sup>27</sup>

Other activities, such as education and outreach programs, may also be eligible for CMAQ funds if they contribute to reductions in mobile source emissions. As non-attainment areas, D.C. and Baltimore are eligible for such funding. Regional

policymakers should explore use of this CMAQ funding to reduce NO<sub>x</sub> emissions from vehicles and improve air quality for people and the Bay.

## **Policy Recommendations**

### ***Implement the Clean Air Act and propose a NO<sub>x</sub> secondary standard.***

The Chesapeake Bay Program should request that EPA comply with the Clean Air Act's requirement for secondary standards, which are pollution limits based on environmental effects such as damage to property, plants, and visibility. Airborne nitrogen has significant impacts on Chesapeake Bay water quality that EPA is legally required to, but in practice has failed to, address in administering the CAA.

### ***Provide automobile retirement and upgrade incentives.***

The largest source of Bay atmospheric deposition of nitrogen comes from car and truck emissions. Therefore policymakers in the Chesapeake Bay watershed should explore the following vehicle nitrogen reduction policies:

- **Buy-Back and Rebate Programs** – Both of these policies retire older, more heavily polluting automobiles. The rebate program offers owners a rebate for retiring their old car and purchasing a cleaner vehicle. Both programs require eligible vehicle criteria – perhaps seeking to retire vehicles manufactured before 1985.
- **NO<sub>x</sub> Tax** – A NO<sub>x</sub> tax modeled after the UK Vehicle Excise Duty on CO<sub>2</sub> would encourage the use of fuel-efficient cars that cause less damage to the environment. The tax could be implemented on a sliding scale. Vehicles for which there is adequate NO<sub>x</sub> emission and fuel type data would be taxed according to this information. For all other vehicles, the tax would be based on the engine size.
- **New Car NO<sub>x</sub> Offset Program** – New vehicles registered in the Chesapeake Bay watershed would be required to purchase an offset for their net contribution of added nitrogen to the Bay. This amount would be calculated based in part on average lifetime NO<sub>x</sub> emissions in pounds for each vehicle, adjusted for the likelihood of nitrogen from a car reaching the waters of the Bay.

### ***Consider further transportation control measures in non-attainment areas.***

Congestion Mitigation and Air Quality Improvement Program (CMAQ) funding should be used to address non-attainment areas in the Chesapeake Bay watershed. Water quality impacts of airborne nitrogen should be taken into account. Measures that should be considered under CMAQ include the following:

- Transit improvements,
- Alternative fuels programs,
- Shared-ride services,
- Traffic flow improvements,
- Demand management strategies,
- Pedestrian and bicycle programs, and
- Inspection and maintenance programs.

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## Endnotes to Chapter 7

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## **Part III – Steps Toward Cost Effectiveness**



## **CHAPTER 8 – INCREASING COST-EFFECTIVENESS THROUGH OFFSETS AND OTHER NUTRIENT TRADING**

The Clean Water Act (CWA) directly regulates point sources, via National Pollution Discharge Elimination System (NPDES) permits, and imposes the burden on these facilities to keep their facilities technologically up to date. Nationwide, the costs associated with upgrading and maintaining waste water treatment plants (WWTPs) is quite large: from 1974 to 1994, local governments and the federal construction grants programs spent close to \$213 billion on either the construction of new or the upgrading of existing plants. Over the next twenty years, it is estimated that another \$330 billion will be necessary to replace and upgrade obsolete wastewater treatment facilities.<sup>1</sup> It is generally accepted that point sources have already implemented the "low-hanging fruit" in upgrade options, and that further upgrades will be both costly and increasingly less cost-effective.

Non-point sources, not regulated under the CWA by permit, are generally accepted as producing the majority of remaining nutrient discharges and of having much lower costs for implementing discharge-lowering measures.<sup>2</sup> This creates the significant potential for shifting planned expenditures from point sources to non-point sources as a way of achieving large reductions in nutrient loads to water bodies at much less additional financial burden. More cost-effective expenditures of CWA funding could thus yield significantly greater water quality benefits than under current rules and policies. This is true in the case of the Chesapeake Bay, like other important water bodies of the nation.

The CWA treats mitigation measures much differently for non-point sources than point sources. Most abatement programs for farms are voluntary, and are funded by agricultural legislation. Subsidies provided by the U.S. Department of Agriculture (USDA) or EPA usually concentrate on conservation reserve or cost-share programs. While farmers can voluntarily choose to apply for cost-sharing subsidies to implement conservation measures or agricultural best management practices (BMPs), few choose to do so<sup>3</sup>. Funding amounts for these programs are not insignificant (USDA has recently spent around \$3.5 billion per year for conservation programs, and EPA about \$800 million per year), yet the sums are far less than those directed to point sources (about \$40 billion per year)<sup>4</sup>. This funding disparity creates the possibility of large reductions in nutrient loads at little or no additional cost to American society.

U.S. water policies need to provide direct funding to the most cost-effective sources of pollution reduction. Unfortunately, they rarely do so. When technology-based permits fail to achieve the water quality standards mandated for waterways, the CWA requires that states implement water quality standard-based permits. States could do this by determining Total Maximum Daily Loads (TMDLs) of pollutants to affected waterways, and then tying permits to these aggregate caps.<sup>5</sup> To date, however, TMDLs have not been assigned to a majority of affected watersheds. The legal authority of EPA and the states in the enforcement of TMDLs is also uncertain.

### **Water Quality Trading**

Water quality trading works in the space between the costs associated with point source upgrades and non-point source conservation measures, often for waterways with TMDLs, but sometimes before TMDLs are implemented. Trading in water quality is a market-driven solution, based loosely on the success of emissions trading systems for air quality. When coupled with regulation (such as NPDES permits and TMDLs), trading allows WWTPs greater flexibility in reaching compliance, and often drives down costs significantly. Trading works as follows:

Each WWTP faces a different cost curve in upgrading its capital equipment to address regulatory compliance measures (for example, decreasing a wastewater treatment

plant's discharge levels from 13 mg/L of total nitrogen to 5 mg/L). Cost curves depend on a variety of factors, including the size, scale, age, and overall efficiency of the plant. Upgrades for Plant A, a large, fairly modern facility, therefore, may cost much less per pound of reduction than for Plant B, a small, fairly old facility. Implementing BMPs for non-point sources may cost even less in terms of dollars per pound for reduction. Faeth (2000) provides a set of sample scenarios to illustrate the two types of trading, "point-point" or "non-point-point":

In a state with an impaired waterway, let us say that the regulatory agencies decide to impose a 1-ppm limit of phosphorus into the waterway, and they decide to allow trading to meet this requirement. Town A has an old sewer plant that is slated for upgrade. Including the additional phosphorus requirement has little cost impact, so the town upgrades, meets requirements, and is then finished. This is standard command and control regulation of a point source.

Then, let us say that Town B recently partially upgraded its sewer plant, and the cost to upgrade the remaining amount would be prohibitively high. However, another point source nearby is able to upgrade its facility enough to cover both the lower discharge limits and those for the town. Town B splits the cost of the upgrade with the other facility, and both realize cost savings for the same amount of overall reduction. This is an example of a "point-point" trade.

Town C has also recently upgraded its sewer plant, so upgrading further would be prohibitively costly. However, an enterprising councilperson finds a group of local farmers willing to implement enough conservation measures to offset the discharge from the town's sewer plant. The town pays for sufficient conservation measures to offset three times as much discharge as needed, partly in order to address the uncertainty inherent to non-point source discharge. Although the town must pay the farmers, the funds are still less than the costs of the upgrade. This is an example of a "non-point-point" trade.

### **Current Legal Environment**

Although EPA first published draft guidance in 1996, "Framework for Watershed Based Trading, states have been the primary drivers of water emissions trading. Colorado began the first pilot water trading program in the mid-eighties (Lake Dillon reservoir), and Michigan also instituted a fairly complex pilot program in the mid-nineties. However, the lack of formal EPA guidance caused legal uncertainty and often a lack of acceptance for trading programs. In 2003, therefore, the EPA issued an official Water Quality Trading Policy. As part of its policy, EPA noted that a recent report (the National Total Cost to Implement TMDLs) found that using more flexible approaches to improving water quality (such as trading) could save \$900 million annually compared to the least flexible approach (EPA, 2001). The policy also clarified several points with regard to implementing a trading system, and suggested several best practices for successful implementation. The guidance suggests that successful nutrient trading programs would need: clear legal authority for trading to occur, defined units of trade, standard protocols for quantifying loads and reductions, compliance assurance, public participation, and periodic program evaluation.<sup>6</sup> The guidance also stated that EPA supports water quality trading, especially as a cost-reducing measure (EPA, 2003).

The EPA policy, however, is solely guidance, not regulation. Several areas remain ambiguous, and it remains up to the states to more fully rationalize and articulate their own water quality trading policies. The Chesapeake Bay Program has also promulgated its own set of principles, developed by a 38 member Nutrient Trading Negotiation Team. Presented and endorsed in March 2001, the team generated six "fundamental principles" for a successful and defensible trading program in the Bay. Most notably, the principles state that trading should not produce water quality effects "locally, downstream, or Bay-wide that violate water quality standards or criteria." They also produced a series of six "key elements" for nutrient trading, similar to the guidance produced by the EPA.<sup>7</sup>



## Bay State Approaches to Nutrient Trading

Several of the Bay watershed states have, in recent years, either passed or are in the draft stages of passing legislation supporting water quality trading.

**Maryland** – In 1997, Maryland produced a draft policy favoring water quality trading, after a study found that nitrogen credit trading could provide an estimated cost savings of \$9 to \$12 million dollars annually for a reduction of 62.5% below 1985 levels, depending on the proposed trading scheme.<sup>8</sup> However, the state failed to develop a final guidance document or trading rules. Trading has been less of a priority for the Ehrlich administration than for the Glendening administration. In May 2004, Governor Ehrlich signed into law the Chesapeake and Atlantic Coastal Bay Restoration Fund. Colloquially known as the "flush tax," this bill imposed a \$2.50 per month surcharge for sewer-system users and an equivalent, \$30 per year surcharge on septic system users. The sewer tax collections are placed in a fund to upgrade the 66 most significant municipal treatment plants in Maryland. The septic charge is split 60/40, with 60 percent used to upgrade failing or failed septic systems, and the other 40 percent to provide cost-share funds for farmers to plant cover crops on their fields. The Bay Restoration Fund provides some much-needed funding for restoration efforts; however, it also takes some of the incentive away from trading markets, as point sources now receive direct subsidies for upgrades, and have less need to trade for more cost-effective measures. Whether the remaining, smaller point sources will look to trading as an option remains to be seen.

**Virginia** – In Virginia, Governor Mark Warner signed into law S1275, the Chesapeake Bay Watershed Nutrient Credit Exchange Program, on March 24, 2005. Under this law, a general permit will be signed on January 1, 2006, to cover the 120 significant nitrogen and phosphorus dischargers in Virginia. These dischargers include utilities, wastewater authorities, and industrial plants.<sup>9</sup> The general permit supersedes individual permits, and provides for an initial watershed allocation of nutrients for each of the Virginia tributaries, as well as a timetable for compliance. Allocating nutrient limits to dischargers is a new concept for Virginia; the state proposed applying discharge caps for nitrogen and phosphorus for the first time in 2004.<sup>10</sup>

The method of allocating credits to tributaries may produce a situation similar to that previously found for new sources of air pollution under trading within the framework of the Clean Air Act (CAA). Wasteload allocations for each discharger are computed by multiplying the flow of discharge from the plant by the concentration of nutrients. Virginia calculates the concentration of nutrients each discharger is allocated in order to meet the state's reduction allocation under their tributary strategy. For the majority of the upper watershed Virginia rivers, this concentration is at or close to the limit of available technology (LOT), between 3 to 4 mg/L for total nitrogen. Virginia is still in the process of determining nutrient concentration allowances for the James and York Rivers; lying near the head of the Bay, concern for these rivers lies mostly with local, rather than Bay, water quality issues.<sup>11</sup>

At the same time, point sources are constrained in the amount they can lower their discharge amount by the limits of available technology. Conceptually, therefore, if all point sources on a tributary already operate at LOT standards and the cap has been reached, no room will be available for a new source, such as an additional housing development, to discharge additional nutrient flows. Similar to non-attainment area requirements under the CAA, the new source could be required to offset the total amount of their discharge, as they will not receive any allocation under the cap, perhaps by paying for the implementation of BMPs.<sup>12</sup>

This framework supports and encourages trading to meet allocation levels, and the law even includes a provision to set up a Nitrogen Credit Exchange to "coordinate and facilitate participation in the Nutrient Credit Exchange by its members."<sup>13</sup> Existing dischargers looking to meet their new wasteload allocations have two options: upgrade their existing capital infrastructure, or trade with another discharger who has over complied. New or upgrading dischargers also have the option to trade with another point source. In addition, however, the legislation allows these new sources to offset the

amount of new discharge via implementing a non-point source BMP. These offsets will be documented in the individual permits underlying the general permit, and the "buyer" is liable for ensuring that the BMP is implemented and effective.<sup>14</sup> The bill also allows permitted entities to pay into a Water Quality Improvement Fund, if credits are unavailable or lost due to reasons outside of the member's control. With this bill, Virginia has firmly embraced the idea of nutrient trading; how the implementation will progress remains to be determined.

**Pennsylvania** – Following the recommendations of the PA Joint Legislative Air and Water Pollution Control and Conservation Committees (2001), Pennsylvania is also in the process of drafting a nutrient trading policy. As part of this process, the Pennsylvania DEP evaluated trading options, and developed a pilot project in the Conestoga watershed, a small tributary of the Susquehanna River.<sup>15</sup> In December 2004, the first pilot program trade was declared complete. During this trade, Pfizer Company provided Lititz Borough with \$80,000 to fund a stream restoration project to reduce nutrient and sediment flow. In return, Pfizer was granted pollution reduction credits, to trade, retire, or use to offset its own discharge.<sup>16</sup> The state is expected to complete a draft policy document providing interim guidance on nutrient and sediment trading in the summer of 2005.<sup>17</sup>

**Other States** – As of April 2004, West Virginia concluded after a policy assessment that no consensus could yet be reached in the state as to whether or not nutrient trading should be encouraged. New York also is not interested in the trading concept at this point, preferring to focus on conservation measures.

As this brief summary of the Chesapeake Bay region suggests, trading is popular with the Chesapeake Bay Program office and the several states, but not yet with all. With the more robust guidance from the EPA and the Bay Program available for the states to use as a reference, states are looking more favorably on trading, although many issues remain.

### **Structural and Institutional Concerns**

For both point sources and non-point sources, an initial policy issue that must be addressed is how to determine the baseline nutrient loading, in order to then determine the amount of reduction gained after a BMP has been applied. Determining a verifiable baseline level enables credit purchasers to confidently buy offsets, and makes it possible for states to show that they are meeting their reduction goals. Two factors are at play here: first, there may be a base level of BMPs (in the case of farms) or of nutrient-reducing technology (for point sources) that may be required according to state legislation. In Maryland, for example, farmers are required to apply cover crops to their fields, and point sources are, also by law, required to be operating at a nitrogen discharge of 8 mg/L. Second, once the legislated base level of reductions has been applied, the discharger in question needs to be able to reliably and verifiably quantify their baseline level of discharge. This is simple for point sources; testing is routinely conducted at the end-of-pipe to determine discharge levels. For farms and other non-point sources, determining the baseline is neither simple nor easy to verify. Policy needs to be set to determine a standard, transparent method by which to calculate baseline credits.

*NutrientNet*, a web-based application, is an estimating tool developed by the World Resources Institute (WRI) as one way to provide transparency and standardization.<sup>18</sup> *NutrientNet* incorporates modeling tools such as the RUSLE (Revised Soil Loss Equation), attenuation and delivery factors from the Chesapeake Bay Program model, and standardized values for fertilizer nitrogen content and crop uptake to calculate baseline nutrient loadings for field, pasture, or livestock production areas. It can also provide estimates of the reductions in nutrient loadings possible by the application of BMPs, as well as the break-even cost per credit of implementing such BMPs. Originally used to calculate phosphorus loadings in the Kalamazoo River watershed in Michigan,

*NutrientNet* has more recently been used for a demonstration project in the Potomac watershed for Maryland, as well as for providing a reverse auction site for a program in Pennsylvania's Conestoga River.

Tools such as *NutrientNet* may help to reduce the discrepancies between baseline loading values if used throughout a watershed, and provide potential market participants with more confidence in the validity of the amount of credits generated by non-point sources. Although non-point source nutrient loadings and reductions are always estimated, and are dependent on the validity of the modeling process used, utilizing this form of standardized calculation tool with generally accepted calculations increases the acceptance factor. Since farmers can also use the tool to compute the potential number of credits they can generate from BMP implementation, as well as calculate their break-even price, it may also lower barriers to farmer acceptance.

Given that baseline estimates for non-point sources remain estimates rather than direct measurements, policymakers need also to address valid concerns about the uncertainty inherent in using models. They can accomplish this by applying discount factors to the calculated baseline estimates or to the calculated reductions. Discount factors are applied to the calculated baseline, reducing the value to a more conservative amount. Four possible discounting factors exist:

### **Trading (or Uncertainty) Ratios**

This factor seeks to discount the uncertainty related with the actual effectiveness of the implemented BMP, e.g., whether the filter strip will actually prevent as many nutrients from reaching the waterway as predicted. In practice, trading ratios operate as follows: a point source would be required to buy 2 pounds of reduction from a non-point source for each pound they actually need in offset (2:1). When setting policy, a standard trading ratio could be established for the state as a whole, with the caveat that if a source has more site-specific information, they should be able to use that knowledge to either reduce the trading ratio or to improve the standard reduction efficiency for their BMP. This allows for guaranteed coverage of the uncertainty, but with the flexibility to improve the equation if better information exists.

Trading ratios can be applied either in terms of pounds reduced or in cost per offset. For instance, the Cherry Creek Basin trading program in Colorado requires point sources to purchase anywhere from 1.3 to 3 pounds of phosphorus reduction from non-point sources (depending on the uncertainty factor) in exchange for every one pound of reduction required by the point source. In North Carolina, the Tar-Pamlico Basin Association includes a 2:1 trading ratio in the cost of offsets. The Tar-Pamlico trading case is somewhat different from other trading schemes in that the point sources (members of the Association) do not each directly pay farmers to implement BMPs. Rather, if the nutrient cap for the watershed is not met by the Association, members purchase offsets by contributing at a set rate to North Carolina's Agricultural Cost-Share Program for Non-point Source Pollution Control. These monies are then used to pay for BMP implementation within the Tar-Pamlico watershed. Members pay at a cost of \$29/kg/yr. This represents the estimated cost of the *least* cost-effective BMP typical to the watershed (\$13/kg/yr), doubled to address the uncertainty factor, and with an additional 10% administrative fee.<sup>19</sup>

### **Spatial Delivery Ratios**

These factors are applied to the baseline estimate to account for the fact that the amount of nutrients reaching a waterway from a source depends greatly on the location of that source within the watershed. These can be divided into two types of discounts: attenuation coefficients and delivery factors. Attenuation coefficients discount the edge-of-field amount according to how far the field lies from its draining waterway, and compensate for the rate at which nutrients are reduced via natural processes such as hydrolysis, oxidation, and biodegradation. Attenuation coefficients are important only

for non-point sources (point sources deliver their discharge directly to the waterway, with no loss by filtration).

Delivery factors discount the amount of nutrients hitting the waterway according to how far that point is from the terminating water body (e.g., for Bay tributaries, the Chesapeake Bay), and are applicable for both point and non-point sources. The CBP program has derived standardized values for both of these factors in their model, with factors for each of the nineteen segments into which they divide the Bay watershed.

For instance, a farm located in St. Mary's County might have an attenuation factor of 0.9868 and a delivery factor of 1.<sup>a</sup> A farm located in Upper Maryland east of Frederick with the same dimensions and crops might have an attenuation factor of 0.9789 and a delivery factor of 0.607.<sup>20</sup> Note the impact of the delivery factor: since St. Mary's County is very close to the Bay, barely any reduction is applied.

### **Retirement Ratios**

Retirement ratios are policy-driven discounts that are used to increase environmental benefits. With a retirement ratio of 1.5:1, for example, a credit purchaser would be required to purchase 1.5 pounds of reduction for each pound needed. The additional 0.5 pounds are then donated to the state or some other entity that will not apply them towards offsetting loads above a cap.

Retirement ratios for water quality trading are similar to the offset ratios required of new sources in non-attainment areas under the 1990 Clean Air Act amendments. For new sources in marginal non-attainment areas, the amendments require that offsets must be purchased in a 1.1:1 ratio, resulting in a net decrease in overall emissions. New sources in severe non-attainment areas face offset ratios of 1.5:1, with an even greater overall reduction.<sup>21</sup>

### **Equivalence Ratios**

These are used when trading between various types of pollutants is allowed. In an example from Minnesota, the Rahr Malting company is allowed to trade one pound of upstream phosphorus reductions for every eight pounds of carbonaceous biochemical oxygen demand (CBOD) that they discharge.

Policymakers should consider codifying discount factors, such as those listed above, to deal with the inherent uncertainty to non-point source estimates. However, it is important to recognize that overly conservative discounting can have a negative effect on credit prices and markets. Strongly discounting credits reduces their value, and will provide a disincentive for trading, as point sources find the amount of credits needed prohibitively high, or farmers find that the prices offered for their credits are prohibitively low. For instance, a trading ratio of 2 or 3:1 could reduce the price point sources are willing to pay for a credit by 50% to 66.6% below the price if the trading ratio was 1:1.<sup>22</sup>

## **Monitoring and Enforcement**

After states establish a policy for estimating baselines and generating credits, they will need to ensure that those reductions are actually implemented. The states must determine a method to verify that traded credits have actually been generated. At least two options are available to states considering implementing a trading program: monitoring "in-house" via traditional methods, such as USDA service center or soil conservation district agents, or by outsourcing to third-party brokers. Both methods have advantages and disadvantages. Using in-house, traditional methods may allow farmers to feel more comfortable with the program, as most farmers maintain a good working relationship with their conservation district agents. Farmers are also

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<sup>a</sup> Note that the baseline loading of nitrogen is calculated as (Nitrogen In (from deposition, fertilizer, irrigation, fixation) - Nitrogen Out (Crop uptake)) \* Attenuation factor \* delivery factor.

accustomed to agents verifying BMP applications on their farms as most EQUIP and Cost-share monies require that a percentage of implemented BMPs be checked annually. Monitoring and enforcing BMP implementations via existing agencies also requires less initial infrastructure outlays, as the agents are already 'on the ground,' as well as allowing the regulating agencies to keep a closer watch on the status and efficacy of trading programs. However, there is already a shortage of agents available to verify BMP implementation: if water quality standards are dependent on BMP implementation, much more thoroughness may be required, and the need for additional agents could grow.

Outsourcing monitoring and verification to third-party agents is also an option. Choosing this option requires state regulatory agencies to devise a method by which they receive reports from these agents. This model has been used in the field of wetlands mitigation banking, where credits are gained by the creation of new wetlands or restoration of degraded wetlands by private entities. Regulatory agencies still reserve the right to perform random inspections of the banks to verify that the created wetlands exist and are ecologically viable, but the burden of monitoring has been shifted to the third-party<sup>23</sup>. Advantages lie in transferring the burden of monitoring and enforcement to the profit-seeking private entity, rather than using limited governmental resources. The burden of paying for third-party agents could even be shifted to the traders, thereby reducing government expenditures. Unless a transparent reporting mechanism is developed for third party agents, however, public confidence in the actual verification may remain low.

### **Liability**

One of the biggest barriers to creating a vibrant market for nutrient trading is the issue of liability. Buyers may be resistant to trading and markets may be slow to develop if buyers are held liable. If a buyer is held liable for failed BMPs, especially due to lack of implementation, there is both little incentive for the farmer to take care in implementing the BMP, and no way for the buyer to estimate the cost of their exposure. As mentioned above, Virginia has sought to minimize risk to the buyer by providing for payment to a Water Quality Fund if hurricanes or other such "acts of God" ruin purchased BMPs.

Another potential option for states is to allow third-party agents to act as brokers, "banking" credits, and holding them liable for credit production. In this scenario, private brokers, rather than the credit buyer, assume the liability for assuring that BMP implementations are successful. This scenario could be beneficial in several ways: first, it provides a true fiscal incentive for the private broker to ensure compliance among its participating credit sources, helping to alleviate some of the concerns expressed above with regards to third-party monitoring. Second, removing liability from the buyer's side could make point sources, and other potential buyers, more willing to participate in trading, secure that they will not be held responsible for failed BMPs. Allowing private parties to operate as brokers or banks for credits may also provide for more successful implementation, especially if the bank is held liable. For instance, in wetlands mitigation banking (where banks are responsible for remediation in the case of wetland failure), banked mitigation may be more ecologically viable and lasting.<sup>24</sup>

### **Transparency and Access to Information**

Participants require access to good information in order to make the most prudent choices possible. The EPA trading policy highlights this, suggesting that information on trading parties, credits generated and traded, market prices, and watershed and trading boundaries should all be publicly available knowledge (EPA, 2003). This has two benefits: first, it allows market participants the greatest possible information, and second, by providing transparency concerning the markets, it allows the public to feel more comfortable with the trading concept. At least two ways exist to facilitate the dissemination of information. Online registry systems, such as *NutrientNet* or any of the newly emerging carbon trading markets (CCx, etc.), provide easy access to fairly real-

time information. An alternative method would be to allow interested parties to form associations that would facilitate information sharing.

Examples of this concept can be found in the Grasslands Area Farmers program (an agricultural group dealing with drainage districts in California) or the Association of point sources in the Tar-Pamlico River in North Carolina. In the case of the Grasslands Area program, farmers participating in the program are organized in districts; monthly meetings between district representatives facilitate trade arrangements. A Regional Drainage Coordinator also acts to facilitate information sharing between the various districts.<sup>25</sup> The Tar-Pamlico Basin Association in North Carolina is a group of sixteen municipal and industrial dischargers in the Tar-Pam basin. These sixteen point sources operate under a TMDL bubble that allows them to perform point-point trades, and easily exchange information.<sup>26</sup>

### **"Social" Concerns**

Although trading may seem to be attractive for point sources facing massive capital costs, some valid concerns do exist. While private facilities may be primarily concerned with cost containment, studies in Wisconsin have found that municipal or public wastewater treatment plants are also motivated by maintaining high local water quality standards (preventing "hotspots") and in doing "what's right" for their community. Similar motivation has also been discussed with regard to the Dillon Reservoir program in Colorado and in the Kalamazoo pilot program.<sup>27</sup> Kramer (2003) also found that municipal plant managers felt concern that buying credits outside of the local area might draw criticism from the surrounding community.

WWTPs might also hesitate from participating in trading schemes due to high transaction costs. Generally, a WWTP will require many more credits to reach compliance than a typical farm produces, necessitating contracts with multiple farmers to assemble enough credits to meet regulations. Rather than maintaining contracts with several farmers, a WWTP may find it easier to simply pay the upfront capital upgrade costs – especially if they are liable for each and every contract. An agency or third-party broker that could "bundle" credits together for facilities may help them to move past this concern. Finally, and especially the case where trading is performed in the absence of a TMDL, WWTPs are justifiably concerned about "anti-backsliding" regulations in the CWA. This is especially true in the case of point-point trading; if a point source upgrades more than needed in order to sell credits, its discharge level is set lower than regulation requires. At some point in the future they may wish to stop generating credits and start using them (after an expansion, for instance). EPA guidance and careful state policy can help to alleviate these concerns.

The concerns for farmers are somewhat different from those for point sources. Although the CWA discusses non-point source water pollution, unlike point sources, agricultural non-point sources have yet to be regulated, either by NPDES permits or under TMDLs. (An exception is for CAFOs over 1000 animals: these farms are treated as if they were a point source and are required to apply for a discharge permit.) Some states do attempt to place certain restrictions on non-point sources; for instance, Maryland requires all farms with incomes of over \$2,500 to develop and file nutrient management plans.<sup>28</sup> However, due to the difficulties in quantifying nutrient runoff as discussed above, direct regulation of non-point sources remains quite difficult to implement.

King and Kuch (2003) note that inviting farmers to trade requires that they admit to being "nutrient polluters"—to which farmers may not be willing to agree. Also, participating in any program that both allows farms to quantify their runoff, as well as demonstrate that they can implement measures to reduce that runoff, brings more scrutiny to farmers.<sup>29</sup> This could potentially bring up the specter of NPDES-style regulation, with the requirements for the farm equivalent of Best Available Control Technology (BACT) – a scenario farmers might argue they cannot afford.

Mitigating these concerns may require careful framing of the issue. Greenhalgh and Sauer (2003) point out that trading allows farmers to maintain their independence: instead of being regulated and required to implement BMPs, farmers can choose the most cost-effective option for themselves. Between the options for cost sharing and the potential revenue from allowance sales, farms may also see an increase in farm income with trading.<sup>30</sup> Also, given the generally accepted premise that non-point sources are responsible for the majority of remaining nutrient pollution, farmers may be wise to act now to address their role in water pollution, rather than wait for potentially more stringent legislation. Finally, farmers may derive additional social benefit from being viewed as part of the solution to Bay problems, rather than a source of them.

### **Policy Issues**

To date, no state has developed its own finalized set of comprehensive trading policies to address the issues discussed above. Before any trading program can move forward, this must be completed. In most cases, as well, trading policy has been discussed only on an intra-tributary basis. Trading across tributaries or even across states has not even received serious discussion among policymakers. In fact, the Chesapeake Bay Program nutrient trading principles specifically suggest that trades should be made only within the major Bay tributaries, and be dependent upon state tributary strategies.

Among the draft state trading policies that do exist, most reinforce the idea of within-state, within-tributary trading. However, states may want to look to the Kyoto protocol as another way of conceptualizing trading. Emissions trading under Article 17 of the Protocol, and joint implementation (Article 6) involve the trading of carbon allocations and reduction units, respectively, not only within but also between nations and even continents.<sup>31</sup> Granted airsheds tend to cover greater areas than watersheds, and the atmosphere goes through more mixing than a typical watershed, so concerns about localized effects are potentially less valid. However, Bay area states may want to study these Kyoto provisions to see if there is applicability to water quality trading across state boundaries within the Bay watershed.

Second, a legitimate concern exists around the idea of hot spots, or localized areas of poor water quality, especially if trades are not spatially controlled within the watershed. The concern may be diminished due to fact that, given the nature of the pollutants, hot spot issues tend to be more associated with phosphorus, whereas the greatest problem in the Bay is associated with nitrogen. To avoid such problems, states may need to develop regulations concerning the number of trades that can occur in one segment of a watershed. States could also avoid this problem by creating water quality "bubbles," similar to those found in the CAA, where attainment levels are set per "bubble," and cannot drop below that level.

Next, trading is still a fairly new concept, and despite the numerous trading pilots and programs scattered around the country,<sup>32</sup> few actual trades have been undertaken. This is partly due to the lack of solid state policy to support trading; however, the uncertainty factor associated with agricultural BMPs is also a significant factor. States could devote, and petition EPA to devote, additional research funding towards better quantification of agricultural drainage, as well as more accurate BMP efficiency ratings.

Beyond the quantification issue, however, states should also concentrate their attentions on the issue of monitoring and enforcement. Given the persistent lack of funding, state agricultural agencies are hard pressed to perform the BMP verification required as part of cost share and EQUIP funding. Before a full-scale trading program can be instituted, the enforcement issue must be addressed to drive public confidence in the program.

Finally, and the subject of much study by Dennis King (2003, 2004), is the concept that current regulatory and legislative priorities are destroying any possibility for a robust market. King and Kuch (2003) summarize the obstacles to a robust market as

problems on the supply side as well as the demand side. Supply-side obstacles are the expanding regulatory and subsidy programs that both require farmers to implement BMPs (reducing supply) and pay them to do it (reducing cost). Demand side obstacles center around point sources desiring to hold non-point sources to the "polluter pays principle" (as agriculture is now the primary polluter in most Bay states), as well as legislative "quick fixes" such as the flush tax that remove the economic incentive to trade.

### **Policy Recommendations**

Nutrient trading for water quality, when done effectively, can provide a cost-effective solution for point sources to meet their cap allowances. However, setting up an effective, reliable, and accurate trading system requires careful attention to many items, both structural and social. Trading in nutrient credits also requires defined policies and a more than parochial viewpoint, in order to avoid problems like hotspots and thin markets. The following recommendations offer some ideas for helping nutrient trading become a cost-effective tool for the Chesapeake Bay.

#### ***Encourage legislation that promotes trading throughout the Chesapeake Bay watershed, and then provide necessary policy guidance.***

Without both authorizing legislation and policy directives that address the numerous uncertainties inherent to estimation, nutrient trading will face resistance from both market participants and the public. This should also include more open communication and intensive education on the trading concept, as well as promoting transparency. Trading is still quite misunderstood outside of the professionals in the field, and in order to win approval from the public, more discussion of the topic, its risks, and the protections available is necessary.

#### ***Increase research funding within the state and national agriculture bureaus to better quantify and calibrate baseline estimations and reduction efficiencies.***

Uncertainty about the actual effect of reductions and the accuracy with which measurements can be made is one of the largest obstacles to gaining acceptance of non-point source trading. Promoting more research on this issue will hopefully increase the accuracy of estimation, with beneficial results for both the watershed and public acceptance.

#### ***Consider establishing a nutrient trading broker system, recognized by the states.***

This broker system should be liable for monitoring, enforcing, and verifying the implementation of BMPs. This would remove the liability from the buyer for ensuring the validity of purchased credits, and would increase market participation. Brokers would purchase reduction credits from farmers in advance of specific buyers, and thus would hold banks of credits available for future sale. Brokers could in this way also potentially bundle credits from multiple non-point sources, thus reducing the burden on potential buyers from entering into multiple contracts.

#### ***Consider establishing a regional nutrient exchange board to promote a Bay-wide view and protect against hot spot and other local issues***

In order to avoid hot spot issues, as well as to perhaps support the idea of cross-tributary or even Bay-wide trading, a regional Board of Nutrient Exchange could allow states to coordinate their trading programs. Program coordination could allow for better targeting of reductions, as well as allow for a better overall view of the watershed, to ensure that no one region is becoming an unfair sink for excessive amounts of discharge through the sale of large numbers of emissions credits to other regions. If trading were opened up to the entire watershed, a regional Board could better orchestrate the reductions.



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## Endnotes to Chapter 8

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- <sup>12</sup> InsideEPA.com "Virginia Nutrient Trading Plan May End Chesapeake Group's Suit." Water Policy Report via InsideEPA.com. Vol: 14, Num 7. April 4, 2005.
- <sup>13</sup> Virginia State Assembly. Chesapeake Bay Watershed Nutrient Credit Exchange Program. S1275. March 24, 2005.
- <sup>14</sup> Ibid., Pollock.
- <sup>15</sup> Wiedeman, A. Nutrient Trading for the Chesapeake Bay. April, 2001.
- <sup>16</sup> Pennsylvania Department of Environmental Protection press release. "DEP Applauds PEC, Pfizer, Lititz Borough for Completing Nutrient Trading Project." December 10, 2004.
- <sup>17</sup> Personal communication, Scott Van de Mark, Pennsylvania Environmental Council.
- <sup>18</sup> For more information on *NutrientNet*, please go to [www.nutrientnet.org](http://www.nutrientnet.org).
- <sup>19</sup> Podar, M. "A Summary of U.S. Effluent Trading and Offset Projects," prepared for the US EPA. November, 1999.
- <sup>20</sup> Attenuation and delivery factors from the Chesapeake Bay model. Calculations performed using *NutrientNet*.
- <sup>21</sup> Salzman, J. and B. Thompson, Jr. *Environmental Law and Policy*. Foundation Press. New York. Pg. 94.
- <sup>22</sup> Ibid., King and Kuch, 2003.
- <sup>23</sup> Shabman, L. and P. Scodari. *Past, Present and Future of Wetlands Credit Sales*. Resources for the Future. Discussion paper 04-48. December 2004. Page 9.
- <sup>24</sup> Zinn, J. *Wetland Mitigation Banking: Status and Prospects*. CRS Report for Congress, 97-849 ENR. 1997.
- <sup>25</sup> Austin, S. *Designing a Non-point Source Selenium Load Trading Program*. Harvard Environmental Law Review, 25(2), pp. 339-403. 2001.
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- <sup>28</sup> Maryland Code Ann., Agric. 8-801.1, 8-803.1(b)(1).
- <sup>29</sup> Kramer, J. Lessons from the Trading Pilots: Applications for Wisconsin Water Quality Trading Policy. Prepared for the Fox-Wolf Watershed Alliance. July, 2003.

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<sup>30</sup> Greenhalgh S. and A. Sauer. *Awakening the Dead Zone: An Investment for Agriculture, Water Quality, and Climate Change*. World Resources Institute. February, 2003.

<sup>31</sup> *Ibid.*, Salzman and Thompson Page 120.

<sup>32</sup> The EPA maintains a comprehensive list of water quality trading programs at <http://www.epa.gov/owow/watershed/trading/tradingactivities.html>. Last updated in 2004, the list contains 24 trading programs. For another comprehensive study of trading programs throughout the US, please see <http://www.dartmouth.edu/~kfv/waterqualitytradingdatabase.pdf>.

## CHAPTER 9 – REDIRECTING FEDERAL AGRICULTURAL ASSISTANCE

Reauthorized approximately every five years, the Farm Security and Rural Investment Act of 2002 (hereafter referred to as the Farm Bill) provides conservation and commodity payments throughout the nation through a variety of programs. Since 2002, the Farm Bill has provided approximately \$15 billion in commodity payments and \$3.3 billion in conservation payments nationwide to U.S. farmers.<sup>1</sup>

This chapter examines the conservation and commodity funding provided to three Chesapeake Bay watershed signatory states – the original states of Maryland, Pennsylvania, and Virginia – to determine how well these Farm Bill funds work to achieve the nutrient reduction goals for the Chesapeake Bay. A review of the programs finds that the conservation programs are poorly targeted to specific nutrient reduction goals and the commodity programs provide support for crops that require high amounts of nutrient application. Several recommendations are made to achieve improvements in coordination, targeting, and flexibility.

### Farm Bill Conservation Funding

The 2002 Farm Bill authorized eleven separate conservation programs for farmers in the United States. Eight of these programs provide funding to states or directly to producers to encourage voluntary conservation practices. Table 9-1 outlines these programs and the funding they provided to three Chesapeake Bay states in FY2005.

**TABLE 9-1. FY2005 FARM BILL CONSERVATION FUNDING FOR CHESAPEAKE BAY STATES<sup>2</sup>**

| CONSERVATION PROGRAM                    | MD FUNDING                | PA FUNDING               | VA FUNDING               |
|---|---------------------------|--------------------------|--------------------------|
| Agricultural Management Assistance      | \$721,808 <sup>a</sup>    | \$1,457,970 <sup>a</sup> | \$0 <sup>a</sup>         |
| Conservation Reserve Program            | \$12,921,606 <sup>a</sup> | \$4,535,928 <sup>a</sup> | \$7,600,072 <sup>a</sup> |
| Conservation Security Program           | \$0 <sup>a</sup>          | n/a                      | \$0 <sup>a</sup>         |
| Environmental Quality Incentive Program | \$7,732,193               | \$12,828,822             | \$13,336,380             |
| Farmland Protection Program             | \$6,049,428               | \$5,337,153              | \$1,702,039              |
| Grassland Reserve Program               | \$165,300                 | \$1,180,000              | \$906,532                |
| Wetlands Reserve Program                | \$754,600                 | \$339,780                | \$494,016                |
| Wildlife Habitat Incentives Program     | \$373,358                 | \$254,562                | \$597,161                |
| <b>Total</b>                            | <b>\$28,718,293</b>       | <b>\$25,934,215</b>      | <b>\$17,036,128</b>      |

Note: <sup>a</sup> Funding for FY2004. n/a indicates that the data were not available.

While all of these programs provide funding to Chesapeake Bay states, few of them target their funding to assist in achieving specific nutrient reduction goals for the Bay. According to the National Resources Conservation Service, existing programs address three areas of conservation: improving conservation practices, retiring working lands, and protecting land from conversion to farmland or developed land.<sup>3</sup>

The **Agricultural Management Assistance (AMA)** program is a voluntary program that provides cost-share assistance to farmers to improve "water management, water quality, and erosion control."<sup>4</sup> Eligible conservation practices include improving water management structures or irrigation structures, planting trees for windbreaks or to improve water quality, and mitigating risk through production diversification or resource conservation practices, such as soil erosion control, integrated pest management, or transitioning to organic farming. In FY2004 AMA provided 33 contracts to farmers in Maryland and 41 contracts to farmers in Pennsylvania. No contracts were awarded in Virginia.<sup>5</sup> Total AMA funding in FY2004 for Maryland was \$721,808, and for Pennsylvania was \$1,457,970.<sup>6</sup> AMA funding for FY2005 is not yet available.

Unlike most Farm Bill conservation programs, the **Conservation Security Program (CSP)** is funded on a watershed basis. The CSP is a voluntary program that rewards farmers who have already made a commitment to conservation. The program provides funding and technical assistance to farmers to improve or maintain their conservation practices, especially those relating to soil and water quality. Eligible soil quality practices include crop rotations, cover crops, tillage practices, prescribed grazing, and providing adequate wind barriers. Eligible water quality practices include conservation tillage, filter strips, terraces, grassed waterways, managed access to water courses, nutrient and pesticide management, prescribed grazing, and irrigation water management.<sup>7</sup> While CSP funding is not directed to nutrient management goals, the kinds of farm practices supported by CSP could potentially be employed for that purpose.

The first CSP grants were distributed to eighteen watersheds in 2004.<sup>8</sup> Of the three watershed states, only Pennsylvania received CSP funding in 2004 for its Raystown watershed. In FY2005, a total of \$202 million was appropriated nationwide for CSP-selected watersheds, and the number of funded watersheds increased to 220. For the first time, watersheds were funded in Maryland and Virginia. In Maryland, the Monocacy and Chester-Sassafras watersheds received CSP funds, while in Virginia, the South Fork Shenandoah, Mattaponi, and Lower Rappahannock watersheds received CSP funding. In FY2005, Pennsylvania also received funding for two additional watersheds: Susquehanna-Swatara and Schuylkill. While the Chesapeake Bay is not a designated watershed under the program, of the eight watersheds funded by CSP, seven are a part of the Chesapeake Bay watershed. Total CSP funding for the three states in FY2005 is not available at this time.

The **Environmental Quality Incentives Program (EQIP)** is a voluntary program that provides farmers with funding to implement structural and non-structural best management practices (BMPs) on their land. For structural BMPs, the program provides "grants of up to 90% of installation costs for beginning or limited-resource farmers, and 75% of installation costs for other farmers."<sup>9</sup> For non-structural BMPs, such as nutrient management, EQIP offers flat rate grants (a fixed dollar amount per acre). To obtain funding for certain practices, farmers must compete on a statewide basis.<sup>10</sup> Farmers enter into contracts for up to ten years to implement conservation practices and cannot receive more than \$450,000 in EQIP funding.<sup>11</sup> EQIP provided a significant amount of funding for the Bay States in FY2005: approximately \$7.7 million for Maryland, \$12.8 million for Pennsylvania, and \$13.3 million for Virginia.<sup>12</sup>

EQIP does not currently target funding specifically for use by farmers in the Chesapeake Bay watershed. The program allows individual states to determine which BMPs will be given priority when allocating funding, and the Bay states might be able to employ EQIP funds for this purpose, if Bay nutrient management were made a priority consideration. In 2000, the Lego group proposed that EQIP funding be increased to \$1-1.5 billion per year, \$100 million of which would be earmarked for use in the Chesapeake Bay watershed for a pilot nutrient trading/credit program.<sup>13</sup> However, this proposal was not adopted in the 2002 Farm Bill.

The **Grassland Reserve Program (GRP)** is a voluntary program "that helps landowners and operators restore and protect grassland, including rangeland, pastureland, and certain other lands, while maintaining the areas as grazing lands."<sup>14</sup>

GRP allows farmers to choose between easements, long-term rental, and cost-share for restoring degraded grasslands.<sup>15</sup> When developing priorities, states establish ranking criteria that prioritize working grasslands, while considering the potential of threats such as cropping, invasive species, and urban development.<sup>16</sup> GRP does not target funding specifically to the Chesapeake Bay watershed for nutrient reduction goals, although this might be possible in the future. In FY2005, GRP provided \$165,300 for Maryland, \$1,180,000 for Pennsylvania, and \$906,532 for Virginia.<sup>17</sup>

Established in 1985, the **Conservation Reserve Program** (CRP) is a voluntary program that provides grants and annual rental payments to farmers if they commit to plant cover crops on a portion of their land for 10-15 years.<sup>18</sup> Farmers apply for CRP funding during sign-up periods by submitting an application to their local FSA office. The program is administered by the FSA, with technical and planning assistance provided by NRCS, state extension services, and local soil and water conservation districts. The Commodity Credit Corporation (CCC) provides funding for the program.<sup>19</sup> FY2004 funding for the CRP program was estimated by using data from the USDA's Economic Research Service on CRP's annual rental, cost share, and incentives payments. According to these estimates, Maryland received \$12,921,606, Pennsylvania received \$4,535,928, and Virginia received \$7,600,072 in CRP funding in FY2004.

In 2000, the USDA Commodity Credit Corporation and the State of Virginia established a **Conservation Reserve Enhancement Program** (CREP) to target CREP funds to the Chesapeake Bay and Southern Rivers watersheds. Under the CREP programs, farmers can apply for 10 to 15 year contracts to create filter strips, riparian buffers, and wetland restoration on their land. The goals of the Chesapeake Bay CREP are to "to assist in protecting the Bay from the impacts of excessive nutrient and sediment loading due to agricultural runoff and assist Virginia in meeting the overall goal of reducing controllable nutrient and sediment loading to the Bay by 40 percent."<sup>20</sup> Nutrient and sediment reduction goals for the Chesapeake Bay CREP include reductions of over 600,000 pounds of nitrogen per year; over 90,000 pounds of phosphorus per year; and over 50,000 tons of sediment per year. Additionally, Virginia hopes to "enroll up to 8,000 acres of eligible lands in permanent conservation easements."<sup>21</sup> Total federal funding for the Chesapeake Bay and Southern Rivers CREPs is expected to total \$68 million over 15 years.

A similar CREP program exists in Pennsylvania to improve the water quality of the Chesapeake Bay. The program was expanded in 2003 to add an additional 100,000 acres in 23 northern tier counties to the 20 southern tier counties in the Shenandoah and Potomac River basins. Pennsylvania's goals for the CREP are to reduce erosion into the Chesapeake Bay by 14,400,000 tons and to prevent 193,000 tons of sediment, 26,000,000 pounds of nitrogen, and 418,000 pounds of phosphorus from reaching the Bay.<sup>22</sup> Additionally, the state would like to enroll up to 200,000 acres in the program. For the 2003 expansion, Pennsylvania received \$129 million from the federal government to establish 10 to 15 year contracts with farmers.

Maryland has a similar CREP program that offers additional incentives to farmers to implement BMPs that improve wildlife habitat and reduce sediment and nutrient loading into the Chesapeake Bay. The goals of Maryland's CREP program are to "enroll 16,000 acres of highly erodible cropland into grass, shrubs, and/or tree plantings, establish 77,000 acres of riparian buffer habitat, provide 5,000 acres of water and wetland habitat, and restore 2,000 acres of habitat for declining species."<sup>23</sup> Farmers receive an annual land rental payment and only pay 50 percent of the costs of implementing the BMPs. Additional cost-share funding is also available from the Maryland Department of Agriculture for practices that significantly benefit water quality. The program is administered by the Farm Service Agency with technical assistance provided by NRCS and other agencies.

Established in 1990, the **Wetlands Reserve Program** (WRP) is a voluntary program that provides farmers with funding to "protect, restore, and enhance wetlands on their property."<sup>24</sup> Farmers can choose between enrolling in a permanent easement, a thirty-

year easement, or a cost-share arrangement with the federal government to re-establish lost or degraded wetland habitats.<sup>25</sup> To apply for the program, farmers can submit an application at any time to their local USDA service center or conservation district office. For FY2005, WRP funding for the three Bay states was \$754,600 for Maryland, \$339,780 for Pennsylvania, and \$494,016 for Virginia.<sup>26</sup> The first Wetlands Reserve Enhancement Program (WREP) was established in June 2004 for the Lower Missouri River.<sup>27</sup> Currently, a similar effort does not exist for the Chesapeake Bay but one could be developed. Wetlands improvements have significant potential for reducing nutrient loads reaching the Bay.

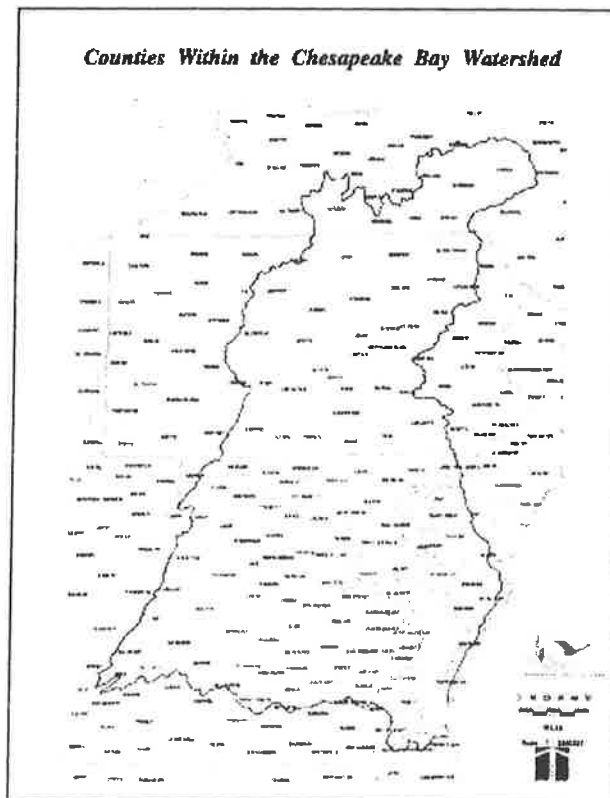
The **Wildlife Habitat and Incentives Program** (WHIP) is a voluntary program that offers farmers technical assistance and cost-share funding to implement a wildlife habitat development plan. WHIP funding for FY2005 is \$373,358 for Maryland, \$254,562 for Pennsylvania, and \$597,161 for Virginia.<sup>28</sup> Currently, funding is not targeted specifically to Chesapeake Bay watershed nutrient reduction goals.

While other conservation programs seek to retire farmland from production, the **Farmland Protection Program** (FPP) is a voluntary program to "to protect farm and ranch lands that contain prime, unique or statewide and locally important soils or historic and archaeological resources from conversion to non-agricultural uses."<sup>29</sup> The USDA partners with state, tribal, and local governments to purchase conservation easements or other interests, and these entities also administer the program. Payment is made at 50 percent of the fair market easement value.<sup>30</sup> The farmers may apply for funding from a State, Tribal, or local government or non-governmental organization during specified sign-up periods. In FY2005, the FPP provided \$6,049,428 for Maryland, \$5,337,153 for Pennsylvania, and \$1,702,039 for Virginia.<sup>31</sup> These are significant levels of funds that could make a noticeable impact but at present funding is not targeted to nutrient reduction goals in the Chesapeake Bay watershed.

### Total Farm Bill Conservation Funding in the Chesapeake Bay Watershed

Calculating how much conservation funding is allocated in Maryland, Pennsylvania, and Virginia provides a rough estimate of the amount of conservation funding available to the Chesapeake Bay watershed. All of the counties in Maryland and a large number of the counties in Pennsylvania and Virginia are included in the Bay watershed (see map).

Nevertheless, rather than statewide totals, a more accurate estimate of the amount of conservation funding spent in the Chesapeake Bay watershed would be to count only conservation funding spent in counties actually located within the watershed. Data from the Economic Research Service of the USDA provides an estimate based on county-level data of the amount of funding provided to watershed counties for five conservation programs (see Table 9-2).



This estimate slightly over-estimates the amount of funding spent in the watershed because it includes funding spent in the entire land area of the county, while some counties only have a limited percentage of their land area within the watershed. The CRP estimates were created by summing CRP annual rental, CRP cost-shares, and CRP incentives.

**TABLE 9-2. CONSERVATION FUNDING SPENT WITHIN CHESAPEAKE BAY WATERSHED, FY2004**

| PROGRAM  | MARYLAND            | PENNSYLVANIA        | VIRGINIA           |
|--|---------------------|---------------------|--------------------|
| Agriculture Management Assistance              | \$40,9456           | \$116,221           | \$0                |
| Conservation Reserve Program                   | \$10,430,963        | \$10,772,885        | \$3,028,026        |
| Grasslands Reserve Program                     | \$2,544             | \$30,841            | \$0                |
| Environmental Quality Incentive Program        | \$1,841,141         | \$2,067,477         | \$1,689,064        |
| Wetlands Reserve Program                       | \$36,146            | \$24,575            | \$0                |
| <b>Total</b>                                   | <b>\$12,351,740</b> | <b>\$13,011,999</b> | <b>\$4,717,090</b> |
| Percentage of Total State Conservation Funding | 100%                | 92.6%               | 61.2%              |

Source: Economic Research Service, USDA

### Farm Bill Commodity Funding

The largest payments in the Farm Bill are made for income supports offered to farmers for specific crops. Income support is provided through three programs: direct payments, counter-cyclical payments, and commodity loans. These payments can have a significant effect on Chesapeake Bay nutrients because they may influence the levels and types of farming practiced within the Chesapeake Bay watershed. Agricultural support programs may end up providing large federal funds to encourage higher levels farming activities that have significant adverse nutrient pollution consequences for the environmental quality of Chesapeake Bay. It is appropriate to examine these support programs and the incentive structures they create with a goal to avoid incentives for activities harmful to Bay water quality.

Direct payments are provided to eligible farmers based on their base acreage and expected crop yields. The formula for direct payments is:

$$DP_{\text{corn}} = (\text{payment rate})_{\text{corn}} \times (\text{payment yield})_{\text{corn}} \times ([\text{Base acres}]_{\text{corn}} \times 0.85)$$

The payment rate is established by the Farm Bill and varies for each crop. The payment yield is also determined by the legislation and is based on the average amount of crops produced by a given farmer.<sup>32</sup> Base acres refer to the amount of acreage eligible for commodity programs.<sup>33</sup> Crops eligible for direct payments include wheat, corn, barley, grain sorghum, oats, upland cotton, rice, soybeans, other oilseeds, and peanuts. Farmers can receive direct payments of up to \$40,000 per crop year.<sup>34</sup> In FY2004, the federal government provided \$1.2 billion in direct payments to U.S. farmers.<sup>35</sup>

Counter-cyclical payments offer income support to farmers during economic downturns. The program functions as a safety net, providing eligible farmers payments whenever the effective price of the commodity is less than its target price. Eligible commodities include wheat, corn, grain sorghum, barley, oats, rice, upland cotton, soybeans, other oilseeds, and peanuts. Farmers can receive counter-cyclical payments of up to \$65,000 per crop year.<sup>36</sup>

Commodity loans are provided to farmers at a specified rate per unit of production. Farmers pledge crop production as collateral for the loans, and eligible crops include wheat, rice, corn, grain sorghum, barley, oats, upland cotton, soybeans, other oilseeds,

peanuts, mohair, wool, honey, small chickpeas, lentils, and dry peas.<sup>37</sup> According to a representative from the USDA's Economic Research Service, only a small number of commodity loans are forgiven, and most are repaid at the loan repayment rate.<sup>38</sup> Table 9-3 shows the total amount of commodity loan payments provided to Chesapeake Bay states in 2004. Virginia farmers led the three states with over \$67 million in loans followed by Pennsylvania (\$18 million), and Maryland (nearly \$15 million).<sup>39</sup> While these numbers may appear to be small, it is important to remember that commodity loans are only one of three commodity programs that provide funding. Additionally, federal agriculture payments are concentrated in a few high-producing states. The U.S. General Accounting Office reported that six states – Illinois, Iowa, Kansas, Minnesota, Nebraska, and Texas – received almost half of the nation's agriculture funding in 1999.<sup>40</sup>

**TABLE 9-3: COMMODITY LOANS TO CHESAPEAKE BAY STATES, CROP YEAR 2004**

| STATE        | COMMODITY LOANS FROM USDA |
|--------------|---------------------------|
| Maryland     | \$14,928,519.98           |
| Pennsylvania | \$18,493,121.47           |
| Virginia     | \$67,549,490.76           |
| Total        | \$100,971,132.21          |

Source: Farm Service Agency, <http://www.fsa.usda.gov/pscad/selectloansummst.asp>

In 2001, Taxpayers for Common Sense (TCS) estimated the amount of Farm Bill commodity payments that would be provided to states under the Senate version of the 2002 Farm Bill.<sup>41</sup> To create the estimates, TCS relied on data from the University of Missouri's Food and Agricultural Policy Research Institute and a database of USDA records assembled by the Environmental Working Group. The average annual commodity payments include "fixed decoupled payments, counter cyclical program payments, loan deficiency payments and marketing loan program benefits for food grains, feed grains, oilseed crops and peanuts."<sup>42</sup> As shown in Table 9-4, the three Chesapeake Bay States were estimated to receive over \$252 million in commodity payments, representing 1.66 percent of total commodity payments, from 2002 to 2006.

**TABLE 9-4: ESTIMATED AVERAGE ANNUAL COMMODITY PAYMENTS TO BAY STATES, 2002-06**

| STATE        | ESTIMATED AVERAGE ANNUAL COMMODITY PAYMENTS | SHARE OF AVERAGE ANNUAL U.S. COMMODITY PAYMENTS RECEIVED |
|--------------|---|--|
| Maryland     | \$65,748,000                                | 0.43%  |
| Pennsylvania | \$80,385,000                                | 0.53%  |
| Virginia     | \$106,353,443                               | 0.70%  |
| Total        | \$252,486,443                               | 1.66%  |

Source: TCS, <http://www.taxpayer.net/agriculture/learnmore/tcsanalysis/farmbillfailures-D.htm>

### Commodity Payments in the Chesapeake Bay Watershed

To determine the amount of commodity payments provided to farmers in the Chesapeake Bay watershed, data on direct and counter-cyclical payments, interest payments, and loan deficiency payments was obtained from USDA's Economic Research Service for all of the counties in Maryland, Pennsylvania, and Virginia within the watershed (see Table 9-5). As with the conservation funding estimate, the commodity payment allocations represent a slight over-estimate due to the fact that only portions of some counties are included in the watershed. The percentage of total state commodity funding for Maryland is 100 percent because all counties in Maryland are included in the watershed.



**TABLE 9-5. COMMODITY FUNDING SPENT IN CHESAPEAKE BAY WATERSHED, FY2004**

|   | <b>MARYLAND</b>        | <b>PENNSYLVANIA</b>    | <b>VIRGINIA</b>        |
|---|------------------------|------------------------|------------------------|
| Direct and Counter-Cyclical Payments        | \$17,953,478.56        | \$18,771,237.95        | \$22,169,828.82        |
| Interest Payments                           | \$2,354.10             | \$13,178.78            | \$3,047.21             |
| Loan Deficiency Payments                    | \$1,213,544.92         | \$337,968.71           | \$472,286.60           |
| <b>Total</b>                                | <b>\$19,169,377.58</b> | <b>\$19,122,385.44</b> | <b>\$22,645,162.63</b> |
| Percentage Of Total State Commodity Funding | 100%                   | 71.5%                  | 65.6%                  |

Source: Economic Research Service, USDA

While commodity payments do not directly address Chesapeake Bay nutrient reduction goals, the eligible commodities represent a challenge to nutrient reduction. Commodity payments favor row crops, such as corn and soybeans, which allow many nutrients to escape as runoff. Researchers from The Institute for Agriculture and Trade Policy and The Minnesota Project find that "the current pattern of large-scale row crop and animal agriculture is contributing to surface water pollution, groundwater pollution, hypoxia zones, increased flooding, depletion of groundwater, air pollution, excessive odors, climate change, , loss of wildlife habitat, degradation of natural ecosystems, loss of pollinators, loss of soil quality and soil erosion."<sup>43</sup> Because of the way row crops are planted, the spaces between the rows allow nutrients to run off the land more rapidly than they would for other crops. This suggests that the structure of farm support payments should be re-examined to reduce the financial incentives for farming that creates greater adverse consequences for the Chesapeake Bay.

### **Policy Recommendations**

A variety of programs under the 2002 Farm Bill provide incentives to farmers in Maryland, Pennsylvania, and Virginia to adopt conservation practices. Many of these conservation practices can decrease nutrient loading and improve water quality in the Chesapeake Bay. However, all the conservation programs are voluntary and, except for CREP programs in Pennsylvania and Virginia, none are targeted specifically to improving the water quality of the Chesapeake Bay.

Moreover, the application process for each of the Farm Bill's conservation programs is different, making it difficult to coordinate efforts across programs. Similar fragmentation exists at the administrative level: FSA administers some programs, while NRCS administers others, and a mix of state and local entities administer the rest.

The largest proportion of funding distributed by the Farm Bill is in the form of commodity payments to support the cultivation of specific crops. Commodity funding is poorly targeted to conservation goals. The funding typically supports the production of crops that require large investments of nutrients and does not reward farmers for reducing nutrient application.

Each of these findings presents opportunities to reform the Farm Bill in ways that help to achieve nutrient reduction goals for the Chesapeake Bay. In order to increase the effectiveness of Farm Bill funding for the Chesapeake Bay, the following areas need to be addressed: coordination, targeting, and flexibility. In order to address the coordination, targeting, and flexibility concerns, policy-makers should consider the option of adopting one or more of the following three recommendations.

#### ***Coordinate better by creating a regional financing authority.***

In 2004, the Chesapeake Bay Watershed Blue Ribbon Finance Panel recommended the creation of a regional financing authority to coordinate and distribute funding "on a regional basis to address critical needs throughout the watershed."<sup>44</sup> As proposed by the Panel, the financing authority would be capitalized by \$12 billion in federal funds, with a \$3 billion contribution from the governments of Delaware, Maryland, New York, Pennsylvania, Virginia, West Virginia, and the District of Columbia. Members of the financing authority would include representatives from the U.S. Environmental Protection

Agency, the six watershed states, the Chesapeake Bay Commission, the advocate community, and stakeholders such as agriculture, wastewater treatment, and business. These members would prioritize projects to fund based on "effectiveness, efficiency and innovation, regardless of geography."<sup>45</sup> The financing authority would also be charged with identifying a sustainable revenue stream for its projects as well as issuing a mix of grants and loans. The creation of a funding authority -- whatever the specific level of funds available to it, and possibly including funds derived from the Farm Bill -- would require the commitment of all the Bay states to share responsibility for funding and priority setting in the watershed.

#### ***Target conservation and commodity payments.***

Both conservation and commodity payments can be targeted better to achieve Chesapeake Bay nutrient reduction goals. Commodity payments could provide incentives for farmers to switch to crops that require a lower application of nitrogen and phosphorous. Commodity payments also could provide farmers with incentives and crop insurance to reduce nutrient application on their crops. The Working Lands Yield Reserve Program was proposed by the Lego Group as a pilot program to target nutrient application during corn production. The Lego Group is a policy-level group of non-federal Chesapeake Bay partners that is chaired by the Chesapeake Bay Commission. The program would pay farmers to apply only 75-85 percent of the nutrients recommended per acre in a nutrient management plan and provide crop insurance to cover any reductions in yield. The four-year program would enroll 25,000 acres in year one and 250,000 acres in year two, with a cost-share of \$40 per acre. Yield insurance would be provided at \$10 per acre. Total program costs are estimated at \$95.75 million, with \$71 million for incentive payments, \$22.75 million for insurance premiums, and \$1 million for promotion and education, and \$1 million for monitoring and evaluation.<sup>46</sup>

Conservation payments could be awarded more efficiently based on a bidding process. In this process, farmers would select their preferred best management practice (BMP) and have the cost per pound of reductions calculated for their BMP. Farmers could then be ranked according to the efficiency and effectiveness of their BMP in achieving Chesapeake Bay water quality goals. The farmers with the most efficient and effective BMP proposals would be awarded conservation payments.<sup>47</sup>

#### ***Increase flexibility by creating a Chesapeake Bay Farm Bill Block Grant.***

If a financing authority has been approved and implemented, there would be a structure by which funding could be coordinated and distributed to priority projects. If federal funding remains rooted in categorical programs, each with its own separate eligibility guidelines, the financing authority will be unable to direct federal funding to priority projects. Block granting federal funding and tying its distribution to the achievement of specific nutrient reduction goals will grant the financing authority the flexibility it needs, while still requiring the authority to be accountable to the federal government for achieving nutrient reduction goals.

According to USDA officials, no authority currently exists for block granting funds in the 2002 Farm Bill.<sup>48</sup> In 2004, the staff of the Blue Ribbon Finance Panel proposed aggregating "Chesapeake Bay watershed or state block-grants for packages of USDA conservation programs targeted to Bay nutrient goals."<sup>49</sup> In the next reauthorization of the Farm Bill, the Chesapeake Bay states should lobby for authority to create a Chesapeake Bay block grant. Such a proposal may create significant political opposition due to the decreased ability of the federal government to provide oversight in the prioritization and spending of program funds.

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#### **Endnotes to Chapter 9**

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## **CHAPTER 10 – RETHINKING THE TRIBUTARY STRATEGIES**

The plans to clean up Chesapeake Bay have lost momentum in the face of seemingly insurmountable funding needs and decades of rapid development and growth within the Bay watershed. The politics of Chesapeake Bay water quality policy are complex. Multiple scales of governance and a combination of point and non-point nutrient sources stymied early designs for traditional command-and-control regulation. Government officials hoped that a decentralized cooperation framework would be able to deal better with the strategic interaction, multiple equilibria, and analytic uncertainty inherent in the Chesapeake Bay ecosystem.<sup>1</sup>

While not required, most states chose to develop tributary strategies. The Chesapeake Bay watershed is comprised of a nested set of tributaries governed by a nested set of state and local governments. It is the goal of the tributary strategies to align its decision-making structure with the political structure of the regulated environment.<sup>2</sup>

The tributary strategies were codified in 1992 in amendments to the Chesapeake Bay Agreement. According to this document, the strategies should “reflect the critical importance of the tributaries in the ultimate restoration of Chesapeake Bay.” It would be necessary to “reduce and control point and non-point sources of pollution to attain the water quality condition” desired for the Bay. This should be done in a manner to “advance both cost-effectiveness and equity.”<sup>3</sup>

Yet, the actual implementation of the tributary strategies is often neither efficient nor equitable. Indeed, there has been little implementation of the Tributary Strategies at all. The strategies adopted have often been based on unrealistic technical assumptions or were economically and/or politically infeasible. Tributary planning has often served as a hurdle to be overcome rather than a stimulus to effective policies and programs to reduce Bay nutrient loadings. Thus, more delay than positive action has typically resulted from the tributary strategies as they have worked in practice.

Yet, the specific problems and policy requirements of the individual tributaries must lie at the heart of any design for improving the water quality of the Chesapeake Bay. Many of the discussions of previous chapters have noted differences among the Susquehanna, Potomac, James, and other major tributaries of the Bay. Achieving greater cost-effectiveness, equity, and other social goals will depend significantly on improved tributary planning and implementation. This chapter examines the development of the current tributary strategies and how the process might be improved for the future. It also reviews the interaction of designated water quality uses, water quality criteria, and water quality standards in contributing to the setting of the tributary load allocations.

### **The Tributary Agreements**

The original signatories of the Chesapeake Bay agreement were Maryland, Pennsylvania, Virginia, and the District of Columbia. The legislatures of Maryland, Pennsylvania, and Virginia are represented on a coordinating institution called the Chesapeake Bay Commission. The U.S. Environmental Protection Agency (EPA) represents the federal interest. The headwater states of Delaware, New York, and West Virginia signed a Memorandum of Understanding in 2002, which also binds them to water quality goals and commitments similar to those of the original signatories.

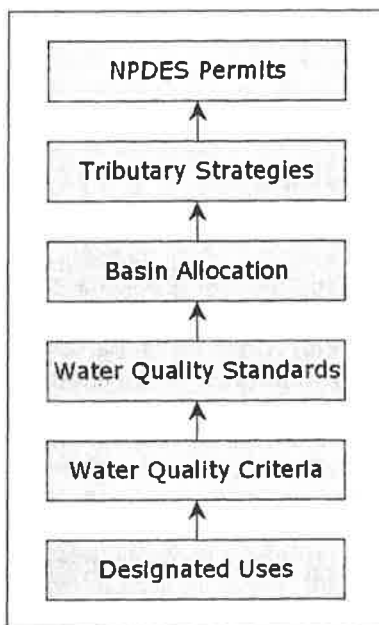
The Chesapeake Bay watershed was divided into broader tributary basins and then into sub-tributaries as shown in Table 10-1.

**TABLE 10-1. TRIBUTARY TEAM WATERSHEDS**

| STATE                | TRIBUTARY     | TRIBUTARY TEAM WATERSHEDS  |
|----------------------|---------------|--|
| Pennsylvania         | Susquehanna   | Central Penn<br>Upper West Branch<br>Susquehannock<br>Lower North Branch<br>Big Bend<br>Bradford/Tioga<br>Upper Susquehanna<br>Wyoming Valley<br>Lackawanna<br>Lower Susquehanna East<br>Lower Susquehanna West<br>Juniata |
|                      | Potomac       |  |
| Maryland             | Potomac       | Lower Potomac<br>Middle Potomac<br>Upper Potomac   |
|                      | Choptank      |  |
|                      | Eastern Shore | Lower Eastern Shore<br>Upper Eastern Shore   |
|                      | Western Shore | Lower Western Shore<br>Upper Western Shore   |
|                      | Patapsco/Back |  |
|                      | Patuxent      |  |
| Virginia             | Shenandoah    |  |
|                      | Potomac       |  |
|                      | Rappahannock  |  |
|                      | York          |  |
|                      | James         | Lower James<br>Middle James<br>Upper James   |
|                      | Eastern Shore |  |
| District of Columbia | Potomac       |  |
|                      | Anacostia     |  |
|                      | Rock Creek    |  |
| New York             | Susquehanna   |  |
| Delaware             | Eastern Shore | Nanticoke<br>Broad Creek<br>Choptank<br>Chester<br>Marshyhope<br>Pocomoke  |
| West Virginia        | Potomac       |  |
|                      | James         |  |

The approach to Chesapeake Bay decision-making has evolved over the years. A general model of the Chesapeake Bay water quality process is as follows:

**FIGURE 10-1. CHESAPEAKE BAY WATER QUALITY DECISION-MAKING MODEL<sup>4</sup>**



The designated uses for the Chesapeake Bay are related to the habitat needs of fish, shellfish, and underwater grasses. The habitat designations are a response to the "impaired waters" designation of Chesapeake Bay tidal tributaries in 1998. The water quality standard originally called for dissolved oxygen levels of 5 mg/L throughout the Bay. However, this standard cannot be met because of variations in salinity, depth, and seasonal effects. Therefore, the signatory states agreed upon a habitat-based approach to set water quality standards as part of the Chesapeake 2000 Agreement.<sup>5</sup> This approach divided Bay waters into the five categories shown in the table below. Maryland re-proposed the water quality standards that follow the habitat designations and will adopt new water quality standards (Table 10-2).<sup>6</sup>

| <b>HABITAT</b>                                | <b>DESIGNATED USE</b>  | <b>SEASONAL-USE APPLICATION</b> | <b>APPLICABLE BAY WATER QUALITY CRITERIA AND STANDARD</b>  |
|---|--|---------------------------------|--|
| Migratory Fish Spawning & Nursery Use Habitat | Protects migratory and resident freshwater fish during spawning and nursery season | February-May (else Open-Water)  | Dissolved oxygen (7 day mean $\geq 6$ mg liter <sup>-1</sup><br>Instantaneous minimum $\geq 5$ mg liter <sup>-1</sup> )                |
| Shallow Water-Bay Grass Use Habitat           | Promotes growth of fish, shellfish, and underwater grasses                         | April-October (else Open-Water) | Water clarity  |
| Open-Water Fish and Shellfish Use Habitat     | Promotes growth of fish and shellfish  | Year-round                      | Dissolved oxygen and chlorophyll_a (30 day mean of $\geq 5.5$ mg liter <sup>-1</sup> in low salinity; 5 mg liter <sup>-1</sup> in high |

|  |   |                                  |   |
|--|---|----------------------------------|---|
|  |   |                                  | salinity<br>7 day mean of $\geq 4$ mg liter <sup>-1</sup><br>Instantaneous minimum of $\geq 3.2$ mg liter <sup>-1</sup> )   |
| Deep-Water Seasonal Fish and Shellfish Use Habitat | Protects growth of fish and shellfish   | June-September (else Open-Water) | Dissolved oxygen (30 day mean of $\geq 3$ mg liter <sup>-1</sup><br>1 day mean of $\geq 2.3$ mg liter <sup>-1</sup><br><br>Instantaneous minimum of $\geq 1.7$ mg liter <sup>-1</sup> ) |
| Deep-Channel Seasonal Refuge Use Habitat           | Provides refuge for deep-channel fish and for benthic organisms (worms and crabs) | June-September (else Open-Water) | Dissolved oxygen (Instantaneous minimum of $\geq 1$ mg liter <sup>-1</sup> )  |

The Chesapeake Bay water quality standards for dissolved oxygen are to be achieved by reductions in two nutrient pollutants – nitrogen and phosphorus. Table 10-3 below describes the various nitrogen and phosphorus loads modeled by Chesapeake Bay Program to determine the likely impact on dissolved oxygen levels in the deep, mid-Bay segment of the Chesapeake Bay. A level of effort, also known as its tier, accompanies each loading allocation. Tier 1 is the lowest level of effort and corresponds to the existing implementation levels of BMPs. Tier 2 is the next highest level of effort and roughly corresponds to a 25 percent BMP implementation level. Tier 3 is an even higher level of effort and roughly corresponds to a 50 percent BMP implementation level. E3 (“everything, everywhere by everyone”) is the highest level of effort and roughly corresponds to a 100 percent BMP implementation level.<sup>8</sup>

From the bottom of Table 10-3, the first model run allocation of nitrogen and phosphorus loads (198 and 15.7 million pounds per year, respectively), did not meet the dissolved oxygen standard throughout the Bay. The second model run also did not meet the dissolved oxygen standard throughout the Bay. This second model run involved a Tier 3 level of effort from all but the three Virginia tributaries nearest the Chesapeake Bay mouth. The third model run also did not meet the dissolved oxygen standard throughout the Bay. This third model run involved a Tier 3 level of effort from all the tributaries in the Chesapeake Bay. The fourth model run is discussed below. The fifth model run involved an E3 level of effort and attained the dissolved oxygen water quality standard Bay-wide.

| TABLE 10-3. BASIN-WIDE CAP LOAD ALLOCATION OPTIONS <sup>9</sup> |   |
|---|---|
| MODELED NITROGEN/<br>PHOSPHORUS LOADINGS<br>(MILLION LB/YR)     | LEVEL OF EFFORT (TIER) AND WATER<br>QUALITY OUTCOME   |
| 160/12.6  | Bay-wide dissolved oxygen attainment  |
| 175/12.8  | Dissolved oxygen criteria attainment Bay-wide except in the deep waters of one mid-Bay segment (CB4)                        |
| 181/13.4  | Tier 3 loading across all of the basins   |
| 188/13.3  | Tier 3 loadings for all except VA (which meant less reduction was required for the York, James, and Virginia Eastern Shore) |
| 198/15.7  | First attempt to allocate   |

The signatories and headwater states agreed to reduce their total loads of nitrogen and phosphorus to 175 million pounds per year and 12.8 million pounds per year respectively, by 2010. This corresponded to varying levels of effort from the signatory states, as detailed in Table 10.4. The Chesapeake Bay water quality model computed



that this load allocation would allow for the attainment of the dissolved oxygen water quality standard for all but the deepest waters of one segment of the Chesapeake Bay (CB4 between the Patapsco and Patuxent Rivers in Maryland).

The twenty state-specific basins were grouped by their nutrient pollution control effectiveness: low impact, medium impact, and high impact. These effectiveness groups were chosen based on a number of factors: pollution prevention strategies already implemented by each state, proximity to sensitive areas of the Bay (such as recovering SAV beds and oyster reefs), the overall effectiveness of proposed reductions and each state's relative contribution to water quality impairments.<sup>10</sup> Jurisdiction-basins were allocated nutrient loads (feasibility and equity considerations both factored into these allocations). As part of this process, the Bay Program calculated:

- A baseline by modeling nutrient loading in 2010 with an all-forest watershed and subtracting from this the modeled 2010 watershed nutrient loading with no best management practices.
- An equal percent reduction for each jurisdiction-basin within the same effectiveness group.
- A three percent reduction between the effectiveness groups:
  - High impact—64.6 percent reduction
  - Medium impact—61.6 percent reduction
  - Low impact—58.6 percent reduction

However, non-tidal states were allowed a dispensation out of equity considerations, which equated to an across-the-board Tier 3 level of effort designation. This is reflected in the table by the ***bold, italicized*** numbers showing the discrepancy between reduction of level efforts within the same effectiveness group.

**TABLE 10-4. NUTRIENT ALLOCATION TABLE (NITROGEN)<sup>11 12</sup>**

| JURISDICTION-BASIN                    | NITROGEN (MILLION POUNDS PER YEAR) |                     |   |                     |                        |
|---------------------------------------|------------------------------------|---------------------|---|---------------------|------------------------|
|                                       | PRELIMINARY LOAD DISTRIBUTION      | LOAD ALLOCATION     | ALLOCATION OF "ORPHANED LOADS TO JURISDICTIONS" | FINAL ALLOCATION    | PERCENT REDUCTION/TIER |
| Eastern Shore VA - VA                 | 1.16                               | 1.16                | -   | 1.16                | 64.6/2.4               |
| Susquehanna - MD                      | 0.85                               | 0.85                | 0.02  | 0.83                | 64.6/3.3               |
| Susquehanna - PA                      | 61.06                              | 69.08               | 1.5   | 67.58               | 55.4/3.00              |
| Susquehanna - NY                      | 10.95                              | 12.58               | -   | 12.58               | 47.2/3.00              |
| Western Shore MD - MD                 | 11.47                              | 11.47               | 0.20  | 11.27               | 64.6/2.90              |
| Western Shore MD - PA                 | 0.02                               | 0.0192              | -   | 0.02                | 64.6/NA                |
| Patuxent - MD                         | 2.50                               | 2.50                | 0.04  | 2.46                | 64.6/3.55              |
| <b><i>High Impact Basin Total</i></b> | <b><i>88.01</i></b>                | <b><i>97.66</i></b> | <b><i>1.76</i></b>                              | <b><i>95.90</i></b> | -                      |
| Eastern Shore MD - MD                 | 11.05                              | 11.05               | 0.16  | 10.89               | 61.6/2.60              |
| Eastern Shore MD - VA                 | 0.06                               | 0.0642              | -   | 0.06                | 61.6/3.10              |
| Eastern Shore MD - DE                 | 2.88                               | 2.88                | -   | 2.88                | 61.6/3.00              |

|  |                           |                           |                         |                           |           |
|--|---------------------------|---------------------------|-------------------------|---------------------------|-----------|
| Eastern Shore<br>MD – PA                       | 0.24                      | 0.27                      | -                       | 0.27                      | 54.5/3.00 |
| Potomac – DC                                   | 2.80                      | 2.80                      | 0.40                    | 2.40                      | 61.6/2.90 |
| Potomac – MD                                   | 11.99                     | 11.99                     | 0.18                    | 11.81                     | 61.6/3.20 |
| Potomac – VA                                   | 12.84                     | 12.84                     | -                       | 12.84                     | 61.6/3.20 |
| Potomac – PA                                   | 3.73                      | 4.02                      | -                       | 4.02                      | 57.5/3.00 |
| Potomac – WV                                   | 4.18                      | 4.71                      | -                       | 4.71                      | 53.0/3.00 |
| <b>Medium Impact<br/>Basin Total</b>           | <b>49.77</b>              | <b>50.62</b>              | <b>0.74</b>             | <b>49.88</b>              | -         |
| Rappahannock –<br>VA                           | 5.24                      | 5.24                      | -                       | 5.24                      | 58.6/2.70 |
| York – VA                                      | 5.18                      | 5.70                      | -                       | 5.70                      | 52.5/2.4  |
| James – VA                                     | 26.79                     | 27.90                     | 1.5                     | 26.40                     | 56.5/2.0  |
| James – WV                                     | 0.03                      | 0.03                      | -                       | 0.03                      | 31.1/3.00 |
| <b>Low Impact<br/>Basin Total</b>              | <b>37.24</b>              | <b>38.87</b>              | <b>1.5</b>              | <b>37.37</b>              | -         |
| <b>Bay-Wide<br/>Subtotal</b>                   | <b>175.00<sup>1</sup></b> | <b>187.15<sup>2</sup></b> | <b>4.00<sup>3</sup></b> | <b>183.15<sup>4</sup></b> | -         |
| Pennsylvania (EPA Clear Skies to 2010)         |                           |                           |                         | 4.1                       |           |
| Maryland (EPA Clear Skies to 2010)             |                           |                           |                         | 0.99                      |           |
| Virginia (EPA Clear Skies to 2010)             |                           |                           |                         | 1.64                      |           |
| District of Columbia (EPA Clear Skies to 2010) |                           |                           |                         | 0.02                      |           |
| New York (EPA Clear Skies to 2010)             |                           |                           |                         | 0.8                       |           |
| Delaware (EPA Clear Skies to 2010)             |                           |                           |                         | 0.11                      |           |
| West Virginia (EPA Clear Skies to 2010)        |                           |                           |                         | 0.35                      |           |
| <b>EPA Clear Skies to 2010 Total</b>           |                           |                           |                         | <b>8.01</b>               |           |
| <b>Bay-Wide Total</b>                          |                           |                           |                         | <b>175.14<sup>5</sup></b> |           |

<sup>1</sup> Preliminary Load Distribution was based on preliminary modeling results.

<sup>2</sup> Load allocated was based on the level of effort value (Tier value), which was determined by equity considerations.

<sup>3</sup> Orphaned Load is the difference of the Load Allocation (187.15 million pounds) and Preliminary Load Distribution (175.00 million pounds) minus the EPA Clear Skies expected reductions (8 million pounds).

<sup>4</sup> Final Allocation is the Load Allocation (187.15 million pounds) minus the Orphaned Load (4.00 million pounds).

<sup>5</sup> Bay-Wide Total is the Final Allocation (183.15 million pounds) minus the EPA Clear Skies expected reductions (8 million pounds).

## Tributary Strategies

The tributary strategies are in essence the roadmaps states have chosen to meet their basin allocations. Each state has multiple tributary strategies (based on the way the state divided up its watersheds), which are aggregated into a statewide tributary strategy. Each state tributary strategy was developed based on collaboration between the state and the individual tributary teams. The tributary teams represent the stakeholders in each jurisdiction-basin, and are comprised of representatives from soil and water conservation districts, the agricultural community, developers, local governments, and watershed groups. The tributary teams were tasked with reaching a consensus on what combination of non-point source best management practices (BMPs), and wastewater treatment plant (point source) reductions should be included.

However, the tributary teams were never really considered active players in the development of local water quality policy. The tributary teams were treated more as advisory panels than as primary decision makers. The clearest example of this is the centralization of the Chesapeake Bay model development in EPA. Tributary teams met individually in each of the states to determine feasible point and non-point source reductions, but the real decision-making took place at the state level. The state would transmit the recommendations of the tributary teams to EPA; EPA in turn would feed the

point and non-point reduction strategies into the Chesapeake Bay watershed model and then the water quality model. The watershed model would compute the expected reductions based on the point and non-point source reductions provided and the water quality model would indicate whether this would meet water quality standards.

If these reductions were not enough to meet the cap load allocation for that tributary, the plans were remanded to the tributary team. In Maryland's case, this iterative process occurred about five times. Maryland state officials had to make a command and control decision on nutrient reduction practices in the final iteration in order to meet Chesapeake Bay water quality standards.

In the case of the Middle Potomac, the tributary teams were never staffed with enough experts to make informed decisions. Therefore, the tributary teams had to defer to the superior aggregating skills of the Maryland Department of Natural Resources. The tributary teams were also never given enough power to truly affect change on their scale of influence. This is shown by the Middle Potomac tributary team's inability to challenge the level of agricultural effort sought by the state. Before the Tributary Strategies were due, the Maryland Department of Natural Resources seemingly made a command and control decision at the state level to increase dramatically the level of effort required by the agricultural community in the Middle Potomac. This has led to increased skepticism by the local farmers and may lead to a difficult process of implementation ahead.

### **Implementation Challenges**

The delayed publication of the tributary strategies may forecast the difficulty of their implementation. For instance, Maryland still has not published an implementation plan despite earlier projections of completing it in December 2004. Other states folded the implementation plan into their tributary strategies, but appear to be in a holding pattern in terms of actual implementation.

The tributary strategies are heroically ambitious, if not impossible. They are somewhat reminiscent of other environmental legislation with high aspirations enacted by the Congress in the 1970s in that they call for wide-scale lifestyle/behavior change that is likely to be infeasible in practice. Yet, the states must fulfill their tributary strategies in order to meet the Chesapeake Bay water quality standards. The recent shift from a cooperative and voluntary approach to a potentially more regulatory approach under TMDLs may be one answer to this dilemma of how the states will administer the tributary strategies.

Skepticism in the agricultural community is high. The West Virginia Tributary Strategy openly defends the agricultural community's skeptical perspective on nutrient reduction and seeks to shift the burden back onto urban shoulders. This is a common refrain in many parts of the watershed and perhaps is reflective of a way of life increasingly challenged by a globalizing economy and an uncertain mandate for the future. Yet, agricultural nutrient reduction is key to the success of the tributary strategies and the overall cleanup of Chesapeake Bay. Therefore, the states must resolve the impasse with agriculture through either a shift in incentives or greater farmer involvement in the decision-making process.

### **Cost of Implementation**

While cost estimates vary, the tributary strategies yielded an expensive solution to the Chesapeake Bay water quality problem. The Blue Ribbon Financing Panel provided an estimate of \$28 billion. So far, the states have not had to justify how their tributary strategies would be funded. In fact, one could argue that states may be inflating costs until they become politically impossible and require federal funding, relaxed water quality standards, or an indefinitely postponed timeline for compliance.

## Analysis and Future of Tributary Strategies

Tributary Strategies are a voluntary approach to the achievement of a Total Maximum Daily Load (TMDL). They are intended to be cooperative in order to work across jurisdictions and land uses. A comparison of the TMDL and tributary strategies approaches is found in the table below. As Table 10-5 shows, TMDL strategies involve more regulation and less input from stakeholders, while tributary strategies are voluntary and involve more input from stakeholders.

| <b>TABLE 10-5. COMPARISON OF TMDL AND TRIBUTARY STRATEGIES APPROACHES TO NUTRIENT AND SEDIMENT REDUCTION<sup>13</sup></b> |                     |                              |
|---|---------------------|------------------------------|
|   | <b>TMDL</b>         | <b>TRIBUTARY STRATEGIES</b>  |
| Approach  | Command and control | Voluntary and cooperative    |
| Decision-making   | State               | Tributary Teams and State    |
| Modeling  | State               | Chesapeake Bay Program (EPA) |
| Nutrient Limitations  | TMDLs               | Nutrient caps                |
| Implementation  | NPDES permits; BMPs | NPDES permits; BMPs          |

Maryland finalized its water quality standards in Summer 2005, which are largely based on the Chesapeake Bay living resources described above.<sup>14</sup> These standards will provide the basis for an interstate comparison and EPA will be able to start writing permits for Bay watershed states. This step in the process has been so long in coming because of an overly ambitious Bay-wide dissolved oxygen water quality standard set in the past. The extensive science research and monitoring that informed the new water quality standards has hopefully eliminated this concern and allowed for the movement towards the regulation of nutrients in point source permits.

Delaware was the first state to approve the water quality standards, and was recently joined by Maryland; standards for Virginia and D.C are forthcoming. Meanwhile, Delaware completed TMDLs for Nanticoke River and Broad Creek.<sup>15</sup> It will complete TMDLs for Choptank River, Chester River, Marshyhope Creek and Pocomoke River by the end of 2005.<sup>16</sup> Pennsylvania has plans to complete TMDLs for the Potomac River and Susquehanna River basins.<sup>17</sup> The other states have not expressly declared their TMDL completion intentions.

Two TMDL milestones are important. The EPA may reassess the NPDES permitting practices and the schedule for TMDL development in 2007.<sup>18</sup> In addition, it will undertake a second assessment of all nutrient and sediment-impaired waters to reevaluate the need for TMDLs in 2011.<sup>19</sup>

Along the way to these TMDL milestones, the states will need to address the critical issue of cap maintenance. Cap maintenance is defined as a no net increase in capped nutrient load.<sup>20</sup> Some of the issues to consider when developing cap maintenance strategies include air deposition, cap and trade programs, carrying capacity, cooperative agreements, education, and financial support. Some see cap maintenance as an important front-end feature of cost-effective tributary strategies; another perspective is to wait for a technological breakthrough that might obviate cap maintenance strategies.

Cap maintenance is a subset of a larger question: whether the load caps will attain the desired water quality.<sup>21</sup> The many-layered modeling of the Chesapeake Bay is fairly accurate on a macro-level, but is somewhat inaccurate on the micro-level.<sup>22</sup> Thus nutrient load reductions specified by the tributary strategies may move water quality in the right direction for water quality standards to be achieved, but they may not actually attain the desired water quality standards.

Currently, the EPA is moving towards a "watershed permit" approach to nutrient reduction. This new watershed permit aggregates point sources, which would potentially

allow for nutrient trading, to equalize the marginal cost per unit of nutrient reduction once the cap load allocation for each facility has been determined. In this scenario, nutrient trading is used for cap maintenance and not nutrient reduction (net decrease in the nutrient load), but it at least allows for efficient coordination of point source nutrient loads.

## **Recommendations**

### ***Strengthen leadership on Bay-related issues from a variety of stakeholder groups, and make decisionmaking more inclusive.***

The tributary strategy process could be improved by developing a leadership program that brings together existing and potential leaders from a variety of stakeholder groups to discuss Chesapeake Bay water quality issues. This would involve the potential leaders in decision-making processes and encourage existing leaders to justify their decisions to both the potential leaders from their same stakeholder group and to the potential leaders from the other stakeholder groups.

The tributary strategies are just the beginning of the difficult process of implementation. Funding concerns and free rider problems will challenge every step of the implementation process, making leadership crucial. The analysis-paralysis generated by funding concerns is already playing out in the lengthy discussions about the cost-effectiveness of various nutrient reduction strategies. Successful tributary strategy implementation will not occur without leaders with a vision to inspire action despite funding uncertainty.

### ***Decentralize the decision-making process further and incorporate tributary strategy principles into municipality- and/or county-level decisionmaking and planning.***

The current incentive structure discourages stakeholders from involvement in the tributary strategies. All the effective regulatory tools are oriented towards point sources, and therefore limit the involvement and substantial input city/county stakeholders could provide to the tributary strategies. Strengthening the non-point source regulatory tools would help alleviate this disincentive as would either decentralizing the decision-making or allowing for more collaborative efforts between tributary teams, local municipalities/counties, and the state.

### ***Commit to enforcing simultaneously agricultural nutrient management plans, combined sewer overflow upgrades, and conservation zoning ordinances. Encourage key stakeholder farmers, municipal officials, and developers to attend compliance visits for sectors in which they are not usually involved.***

Existing laws must be enforced in order to prepare for the implementation of even more challenging future laws. Strong skepticism is perhaps legitimate in the agricultural community considering the lack of enforcement of nutrient management plans and the Chesapeake Bay Critical Area Protection Act. Every time a law is allowed to lapse, it creates further skepticism. By contrast, enforcement of existing laws shows decisiveness in resolving the problems of Chesapeake Bay water quality and creates a culture of possibility. Enforcement of existing laws can work as an incentive to encourage buy-in from stakeholders. If the stakeholders involved in the tributary teams are given a legal and enforceable foundation on which to base their actions, then they will be advocates for the implementation of the tributary strategies and will be assisted in leveraging the voluntary and cooperative behavior necessary to implement best management practices.

***Develop a one-year science course for grade school children based on the human ecology of living in the Chesapeake Bay watershed.***

Education is the key to the future. The children today will be the farmers, developers, government employees, and teachers of tomorrow. Short-term change in the Chesapeake Bay watershed will be defeated if there is no long-term commitment to change. This commitment should involve a critical look at current lifestyle and behavioral choices and an awareness of the potential for beneficial change. Education is central to these concerns as is the more specific tool of adaptive management. Courageous leadership is needed to make adaptive management the foundation of Chesapeake Bay water quality policy-making.

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## **CHAPTER 11 – THE CHESAPEAKE BAY AS A WATER QUALITY NON-ATTAINMENT AREA**

This final chapter reviews the opportunities for cost-effective nitrogen reductions and introduces a new policy framework: envisioning the Chesapeake Bay as a “water quality non-attainment area” operating under an offset policy and a nutrient trading mechanism.

If Chesapeake Bay were an air quality region, it would be declared a “non-attainment” area under the provisions of the Clean Air Act. Tight restrictions would be imposed on entry of new uses – including prohibitions on any new large industrial or other major uses that do not generate matching (or more than matching) “offsets.” Such strict mandates of the Clean Air Act for non-attainment areas reflect a strong commitment to curbing adverse consequences of air pollution for human health and welfare. The pollution of the Chesapeake Bay does not currently involve a significant threat to human health. However, given the central place of the Chesapeake Bay in the life of the region, its cleanup should be treated with the same urgency as the improvement of air quality throughout the United States.

The required measures would then include tight restrictions on any new additions to water pollution within the Chesapeake Bay watershed. Following the model of the Clean Air Act, if a prospective new land use sought to move into the watershed area, it would either be required to achieve zero water pollution emissions or it would be required to create offsets equal to (or greater than) its additional water pollution load. This requirement has been applied in Los Angeles, Houston, and many other airsheds across the United States.

Under a “non-attainment” policy framework for the Bay, it is likely that the water quality goals for the Bay can be achieved within the financial means available and within a reasonable time frame. It would help to ensure that existing resources being devoted to Bay cleanup are in a cost-effective manner. The obstacles to a cost-effective cleanup of the Bay at present lie mainly in ineffective water quality policies and procedures and a lack of transboundary solutions, all of which could result in large gains in efficiencies and effectiveness. This chapter shows how nitrogen and standards for Chesapeake Bay water quality can be attained in a timely fashion and in a politically and financially practical manner largely with existing resources. There are no miracles required, merely a greater focus of resources on more efficient and effective solutions and political support to make the necessary regulatory requirements a reality. Designating the Chesapeake Bay as a “water quality non-attainment area” would be an important step in that process.

### **Cost-Effective Alternatives**

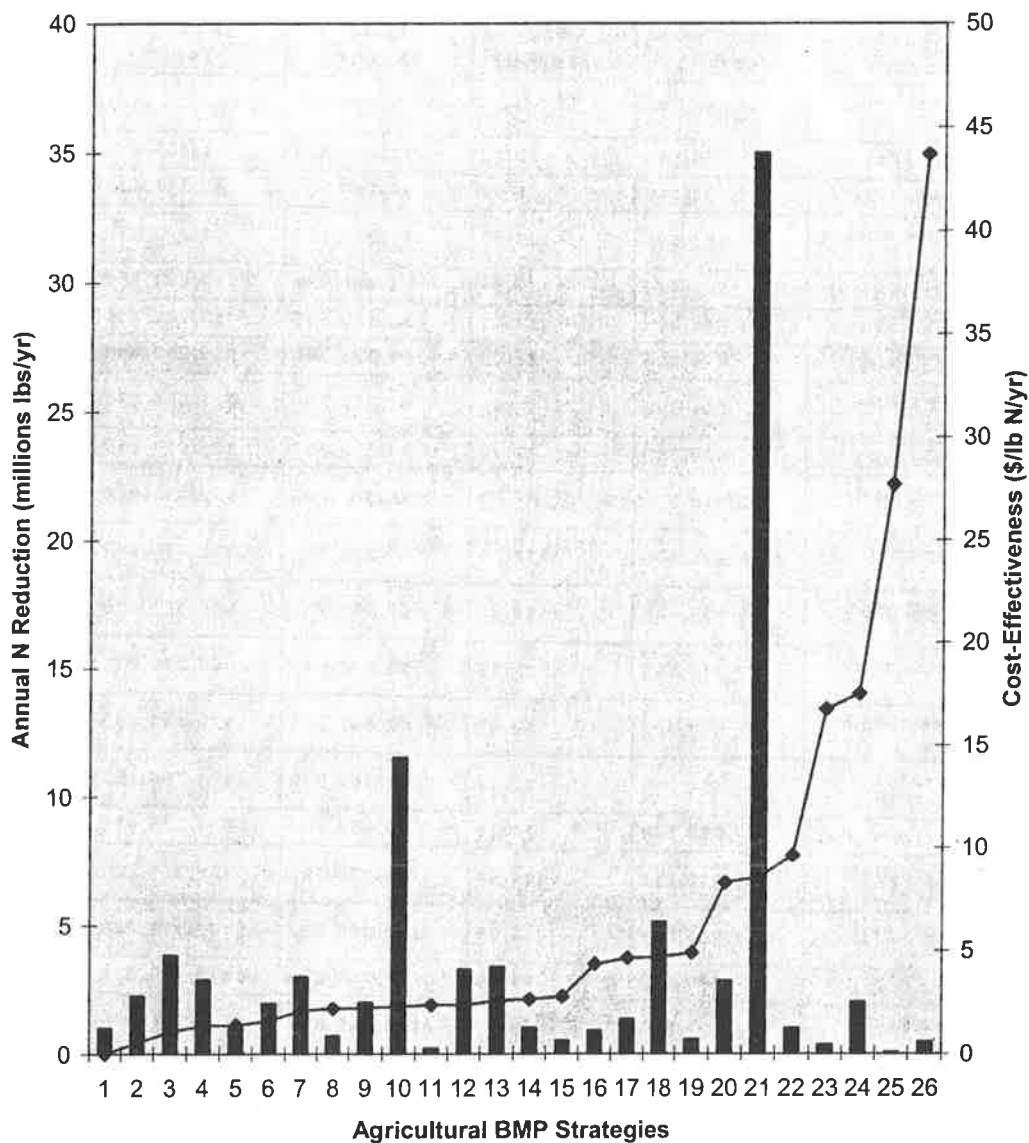
As previous chapters have found, significant nitrogen reduction opportunities can be achieved for low costs per pound each year. Indeed, by analyzing most common agricultural best management practices in the three signatory states, more than half (56 million pounds) of the annual 103-million pound per year nitrogen reduction goal could be achieved for \$110 million each year. When the “free” nitrogen reductions are included from the implementation of the Clean Air Act, the nitrogen reduction potential jumps to 67 million pounds. And, finally, when reduction efforts at wastewater treatment plants and industrial facilities are accounted for, 35 million more pounds of nitrogen reductions for an additional \$300 million per year could be achieved<sup>1</sup>. Thus, with all three types of strategies included – low cost agricultural sources, free air deposition reductions, and point sources – the Bay region could achieve 102 million pounds of nitrogen reductions annually costing about \$500 million per year. That is only one million pounds shy of the 103 million Bay Agreement goal. In addition, the \$500 million figure is much below the many billions per year that some have suggested would be needed over the next few years for the clean-up efforts.

Table 11-1 lists, in order of cost-effectiveness, the 24 agricultural strategies, the “free” nitrogen reduction efforts, and the sewage treatment plant upgrades, that could

achieve 98 million pounds of nitrogen reduction. Figure 11-1 graphs the last two columns of Table 11-1, cumulative spending and cumulative nitrogen reductions, to demonstrate the value of prioritizing resources for spending on the most cost-effective solutions first.

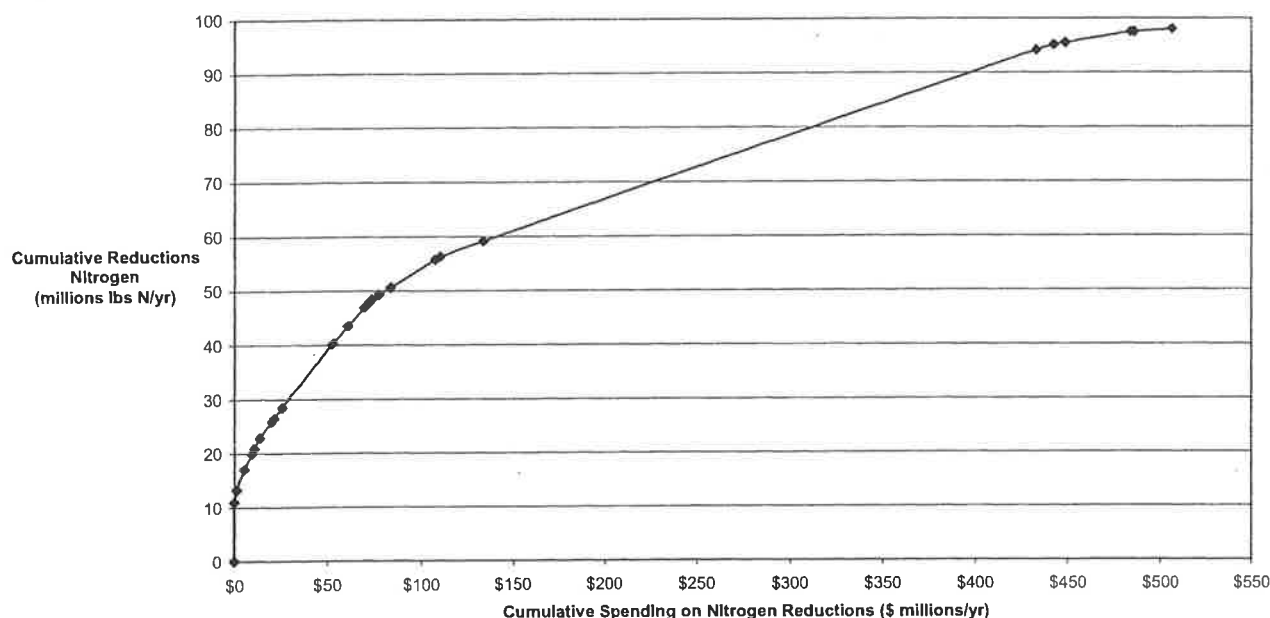
| <b>TABLE 11-1. CHESAPEAKE BAY NITROGEN REDUCTION POTENTIAL FROM NUTRIENT REDUCTION STRATEGIES IN MARYLAND, PENNSYLVANIA, AND VIRGINIA</b>  |  |                                       |                                   |                                     |  |
|--|--|---------------------------------------|-----------------------------------|-------------------------------------|--|
| <b>STRATEGY<br/>(MOST TO LEAST COST<br/>EFFECTIVE)</b>   | <b>ANNUAL<br/>NITROGEN<br/>REDUCTION<br/>(LB/YR)</b> | <b>ANNUAL<br/>COST<br/>(\$/LB/YR)</b> | <b>TOTAL<br/>COST<br/>(\$/YR)</b> | <b>CUMULATIVE<br/>COST<br/>(\$)</b> | <b>CUMULATIVE<br/>NITROGEN<br/>REDUCTION<br/>(LB/YR)</b> |
| 1:CAA Implementation (all)   | 1,000,000  | "free"                                | --                                | --                                  | 11,000,000   |
| 2:Cons. Tillage (PA)   | 2,228,580  | \$0.54                                | \$1,203,433                       | \$1,203,433                         | 13,228,580   |
| 3:Nutrient Mgmt (MD)   | 3,821,210  | \$1.08                                | \$4,144,000                       | \$5,347,433                         | 17,049,790   |
| 4:Chicken House Buyout (MD)  | 2,863,594  | \$1.37                                | \$3,923,124                       | \$9,270,557                         | 19,913,384   |
| 5:Grassed Buffers (MD)   | 982,440  | \$1.39                                | \$1,360,999                       | \$10,631,556                        | 20,895,824   |
| 6:Nutrient Mgmt (VA)   | 1,944,091  | \$1.60                                | \$3,109,556                       | \$13,741,112                        | 22,839,915   |
| 7:Cons. Tillage (MD)   | 2,979,854  | \$2.09                                | \$6,221,296                       | \$19,962,408                        | 25,819,769   |
| 8:20% Poultry Litter Transport (VA)  | 694,300  | \$2.19                                | \$1,518,264                       | \$21,480,672                        | 26,514,069   |
| 9:Grass Buffers (VA)   | 1,979,393  | \$2.22                                | \$4,393,697                       | \$25,874,369                        | 28,493,462   |
| 10:Cover Crops, Early (PA)   | 11,514,082   | \$2.29                                | \$26,367,248                      | \$52,241,616                        | 40,007,544   |
| 11:Land Retirement (MD)  | 226,693  | \$2.36                                | \$535,546                         | \$52,777,162                        | 40,234,237   |
| 12:Animal Waste Mgmt Systems (PA)  | 3,279,108  | \$2.38                                | \$7,804,277                       | \$60,581,439                        | 43,513,345   |
| 13:Cover Crops, Early (VA)   | 3,376,445  | \$2.56                                | \$8,637,573                       | \$69,219,012                        | 46,889,790   |
| 14:Animal Waste Mgmt Systems (VA)  | 1,007,402  | \$2.65                                | \$2,667,141                       | \$71,886,153                        | 47,897,192   |
| 15:Manure Transport (MD)   | 504,700  | \$2.77                                | \$1,400,000                       | \$73,286,153                        | 48,401,892   |
| 16:Grassed Buffers (PA)  | 892,134  | \$4.36                                | \$3,889,704                       | \$77,175,858                        | 49,294,026   |
| 17:Stream Protection with Fencing (PA)   | 1,336,716  | \$4.64                                | \$6,202,362                       | \$83,378,220                        | 50,630,742   |
| 18:Cover Crops, Early (MD)   | 5,118,000  | \$4.69                                | \$24,000,000                      | \$107,378,220                       | 55,748,742   |
| 19:Cons. Plans (VA)  | 565,188  | \$4.90                                | \$2,766,856                       | \$110,145,075                       | 56,313,929   |
| 20:Land Retirement (PA)  | 2,817,796  | \$8.31                                | \$23,415,885                      | \$133,560,960                       | 59,131,725   |
| 21:WWTP Upgrades (all)   | 35,000,000   | \$8.56                                | \$299,600,000                     | \$433,160,960                       | 94,131,725   |
| 22:Animal Waste Mgmt Systems (MD)  | 994,643  | \$9.63                                | \$9,574,102                       | \$442,735,062                       | 95,126,369   |
| 23:Cons. Plans (PA)  | 359,244  | \$16.75                               | \$6,017,337                       | \$448,752,399                       | 95,485,613   |
| 24:Off-Stream Watering with Fencing (VA)   | 2,006,454  | \$17.50                               | \$35,121,097                      | \$483,873,496                       | 97,492,066   |
| 25:Off-Stream Watering with Fencing (MD)   | 62,149   | \$27.70                               | \$1,721,319                       | \$485,594,815                       | 97,554,215   |
| 26:Cons. Plans (MD)  | 480,263  | \$43.69                               | \$20,981,865                      | \$506,576,680                       | 98,034,478   |
| Source: For all the agricultural strategies, data sources are provided in Chapters 1, 2, and 3 of this report. References for the "free" nitrogen reductions are provided in Chapter 7. The data for the sewage treatment plants are from the Chesapeake Bay Commission, Cost-Effectiveness Strategies for the Bay. Six Smart Investments for Nutrient and Sediment Reduction. December, 2004. |  |                                       |                                   |                                     |  |

**Figure 11-1: Cost-Effectiveness of Agricultural BMP Strategies in MD, PA, and VA**



Sources: Strategies and data in this figure in Table 11-1

**Figure 11-2. Nitrogen Reduction Potential per Dollar Spent in MD, PA, and VA on Agricultural Strategies, Sewage Treatment Plants, and Free CAA reductions**



Source: Data for this figure listed in Table 11-1.

Table 11-1, Figure 11-1, and Figure 11-2 show that a large number of nitrogen reduction strategies are cost-effective. In fact, in addition to the free reductions from air programs, the first 18 agricultural BMPs (from conservation tillage in Pennsylvania to conservation plans in Virginia) are under \$5.00/lb N reduced/yr, and could provide about 56 million pounds of nitrogen reduction for \$110 million per year. Thus, half the Bay-wide goal could be achieved with the most cost-effective agricultural BMPs alone. The costs per pound for subsequent strategies rise to about \$8/lb of nitrogen reduced. For the next additional \$300 million spent – on land retirement in Pennsylvania and sewage treatment plant upgrades – about 35 million pounds could be reduced per year. This brings the total to about \$400 million and 91 million pounds of nitrogen reduction per year. For the final \$100 million spent, only 6.6 million more pounds might be reduced from the five agricultural BMPs (from animal waste systems in Maryland to conservation plans in Maryland) – possibly a questionable set of expenditures.

If total resources are insufficient to support the full on-going clean-up effort, policymakers could choose to allocate existing resources to those strategies that achieve the greatest nitrogen reductions per dollar spent. This analysis demonstrates that the most cost-effective solutions are agricultural BMPs spread across the states. Indeed, agricultural practices can provide 55 percent of the nitrogen reductions (56 million pounds) for just 23 percent of the costs (\$110 million).

## Obstacles

Policymakers will need to overcome several potential hurdles to the adoption of such a cost-effectiveness strategy. First, from a Bay-wide watershed perspective, if policymakers are to re-allocate existing funds, they may wish to distribute either existing state funds or existing federal funds across state boundaries to pay for the lowest cost reduction efforts first. This poses some political challenges. For state funds, it may be difficult to convince taxpayers in one state to pay farmers to reduce nutrients in a

second state. For federal funds already earmarked for specific states, this may be less of a challenge but still a politically sensitive subject.

A second obstacle relates to confidence of future nutrient reductions. Most of the agricultural reductions have to be paid for every year while the reductions from sewage treatment plants are capital investments that require a one-time cost. When upgrades at a sewage plant reduce the concentration of nitrogen from the facility's effluent, the future environmental benefits are secure. Agricultural reductions, however, will be less certain because they require continuing actions over future years.

Moreover, contributions from sewage plants are considered "delivered to the Bay." In agriculture, a variety of factors may attenuate the amount of nitrogen reductions from agricultural sources, not only lowering these reductions but also making their effect on the Bay's ecosystems more uncertain. When nitrogen reductions occur many miles from the Bay, the ultimate impact on the Bay nutrient loads may be difficult to predict.

Obtaining participation from farmers in order to achieve each state's tributary strategy goals remains a significant hurdle. The example of farmer resistance in Maryland to a regulatory regime reminds policymakers that even a legal requirement for nutrient management practices does not guarantee actual reductions. Therefore, in addition to finding sufficient resources to pay farmers to implement agricultural nutrient reduction efforts, policymakers will have to provide farmers with alternative motivations to overcome their resistance to participation.

### **TMDL Policy for the Bay**

The Clean Water Act requires development of plans to achieve "total maximum daily loads" (TMDLs) in impaired waterbodies. In some ways, the requirement for a TMDL is similar to the designation of a non-attainment area under the Clean Air Act. However, EPA largely ignored the TMDL language of the law for the first 25 years of the Clean Water Act (enacted in 1972). The authority to bring a water body into compliance with TMDL requirements is also legally less secure than the mandated steps to achieve air quality standards in a non-attainment airshed.

In 1999, EPA discussed designing a joint TMDL for the whole Bay. However, this policy idea did not go any further owing to the lack of TMDL-oriented water quality data developed by the Bay Agreement signatory states or a clear picture on the kind of administrative structure that would implement the program. It was only in 1998 that lawsuits by environmental groups forced EPA into a 10-year Memorandum of Understanding (MOU) with Maryland for the state to begin developing their TMDL program by identifying "impaired waters" and promulgating TMDLs for them.<sup>2</sup> A few years earlier, EPA and four states that lie within the Bay watershed (Delaware, Virginia, Pennsylvania, and West Virginia) were ordered by consent decree to promulgate TMDLs. Should the states fail to do so according to each of their determined schedules, the EPA agreed to "backstop" the TMDL development by establishing its own TMDL program for the states.

The third and current reiteration of the Chesapeake Bay Agreement, known as Chesapeake 2000, was the coordinated policy implementation plan of the three Bay signatory states to comply with TMDL requirements. The Bay states intended Chesapeake 2000 to be the voluntary, cooperative policy approach to "correct[ing] the nutrient- and sediment-related problems in the Chesapeake Bay and its tidal tributaries sufficiently to remove the Bay and the tidal portions of its tributaries from the list of impaired waters under the Clean Water Act."<sup>3</sup> Should these areas remain impaired after 2010, the EPA, under Section 303 (d) of the Clean Water Act, could force the Bay states to return their authority to run the federal NPDES and TMDL programs to the EPA.

Now, five years into the Chesapeake 2000 Agreement and six or more years into the state TMDLs, the Bay appears not much closer to being removed from the list of impaired waters. It seems doubtful that the necessary steps to limit pollution from non-

point sources will have been taken. The state TMDL programs assume that the states Tributary Strategies for agricultural and non-point urban source best management practices will serve as the implementation mechanism for the non-point source load allocation portion of a waterbody TMDL. However, regulation of non-point sources remains uncoordinated among the various implementing agencies. Usually, state departments of environment run the TMDL program while the departments of agriculture and natural resources manage the agricultural non-point sources programs.

At the current pace of implementation of the tributary strategies, portions of the Bay and its tidal tributaries will probably not be clean enough in 2010 to be removed from the list of impaired waters. The question remains: will the EPA issue a Bay-wide and joint TMDL in 2010 and take over the states' NPDES and TMDL programs? Additionally, would a Bay-wide and joint TMDL provide any better policy carrots and sticks towards achieving the tributary strategies and making significant progress?

### **An Offset Policy Approach**

Given the uncertain prospects of the existing regional Bay Agreement partnership and the overarching federal TMDL framework, it will be important in the future to establish a strict cap on total loadings of nutrients into Chesapeake Bay. In effect, the Chesapeake Bay should be declared a water quality "non-attainment area," analogous to non-attainment areas as declared under the Clean Air Act. Similar policies for the Chesapeake Bay should be adopted, reflecting current precedents as found in air quality management of non-attainment areas across the United States.

Under such a policy, new uses would not be allowed to add to the total nutrient pollutant load in Chesapeake Bay. By requiring offset purchase ratios of greater than 1:1, the entry of a new use into the Bay watershed could then even contribute to overall movement toward reaching Bay goals. Offsets purchased by developers and others planning new land uses within the Bay watershed would provide a potentially large source of funds to pay for farmer and other nutrient load reductions.

For example, recognizing that the developer of a new housing project creates some amount of additional nitrogen nutrient load, this developer would have to compensate for this impact elsewhere, likely in the agricultural sector. The actual offset could be determined by first estimating the nutrient load associated with the new housing project. Developers would offset or perhaps pay a fee for an amount that was tied to the pollution created by the new activity.

In theory the development fee would equal the full marginal nutrient pollution costs that the development imposes on the community. Such nutrient development fees have a precedent in the more general impact fees that are now often meant to ensure that land development does not overrun the existing capacity of an area's infrastructure. According to McConnell and Walls (2004), twenty-eight states have legislation that permits the use of general impact fees, and the use and amount of these fees are both on the rise.<sup>4</sup> Fees average around \$6,000 for a single-family home, and vary depending on the type of dwelling and development. In addition, the fee may be parsed out further among its contribution to specific infrastructure programs. Nutrient management burdens could then be added to the general impact fee.

If developers or other parties are paying for offsets, it will be important to have a credible mechanism for assuring that the offsets claimed are actually being achieved. For this purpose, the government might sign binding contracts with farmers and other providers of offsets. Alternatively, private "offset brokers" might be encouraged and monitored. Such a private broker might have to obtain government accreditation. It would also be important for the government to create formal guidance for legitimate offsets, addressing baseline and other issues discussed previously in this report.

## **A Chesapeake Bay Cap and Trade System**

An offset program is based on individual trades of offsets that are purchased by individual new users from other individual users in a non-attainment airshed or watershed. The rate of improvement in the quality of Bay waters depends in part on the number of new uses, the offset trading ratio, and other considerations. Under the Clean Air Act Amendments of 1990, a further step was taken with the development of a "cap and trade" system of pollution allowances for sulphur dioxide (SO<sub>2</sub>). Not only new sources must have permission for their current emission levels but older, pre-existing sources as well. Thus, the government sets a total "cap," allocates pollution rights among existing polluters, and then requires that each polluter hold rights equal to their level of pollution.

Under such an approach, the Chesapeake Bay would set a cap for some future year – say 175 million pounds of nitrogen for 2010. The overall total might then be divided into individual state shares. Each state would then allocate nitrogen allowances equal to its share of the grand total of 175 million pounds among existing sources of nitrogen pollution (the precise manner of allocation is an important policy issue). The holders of the nitrogen allowances would be permitted to buy and sell them. Instead of buying an offset from some other specific party, new users in the Chesapeake Bay watershed would enter a general market for nitrogen allowances, corresponding to any nutrient loadings resulting from their use.

The advantage of a cap and trade system for Chesapeake Bay is that it would guarantee the achievement of planned total Bay nutrient loadings within the time frame desired. There would be no funding issue. The parties responsible for nutrient reductions provide the funds to achieve required nutrient reductions internally within the system. The development of a nutrient trading system for Chesapeake Bay would involve a number of administrative and policy complexities, as described above in Chapter 8. Nevertheless, it would provide the surest guarantees and most direct route for cleaning up the Chesapeake Bay. In essence, the "nutrient absorptive capacity" of the Chesapeake Bay (levels of nutrients that can be handled without environmental harm to the Bay) would be considered as a scarce natural resource to be allocated within a market framework. Beyond this capacity, further nutrient loads would not be permitted.

## **Policy Recommendations**

Along with the many specific recommendations provided in the previous ten chapters, this report, written by the Environmental Policy Workshop at the University of Maryland School of Public Policy, recommends three "big picture" policies.

### ***1. Allocate existing and future financial resources within each signatory state to fund the most cost-effective solutions first.***

The current situation of funding a myriad of agricultural best management practices, non-point urban practices, wastewater treatment plant upgrades with specifically earmarked local, state, and federal funds is failing to achieve nutrient reductions sufficient to clean-up the Bay. State policymakers should consider reallocating their upcoming, and even, existing funds, to first pay for nutrient reductions that get "the biggest bang for the buck." This economically efficient approach will assure the public that policymakers are serious about making scarce public resources go as far as possible and not just paying lip service to mottos and slogans.



**2. *Reinvigorate the Chesapeake 2000 Agreement by adopting a non-attainment area offset policy to the existing TMDL framework.***

It seems likely that the goals of the Chesapeake Bay Agreement will not be achieved by 2010 and EPA will then require a Bay-wide TMDL. To make good use of the remaining five years and existing resources, policymakers should consider immediately establishing the Bay as a non-attainment area and prohibiting entry of new nutrient pollution sources to the watershed unless they obtain offsets greater than their nutrient pollution. In addition to real and direct offsets, this policy proposal could also be implemented through a development fee. This new framework for addressing water quality problems would help to spur significant additional participation by the agricultural sector who may be the source of many of the offsets as sold through voluntary transactions.

**3. *Establish a "cap and trade" nutrient trading mechanism***

The most far-reaching "big picture" policy is the establishment of a nutrient trading system. There are numerous advantages of setting a cap to the pounds of nitrogen emissions allowable to maintain a clean Bay, initially allocating the allowances among nitrogen sources and then allowing the market principles of supply and demand to direct the buying and selling of these allowances.

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**Endnotes to Chapter 11**

<sup>1</sup> Chesapeake Bay Commission. *Cost-Effectiveness Strategies for the Bay*. Six Smart Investments for Nutrient and Sediment Reduction. December, 2004.

<sup>2</sup> Memorandum of Understanding between Maryland Department of Environment and the Environmental Protection Agency, August 1, 1998.

<sup>3</sup> Chesapeake Bay Program. "Chesapeake 2000." June 28, 2000: 9.

<sup>4</sup> McConnell and Walls, 2004. "Incentive-Based Land Use Policies and Water Quality in the Chesapeake Bay." Resources for the Future, March 2004, Discussion Paper 4-20.



## Conclusion

The obstacles to saving the Chesapeake Bay are more political and institutional than technical and financial. As previous chapters have shown, there are many cost-effective methods of reducing nutrient loads into Chesapeake Bay. There are also significant regulatory requirements that necessitate the expenditure of large funds by point sources. Additional significant funds are available from federal agricultural programs. Recent revenue initiatives, including Maryland's 2004 "flush tax", Virginia's 2005 legislative commitment, and Pennsylvania's 2005 "Growing Green Bond", will provide even more resources.<sup>a</sup> In total, the existing and upcoming funds are largely sufficient to pay for the necessary actions to reduce nutrient loads to reach Chesapeake Bay nutrient targets and water quality standards, if cost-effective measures are implemented.

The problem is that the funds and the required nutrient reduction actions often do not match up well. Funding is frequently available for less cost-effective means of reducing nutrients, while more cost-effective means of nutrient reductions receive little support. In addition, some very cost-effective methods of reducing nutrients such as the use of "low impact development" in new housing projects are blocked by antiquated local government regulatory standards.

This report does not address how to generate and sustain the political will to address these concerns. It has shown how, if such a political will is forthcoming, the practical solutions to the nutrient problems of the Bay are at hand. As mentioned throughout the report, the slow rate of implementation of best management practices in agriculture threatens failure of the goals agreed upon by each signatory state. Reducing nutrients in the Bay should fall on all who contribute pollution – homeowners, farmers, agricultural corporations, factory owners, developers, golf course owners, and sewage treatment plant owners.

With just five years left until 2010, the Chesapeake 2000 Agreement is in serious jeopardy of failing. As this report demonstrates, success appears to be within reach but a new federal, regional, and state policy and institutional approach that sets clear priorities for the implementation of the most cost-effective solutions will be necessary.

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<sup>a</sup>Maryland's Chesapeake Bay Restoration Fund was approved on May 26, 2004 to provide \$65 million per year for sewer treatment plant upgrades through a user fee on customer's water and waste water bills. The fund will also provide \$12.6 million from similar fees on septic system owners though 60 % of those funds will upgrade failing septic systems while 40% will fund farmer installation of cover crops (Maryland Department of Environment website). Pennsylvania voters passed the \$625 million "Growing Greener Bond" initiative on May 17, 2005 in Pennsylvania's Primary Election. How the bond funds will be raised and how they will be allocated to acid mine drainage, farmland preservation, and watershed restoration projects has yet to be decided by the state legislature (Pennsylvania Environmental Council website). In February, 2005, the Virginia General Assembly approved a budget with \$50 million appropriated for upgrading sewage treatment plants and reducing farm nutrient run-off. The bill provides 10 percent of any general fund surplus that remains at the end of each fiscal year for the next 10 years to pay for Bay clean-up efforts (Blankenship, 2005).

