Economic Impact Analysis
Virginia Department of Planning and Budget

9 VAC 25-40 and 9 VAC 25-720 – Policy for Nutrient Enriched Waters and Water Quality Management Regulation

Department of Environmental Quality

December 1, 2004

The Department of Planning and Budget (DPB) has analyzed the economic impact of this proposed regulation in accordance with Section 2.2-4007.G of the Administrative Process Act and Executive Order Number 21 (02). Section 2.2-4007.G requires that such economic impact analyses include, but need not be limited to, the projected number of businesses or other entities to whom the regulation would apply, the identity of any localities and types of businesses or other entities particularly affected, the projected number of persons and employment positions to be affected, the projected costs to affected businesses or entities to implement or comply with the regulation, and the impact on the use and value of private property. The analysis presented below represents DPB's best estimate of these economic impacts.

Summary of the Proposed Regulation

The General Assembly mandates in §62.1-44.15 of the Code of Virginia that the State Water Control Board (board) adopt such regulations as it deems necessary to enforce the general water quality program of the board in all or part of the Commonwealth. Specifically, the code mandates that the board establish requirements for the treatment of sewage, industrial wastes, and other wastes that are consistent with the purposes of the State Water Control Law.

Proposed regulation 9 VAC 25-260 (Water Quality Standards) establishes water quality standards for the Chesapeake Bay and its tidal tributaries. It establishes five subcategories of designated use and provides new and updated criteria (numerical and narrative) to protect these designated uses from the impact of nutrients and suspended sediments. It also allows the board to issue or modify Virginia Pollutant Discharge Elimination System (VPDES) permits for point sources located in the Chesapeake Bay watershed[1] such that the requirements of the regulation are met.

The proposed regulations establish specific requirements for point sources discharging into the Chesapeake Bay watershed in order to ensure that water quality goals are met. The proposed regulations (1) set technology-based annual average total nitrogen and total phosphorus concentration requirements for certain existing point sources and certain new and expanded point sources discharging into the Chesapeake Bay watershed, (2) establish total nitrogen and total phosphorus annual waste load allocations for sources defined as significant dischargers[2], and (3) authorize a trading and offsets program for all significant dischargers within a river basin to assist in the achievement and maintenance of the total annual waste load allocation.

Estimated Economic Impact

Background:

In May 1999, the Environmental Protection Agency (EPA) placed most of Virginia's portion of the Chesapeake Bay and several of its tidal tributaries on the impaired waters list. The 2000 Chesapeake Bay agreement[3] set a goal of removing these waters from the list of impaired water bodies for nutrients and sediments by 2010. If water quality standards are not met by 2010, a total maximum daily load (TMDL) is to be developed for the entire Chesapeake Bay. One of the key aspects of the Chesapeake Bay agreement was to define water quality conditions necessary to protect aquatic living resources in the bay. In response, the EPA issued a regional criteria guidance document entitled, "Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity, and Chlorophyll *a* for the Chesapeake Bay and Its Tidal Tributaries"[4]. The regional criteria guidance was developed in order to assist Chesapeake Bay states (Maryland, Virginia, Delaware, and Washington, D.C.) in adopting revised water quality standards to

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[1] The Chesapeake Bay watershed consists of the following river basins: Potomac river basin, James and Appomattox river basin, Rappahannock river basin, York river basin, and Chesapeake Bay and small coastal basins.

[2] Significant dischargers are defined as existing point sources listed in the proposed regulations (specifically, 9 VAC 25-720) and new or expanded point sources authorized under a VPDES permit issued after July 1, 2004 to discharge 2,300 pounds or more of nitrogen per year or 300 pounds or more of phosphorus per year (equivalent to the annual waste load from a municipal wastewater treatment plant discharging 40,000 gallons or more per day).

[3] The signatories to the 2000 Chesapeake Bay agreement were Pennsylvania, Maryland, Virginia, Washington, D.C., the Chesapeake Bay Commission, and EPA. However, in a separate six-state memorandum of understanding with EPA, New York, Delaware, and West Virginia also made the same commitment.

[4] Prepared by Region III of the U.S. Environmental Protection Agency, in coordination with the Office of Water and the Office of Science and Technology, Washington, D.C.

address nutrient and sediment-based pollution in the Chesapeake Bay and its tidal tributaries. The guidance document defined water quality conditions called for in the 2000 Chesapeake Bay agreement by developing Chesapeake Bay-specific water quality criteria for dissolved oxygen, water clarity, and chlorophyll *a*. The guidance document also identified and described five habitats, or designated uses, which provided the context for deriving water quality criteria that were adequately protective.

Based on EPA's regional criteria guidance, proposed regulation 9 VAC 25-260 (Water Quality Standards) establishes five subcategories of designated use for the Chesapeake Bay and its tidal tributaries. The five new subcategories are migratory fish spawning and nursery, shallow water submerged aquatic vegetation, open water aquatic life, deep-water aquatic life, and deep channel seasonal refuge. The regulation also provides new and updated criteria (numerical and narrative) to protect the new designated uses from the impact of nutrients and suspended sediments, including criteria for dissolved oxygen, submerged aquatic vegetation, water clarity, and chlorophyll *a*.

Achievement of these water quality standards requires the establishment of effluent limitations on the discharge of nutrients (total nitrogen and total phosphorus) and sediment into Virginia's portion of the Chesapeake Bay watershed. Reductions in the discharge of nutrient and sediments into the Chesapeake Bay and its tidal tributaries are required from all point and non-point sources. Point sources include municipal wastewater treatment plants, industrial facilities, and other federal- and state-owned facilities. Non-point sources include run-off from agricultural, forest, urban, septic systems, and mixed open lands. The Department of Environmental Quality (DEQ) estimates that, based on 2002 conditions, approximately 33% of the nitrogen entering the Chesapeake bay and its tidal tributaries from Virginia can be attributed to point sources, with the remaining 66% attributable to non-point sources. Approximately 24% of the phosphorus delivered to these waters from Virginia can be attributed to point sources, with the remaining 76% attributable to non-point sources. All sediment occurring in these waters is attributable to non-point sources. The proposed regulations only address nutrient discharge by point sources (excluding the permitted discharge of not-contact cooling water or storm water) into Virginia's portion of the Chesapeake Bay watershed.

Description of the Regulations:

The proposed regulations are intended to establish limits on the discharge of total nitrogen and total phosphorus by point sources into Virginia's portion of the Chesapeake Bay watershed. Existing regulations only require point sources authorized under a VPDES permit to discharge 1,000,000 gallons or more per day into nutrient enriched waters (including Chesapeake Bay tidal waters) to meet a monthly average total phosphorus concentration of 2.0 mg/l or less. New sources authorized under a VPDES permit issued after July 1, 1988 to discharge 50,000 gallons or more per day are also required to meet a monthly average total phosphorus concentration of 2.0 mg/l or less.

(1) The proposed regulations state that it is the State Water Control Board's policy that point sources discharging into the Chesapeake Bay watershed utilize, at a minimum, biological nutrient removal (BNR) treatment or its equivalent whenever feasible.[5] Specifically, the proposed regulations set technology-based annual average total nitrogen and total phosphorus concentration requirements for certain existing point sources and certain new and expanded point sources discharging into the Chesapeake Bay watershed.

- Significant dischargers authorized to discharge under a VPDES permit issued on or before the effective date of these regulations are required to meet an annual average total nitrogen concentration limit of 8.0 mg/l and an annual average total phosphorus concentration limit of 1.0 mg/l. These limits are to be met within four years of re-issuance or major modification of the VPDES permit, but no later than December 31, 2010.
- Point sources not defined as significant dischargers, but authorized under a VPDES permit issued on or before July 1, 2004 to discharge 40,000 gallons or more per day are also required to meet an annual average total nitrogen concentration limit of 8.0 mg/l and an annual average total phosphorus concentration limit of 1.0 mg/l. These effluent limits are to be included in reissued or modified VPDES permits after December 31, 2010 and are to be met within four years of re-issuance or modification.

[5] According to DEQ, BNR treatment reduces the annual average nitrogen concentration to 8.0 mg/l and phosphorus concentration to 1.0 mg/l.

- New and expanded point sources authorized by a VPDES permits issued after the effective date of these regulations to discharge 40,000 gallons or more per day are required to meet an annual average total nitrogen concentration limit of 3.0 mg/l and an annual average total phosphorus concentration limit of 0.3 mg/l. According to DEQ, a 3.0 mg/l concentration limit for nitrogen is currently at the limit of technology. The limit of technology for phosphorus is a concentration limit of 0.1 mg/l.

The proposed regulations also contain provisions for alternative effluent limitations. If a point source can demonstrate that the applicable effluent concentration limits cannot be achieved, the board can then require alternative effluent limitations.

(2) The proposed regulations also establish total nitrogen and total phosphorus annual waste load allocations for existing significant dischargers. All existing significant dischargers are listed, by river basin, in the proposed regulations along with a total nitrogen and a total phosphorus waste load allocation in pounds per year. The individual waste load allocations are based on EPA's calculation of the total waste load allocation for Virginia and the total waste allocation for each river basin.[6] According to DEQ, individual allocations are determined based on a facility's existing design flow capacity (some of which is currently unused) and effluent concentration limits of 3.0 mg/l or 4.0 mg/l for nitrogen and 0.3 mg/l or lower for most significant dischargers for phosphorus[7]. The entire point source waste load allocation is distributed among existing significant dischargers. New significant dischargers, i.e., dischargers authorized under a VPDES permit issued after July 1, 2004 to discharge 2,300 pounds per year or more of nitrogen or 300 pounds per year or more of phosphorus, are not assigned a waste load allocation. The proposed regulations require existing significant dischargers to achieve their waste load allocation within four years of re-issuance or major modification of the VPDES permit, but no later than December 31, 2010.

(3) The proposed regulations authorize a trading and offsets program for significant dischargers within a river basin to assist in the achievement and maintenance of the total annual

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[6] The individual waste load allocations can be found in the Chesapeake Bay Nutrient and Sediment Reduction Tributary Strategy for the Eastern Shore, James River, Lynnhaven, and Poquoson Coastal Basins, Shenandoah and Potomac River Basins, Rappahannock River and Northern Neck Coastal Basins, and York River and Lower York Coastal Basins.

[7] The phosphorus concentration limit was assumed to be 0.3 mg/l or lower for most municipal plants and was determined on a case-by-case basis for most industrial plants.

waste load allocations. Trading between nutrients is not allowed. Moreover, trading can occur only through VPDES permits. Currently, trading through VPDES permits would require modifications to individual VPDES permits each time a trade occurs, a time consuming and burdensome process. However, DEQ anticipates the establishment of a VPDES watershed permit prior to the effective date of these regulations.[8] Following its establishment, the agency expects trading to occur through VPDES watershed permits for each river basin. A watershed permit would not require modifications to the permit each time a trade occurred between point sources discharging into a river basin. Moreover, it would allow trading to occur without triggering federal anti-backsliding and anti-degradation provisions (a more detailed discussion of the benefits of a watershed permit is provided later in the analysis).

For the purposes of trading in nitrogen and phosphorus waste load, the proposed regulations establish delivery factors for all existing significant dischargers based on their location within a river basin. Delivery factors adjust the waste load discharged by a point source for any alteration to the load due to biological, chemical, and physical processes while being transported to Chesapeake Bay tidal waters. Each discharger's total waste load allocation is adjusted by the delivery factor to arrive at the total waste load delivered allocation. For example, point sources discharging directly into tidal waters will have a delivery factor of one and the total waste load delivered will be identical to the total waste load initially discharged. However, point sources discharging upstream of tidal waters are likely to have a delivery factor of less than one and the total waste load delivered into tidal waters is likely to be less than the total waste load initially discharged. Thus, any trades between point sources are required to account for the delivery factor assigned to each discharger and to be in terms of the waste load eventually delivered into tidal waters, not the waste load initially discharged. Trades are also required to meet anti-degradation provisions specified in the proposed regulations. Specifically, all trades are required to be such that they do not have an adverse impact on local water quality and do not lead to violations of water quality standards.

As mentioned above, the proposed regulations do not assign a waste load allocation to new significant dischargers. Neither do the proposed regulations allow for expanded discharges from existing significant dischargers over and above their assigned waste load allocation. Any

[8] DEQ expects legislative action establishing a watershed permit prior to the effective date of these regulations.

discharge from a new significant discharger or expanded discharges above the assigned waste load allocation from an existing significant discharger requires (i) a trade for an equivalent or greater waste load reduction of the same pollutant from other existing point sources within the river basin or (ii) achievement of at least twice the required waste load reduction from a non-point source. Due to uncertainties associated with non-point source reductions, the proposed regulations establish a trading ratio of 2:1 between non-point and point source reductions. According to a 1999 EPA study[9], there have been several trading and offset projects in the United States since the 1980s. Of these, 24 involved nitrogen, phosphorous, or both. A majority of these 24 projects allowed for some trading between non-point and point sources, with trading ratios ranging from 1.1:1 to 4:1. Several projects, including the Tar-Pamlico Nutrient Reduction Trading Program in North Carolina and the Lake Dillon Trading Program in Colorado, use a 2:1 trading ratio between non-point and point source reductions. The 2001 "Chesapeake Bay Program Nutrient Trading Fundamental Principles and Guidelines" prepared by the Chesapeake Bay Program Nutrient Trading Negotiation Team notes that a trading ratio of 2:1 between non-point and point source reductions is the most commonly used trading ratio.

Prior to purchasing non-point source offsets, the proposed regulations require point sources to meet an annual average total nitrogen concentration limit of 3.0 mg/l and an annual average total phosphorus concentration limit of 0.3 mg/l. In addition, non-point source offsets are to be purchased within the locality served by the new or expanded significant discharger unless otherwise determined by the board. Credit is to be given only for those non-point reductions over and above what is currently required to meet Chesapeake Bay water quality standards and for those non-point source reductions not financed through government programs. Installation, maintenance, and monitoring of non-point source best management practices are to be required through the discharger's VPDES permit and the best management practices are to be implemented only following issuance of the permit.

While new and expanded significant dischargers have the option of trading for an equivalent waste load reduction with other point sources or implementing non-point source best management practices that achieve twice the required waste load reduction, existing significant dischargers can only trade with other point sources. According to DEQ, uncertainty over

[9] *A Summary of U.S. Effluent Trading and Offset Projects*. Prepared by Environomics for the U.S. Environmental

implementing and achieving non-point source reductions is the main reason for not allowing existing significant dischargers to purchase non-point source offsets.

Estimated Economic Impact:

The proposed regulations are likely to impose economic costs and produce economic benefits. Economic costs will be incurred by point sources in meeting the individual technology-based nitrogen and phosphorus concentration limits and the total annual waste load allocation. On the other hand, economic benefits will accrue from the attainment of water quality standards in the Chesapeake Bay, including benefits to public health, commercial fisheries, tourism and recreation, property values in surrounding areas, and the regional economy in general.

Economic Costs: The proposed regulations are likely to impose economic costs on existing point sources defined as significant dischargers. These point sources will be required to meet both the individual technology-based effluent concentration limits and their annual waste load allocation. The proposed regulations identify 120 existing significant dischargers, 95 municipal wastewater treatment plants[10] and 25 industrial and other facilities. DEQ estimates the capital costs of retrofitting existing significant dischargers such that they meet effluent concentration and waste load allocation limits at approximately $1.1 billion, $1.015 billion to retrofit municipal wastewater treatment plants and $0.085 billion to retrofit the remaining facilities.[11] Significant dischargers and capital cost estimates by river basin are provided below.

Table 1: Summary of Existing Significant Dischargers and Capital Costs, by River Basin

	Significant Dischargers	Total Capital Cost (millions)
Eastern Shore Basin	5	$14
James River Basin	39	$486
York River Basin	11	$31
Rappahannock River Basin	22	$93
Potomac/Shenandoah River Basin	43	$476

Protection Agency's Office of Water, 1999.

[10] According to DEQ, 21 municipal wastewater treatment plants identified as significant dischargers have already installed BNR treatment and meet the required effluent concentration limits.

[11] The capital cost estimates have an uncertainty range of –30% to +50%.

In addition, the agency estimates that existing significant dischargers are likely to incur operation and maintenance costs of $41.5 million a year.[12]

The proposed regulations are likely to impose economic costs on existing point sources not defined as significant dischargers, but authorized under a VPDES permit issued prior to July 1, 2004 to discharge 40,000 gallons or more per day. These point sources will now be required to meet individual technology-based effluent concentration limits. DEQ estimates there to be 117 municipal wastewater treatment plants that are not defined as significant dischargers, but that will be required to meet individual technology-based effluent concentration limits. The capital cost of retrofitting these wastewater treatment plants is estimated to be $72 million.[13] The number of affected municipal dischargers and capital cost estimates by river basin are provided below.

Table 2: Summary of Affected Municipal Dischargers not Defined as Significant Dischargers and Capital Costs, by River Basin

	Smaller Municipal Plants	Total Capital Cost (millions)
Eastern Shore Basin	0	$0
James River Basin	40	$25
York River Basin	14	$9
Rappahannock River Basin	12	$7
Potomac/Shenandoah River Basin	51	$31

In addition, the agency estimates that non-significant municipal dischargers are likely to incur operation and maintenance costs of $904,400 a year. Apart from municipal wastewater plants, a number of smaller industrial plants may also be required to meet individual technology-based effluent concentration limits. Based only on a review of facility design capacity (and not of nutrient data), DEQ estimates the maximum number of such facilities to be 174. However, the capital cost of retrofitting these facilities is not currently available. Annual operation and

[12] Capital cost estimates have been updated since the estimates reported in the economic impact analysis of 9 VAC 25-260 (Water Quality Standards). Annual operation and maintenance cost estimates have also been developed since the analysis.

[13] The capital cost estimates are rough calculations based on cost and design flow data of eleven non-significant facilities, nine in Virginia and two in Maryland.

maintenance costs for smaller municipal and non-municipal plants required to meet individual effluent concentration limits are also not currently available.[14]

The proposed regulations are also likely to impose additional costs on certain new and expanded point sources. Point sources authorized to discharge 40,000 gallons or more per day under a VPDES permit issued after July 1, 2004 will be required to meet total nitrogen and total phosphorus effluent concentration limits of 8.0 mg/l and 1.0 mg/l, respectively. Point sources authorized to discharge 40,000 gallons or more per day under a VPDES permit issued after the effective date of these regulations will be required to meet total nitrogen and total phosphorus effluent concentration limits of 3.0 mg/l and 0.3 mg/l, respectively. In addition, these new and expanded point sources will be subject to the total annual waste load limit. New point sources discharging 40,000 gallons or more per day and expanded point sources discharging in excess of their waste load allocation will be required to trade with existing point sources for an equivalent waste load reduction or buy twice the required reductions from non-point sources prior to discharge. Individual technology-based effluent concentration limits and the total annual waste load allocation are likely to make it more expensive for new and expanded point sources to operate compared to existing requirements. The number of entities likely to be affected by these requirements and the additional cost to them of meeting these requirements is not known at this time.

Economic Benefits: The proposed regulations are also likely to produce economic benefits. The benefits accruing from the restoration of water quality include benefits to public health, commercial fisheries, tourism and recreation, property values in surrounding areas, and the regional economy in general. In a 2003 analysis[15], EPA attempted to evaluate the value of Chesapeake Bay's ecological goods and services. Based on regional economic impact modeling, it was estimated that the Chesapeake Bay watershed affects industries such as commercial fishing, boat building and repair, and tourism that generate approximately $20 billion in output per year and account for approximately 340,000 in jobs (1998 conditions). It should be noted that Chesapeake Bay is only one of many factors affecting these industries and the exact extent

[14] These costs will be incurred only after 2010 as the proposed regulations require individual technology-based effluent limits for smaller municipal and non-municipal plants to be included in reissued or modified VPDES permits after December 31, 2010.

to which these industries rely on Chesapeake Bay water quality is not known. Based on 1998 conditions, tourism was by far the largest of these industries, accounting for approximately $19.6 billion in output and 337,572 in jobs. Tourism, as a composite industry, was found to represent the fourteenth largest source of output and the eighth largest source of employment in the Chesapeake Bay watershed.[16] The EPA analysis goes on to state that while the extent to which industries rely on the Chesapeake Bay water quality is unclear, participation rates and expenditures on recreational fishing suggest that a significant percentage of tourism output is likely to be linked to the quality of water bodies such as the Chesapeake Bay.

There exists a body of literature on the value of water quality changes. For example, Leggett and Bockstael (2000)[17] find that water quality improvements (in terms of fecal coliform levels) have a positive and significant effect on property values along the Chesapeake Bay. Lipton (2004)[18] concludes that there is reasonable evidence that boaters are willing to pay for improvements in water quality. According to the study, water quality does impact the enjoyment of boating and boaters would benefit by a significant amount if it were to improve. Lipton and Hicks (1999)[19] establish a link between water quality improvements and recreational fishing values in the Chesapeake Bay. They conclude that, while water quality improvements from current levels will have little benefit to striped bass recreational fishermen, allowing water quality to deteriorate from current levels will produce significant effects. Analyses by Bockstael, McConnell, and Strand (1989)[20] and Krupnick (1988)[21] estimate significant benefits of water quality improvements to recreational uses. Studies such as McConnell and Strand (1989)[22] examine the welfare gains associated with commercial fisheries. These studies look at how

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[15] *Economic Analyses of Nutrient and Sediment Reduction Actions to Restore Chesapeake Bay Water Quality*, 2003 - September. Prepared by Region III of the U.S. Environmental Protection Agency.

[16] The tourism sector is based on an aggregate weighted percent of 15 industries including travel, eating and drinking, hotels and lodging, and amusement and recreation services.

[17] Leggett, C. G. and N. E. Bockstael, 2000. Evidence of the Effects of Water Quality on Residential Land Prices. *Journal of Environmental Economics and Management* 39: 121-144.

[18] Lipton, D.W., 2004. The Value of Improved Water Quality to Chesapeake Bay Boaters. *Marine Resource Economics* 19(2):1-6.

[19] Lipton, D.W. and R. Hicks, 1999. Linking Water Quality Improvements to Recreational Fishing Values: The Case of Chesapeake Bay Striped Bass. Proceedings evaluating the benefits of recreational fishing. *Fisheries Centre Research Reports* 7(2): 105-110.

[20] Bockstael, N.E., McConnell, K.E., and I.E. Strand, 1989. Measuring the Benefits of Improvements in Water Quality: The Chesapeake Bay. *Marine Resource Economics* 6(1): 1-18.

[21] Krupnick, A., 1988. Reducing Bay Nutrients: An Economic Perspective. *Maryland Law Review* 47(2): 453-480.

[22] McConnell, K.E. and I.E. Strand, 1989. Benefits from Commercial Fisheries When Demand and Supply Depend on Water Quality. *Journal of Environmental Economics and Management* 17(3): 284-292.

changes in water quality affect costs of production, the growth of stock, and eventually the consumer surplus.

However, benefits estimates are subject to great uncertainty. Estimates of the benefits of water quality improvement in the existing literature cover a wide range of values. Moreover, none of these estimates are specifically applicable to Virginia or to the nutrient load reduction being proposed. Finally, due to problems in quantifying them, it is difficult to arrive at precise estimates for many of the benefits, such as benefits to public health, to commercial fisheries, and to the regional economy in general, likely to accrue from water quality improvements. For example, consider the estimation of recreational use benefits (likely to be the largest benefit category). Bockstael, et al. (1989) estimate that a 20% improvement in nitrogen and phosphorus concentrations is likely to produce annual recreational use benefits for the Maryland portion of Chesapeake Bay of between $21 million and $92 million (inflation-adjusted from 1996). Krupnick (1988) estimates that a 40% improvement in nitrogen and phosphorus concentrations is likely to produce annual recreational use benefits for the Chesapeake Bay area as a whole of between $52 million and $149 million (inflation-adjusted from 1996). Based on Bockstael et al. (1989) and Krupnick (1988), Morgan and Owens (2001)[23] estimate the benefits to the Chesapeake Bay area of improvements in water quality between 1972 and 1996. A 60% improvement in water quality is estimated to have provided annual benefits to people living in Washington, D.C., Virginia, and portions of Maryland of between $432 million and $2.2 billion (inflation-adjusted from 1996). As demonstrated by these studies, estimates of recreational use benefits fall within a wide range of values. Moreover, none of these estimates are specific to Virginia's portion of the Chesapeake Bay or to the nutrient load reduction being proposed[24]. Finally, the estimates do not include many of the recreational use benefits that are likely to accrue from water quality improvements in the Chesapeake Bay. For example, Morgan and Owens (2001) are unable to quantify recreational use benefits associated with activities such as hunting, swimming, and canoeing in the Chesapeake Bay. They are also unable to attribute recreational use benefits of water quality improvements to individuals living outside

[23] Morgan, C. and N. Owens, 2001. Benefits of Water Quality Policies: The Chesapeake Bay. *Ecological Economics* 39: 271-284.

[24] According to DEQ, the proposed regulations are likely to result in a nitrogen load reduction of 8.9 million pounds per year and a phosphorus load reduction 0.87 million pounds per year.

Washington, D.C and the tidal portions of Maryland and Virginia. Recreational use benefits of water quality improvements in the tributaries are also not included in the benefits estimate.

The proposed regulations are likely to provide economic benefits in addition to those discussed above. Some of the costs associated with implementing the proposed water quality standards are likely to be met by federal cost-share programs. Barring any change in federal legislation and appropriation, DEQ estimates that approximately 90% of the estimated cost to point sources is likely to be met by in-state resources. The remaining 10% is likely to be met by federal cost-share programs. DEQ anticipates that existing federal grants to the Virginia Revolving Loan Fund will be used as a primary funding source for point sources.[25] According to the agency, there also appears to be momentum building for the creation of a Chesapeake Bay watershed financing authority[26], with 80% of the needed funds coming from the federal government and 20% of the needed funds coming from participating states. To the extent that additional federal funds are provided to defray some of the costs, it is likely to produce economic benefits for the state. Any additional federal funds will reduce the cost to in-state resources (state, local, and private) in implementing the proposed regulations. Moreover, unlike in-state resources, additional federal funds will inject money into the state economy without any offsetting economic effects elsewhere in the state. These funds are likely to be spent within the state on point source nutrient control, thus increasing Virginia income and output. Finally, as the injected cash is likely to be spent on goods and services in Virginia, the additional federal funds will be subject to an economic multiplier and produce secondary economic benefits for the state.

The proposed regulations are also likely to produce some economic benefits by making Virginia's water quality policies more consistent with those of other states. States such as Maryland, Delaware, and Washington, D.C. (the three other watershed jurisdictions with Chesapeake Bay tidal waters) are currently in the process of promulgating similar regulations implementing water quality standards for the Chesapeake Bay. Virginia is committed to implementing these water quality standards as part of the 2000 Chesapeake Bay agreement and the 2000 six-state memorandum of understanding with EPA. Failure to do so could result in EPA promulgating and implementing water quality standards for the state as well as continued litigation from environmental groups. Thus, there are many significant monetary and non-

[25] The Water Quality Improvement Fund is a supplemental funding source for point sources.

monetary benefits to the state from implementing the required water quality standards for the Chesapeake Bay and its tidal tributaries.

The net economic impact of the proposed change will depend on whether the costs of implementing the proposed water quality standards are greater than or less than the benefits of doing so. The costs and the benefits of implementing the proposed regulations are likely to be large, with estimates for both ranging from the many millions to the billions of dollars. However, estimates of both the costs and benefits are subject to great uncertainty. The capital cost estimates for point sources, significant and non-significant, are subject to great uncertainty. Specifically, the capital cost estimates for existing significant dischargers is subject to an uncertainty band of –30% to +50%. The capital cost estimates for existing non-significant municipal dischargers are rough figures based on cost and design flow data from a small number of facilities. Moreover, there are no estimates currently available for the capital costs associated with retrofitting smaller industrial facilities such that they meet the required technology-based effluent concentration limits. Annual operation and maintenance cost estimates for smaller non-municipal facilities required to meet effluent concentration limits are also not currently available. Finally, the additional cost to new and expanded point sources subject to individual technology-based effluent concentration limits and the annual waste load limit is not known. Benefit estimates are also subject to great uncertainty. Existing benefits estimates fall within a wide range of values, from the millions to the billions of dollars. Moreover, existing benefits estimates are not specific to Virginia or to the nutrient load reduction being proposed. Finally, due to problems in quantifying them, it is very difficult to arrive at precise estimates for many of the benefits that are likely to accrue from improvements in the water quality of Chesapeake Bay and its tidal tributaries. Thus, given the many large uncertainties, it is not possible at this time to make a sound determination of the net economic impact of the proposed change.

However, while evaluating the costs and benefits of the proposed change, it should be kept in mind that, under current law, failure to meet required water quality standards by 2010 will result in the development of a TMDL for the entire Chesapeake Bay. According to DEQ, a TMDL is not likely to impose any additional limits on point source discharges than those being

[26] This is a recommendation of the Chesapeake Bay Program Blue Ribbon Finance Panel.

proposed under these regulations. Thus, by not implementing the proposed regulations, the state would only be putting off the costs associated with their implementation by a few years.

Improving Cost Effectiveness of the Proposed Regulations:

Existing water quality standards have been inadequate for the protection of water quality in Chesapeake Bay and its tidal tributaries. Despite the existence of these standards, most of Virginia's portion of Chesapeake Bay and portions of several of its tidal tributaries were put on EPA's impaired waters list in 1999. Thus, reductions in nutrient and sediment discharge over and above those currently required are essential in order to meet water quality standards being proposed in 9 VAC 25-260 (Water Quality Standards) by 2010. In order to meet water quality goals, point sources and non-point sources will have to reduce nutrient and sediment input from current levels. As discussed in the previous section, the costs to point sources of making the required reduction in nutrient discharge are likely to be large. Due to the magnitude of these costs, ways of achieving the required reductions at the lowest possible cost take on additional importance. It is worth noting that, as most of the reductions are likely to occur at municipal wastewater treatment plants, a majority of the costs will be borne by individual ratepayers residing in localities served by these municipal wastewater treatment plants. Thus, lower cost means of achieving the required nutrient reduction will result in cost savings for ratepayers.

Effluent trading is one way of achieving reductions in nutrient discharge in a cost effective manner. Effluent trading is a market-based approach that allows one source to meet its regulatory obligations by using pollutant reductions created by another source that has lower pollution control costs. It takes advantage of economies of scale and pollution control cost differentials between sources. For example, larger facilities may be able to reduce pollutant discharge at a lower per unit cost than smaller facilities. Under these circumstances, it will be cheaper for the smaller facility to buy an equivalent waste load reduction from the larger facility than for it to reduce its discharge to the required level. Similarly, if non-point source reductions are cheaper than point source reductions, it would be more cost effective for a point source to buy an equivalent non-point source waste load reduction than for it to reduce its discharge to the required level. In addition to cost savings, effluent trading also creates economic incentives for innovation, emerging technology, voluntary pollution reductions, and greater efficiency in improving water quality. For example, knowing that any excess reductions can be sold for additional revenues is likely to make a point source more willing to invest in research into new and innovative ways of reducing effluents and to undertake investments that reduce effluents to below required limits. In turn, increased investment into ways of reducing effluent discharge is likely to result in water quality goals being achieved sooner than they would have been achieved otherwise.

EPA acknowledges the advantages of using market-based approaches such as effluent trading in achieving water quality standards. In fact, EPA has developed a effluent trading policy whose stated purpose is "to encourage states, interstate agencies, and tribes to develop and implement water quality trading programs for nutrients, sediments, and other pollutants where opportunities exist to achieve water quality improvements at reduced costs." [27] The policy document goes on to state that it is EPA's belief that market-based approaches such as effluent trading provide greater flexibility and have the potential to achieve water quality and environmental benefits greater than would otherwise be achieved under more traditional regulatory approaches. A 2002 hearing by the Congressional Subcommittee on Water Resources and Environment[28] also noted that any future pollutant reductions required for bringing water bodies into compliance with state water quality standards are likely to be expensive and complex and may require the use of innovative approaches such as effluent trading. It goes on to note that pollutant control costs may be reduced if flexible approaches, including trading, are utilized. In a 2004 paper, entitled "U.S. Environmental Protection Agency Regions II and III NPDES Permitting Approach for Discharges of Nutrients in the Chesapeake Bay", EPA encourages permitting authorities to consider promoting opportunities for trading nutrient reductions such that the effectiveness of the nutrient permitting process is enhanced.

A 2001 EPA draft report[29] estimated that flexible approaches to improving effluent trading could save $900 million annually compared to the least flexible approach. The report estimates the cost of developing and implementing TMDLs for all 1998 impaired waters under three different scenarios: the least flexible TMDL program that requires all sources to implement the next treatment step, the moderately cost effective TMDL program that ties the

[27] Final Water Quality Trading Policy, January 2003. United States Environmental Protection Agency, Office of Water Quality Trading Policy.
[28] The Subcommittee on Water Resources and Environment Hearing on Water Quality Trading – An Innovative Approach to Achieving Water Quality Goals on a Watershed Basis, June 2002.

pollutant load reduction to that required by a typical TMDL, and the more cost effective TMDL program that allows for more flexibility including trading. The costs are estimated to range from $1.9 billion to $4.3 billion per year under the least flexible TMDL program, from $1.1 billion to $3.4 billion per year under the moderately flexible TMDL program, and from $0.9 billion to $3.2 billion per year under the more cost effective TMDL program.[30] In another analysis of the cost savings generated by trading, the Connecticut Department of Environmental Protection estimates that the Long Island Sound Trading Program (a trading program that allows publicly owned treatment works in Connecticut that discharge into the Long Island Sound to trade nitrogen credits) is likely to reduce capital costs for nitrogen removal by over $200 million, from $960 million to $760 million, over 15 years.

The proposed regulations do include provisions for trading among point sources and for point sources to buy offsetting non-point source reductions. Existing significant dischargers and new and expanded significant dischargers are allowed to trade with each other once they meet the required individual technology-based effluent concentration limits. In addition, new and expanded significant dischargers are allowed to purchase non-point source offsets at a 2:1 ratio. However, opportunities for trading could be enhanced even further, potentially reducing the cost to point sources in achieving the required reductions. Some ways of enhancing trading opportunities and improving the cost effectiveness of the proposed regulations are identified below.

Remove the proposed individual technology-based effluent concentration limits for existing significant dischargers and new and expanded significant dischargers and replace them with an annual waste load allocation that results in an equivalent effluent reduction.[31] Requiring point sources to meet individual technology-based nitrogen and phosphorus concentration limits before trading can occur sacrifices a significant part of the gains from trading. Regardless of the economies of scale and pollutant control cost differentials, point

[29] *The National Costs of the Total Maximum Daily Load Program*, 2001. A Draft Report Prepared by the Office of Water, U.S. Environmental Protection Agency, Washington, D.C.

[30] The cost to point sources is estimated to range from $1.1 billion to $2.2 billion per year under the least flexible TMDL program, from $0.8 billion to $1.6 billion per year under the moderately flexible TMDL program, and from $0.6 billion to $1.3 billion per year under the more cost effective TMDL program.

[31] An annual waste load allocation producing a waste load reduction equivalent to that produced by individual technology-based effluent concentration limits will meet the stated policy objective of using technologically-based numerical limits for nutrients in discharge permits to achieve water quality standards.

sources will not be able to trade until they achieve the required individual technology-based effluent concentration limits. Even if it is cheaper for a facility to buy effluent reductions equivalent to what is achieved by implementing individual technology-based effluent concentration limits, the proposed regulations require the facility to choose the more costly option and reduce effluent concentration. Thus, individual technology-based effluent concentration limits effectively reduce the flexibility of point sources to choose the lowest cost means of achieving the required reductions.

Replacing individual technology-based effluent concentration limits with an annual waste load allocation that produces an equivalent nutrient reduction will provide point sources with the flexibility to choose the lowest cost means of achieving the reductions while retaining the same level of environmental protection. For example, based on the cost associated with each option, point sources can choose to meet their waste load reduction requirements by reducing their effluent concentration levels, trading for an equivalent load reduction with another point source, or purchasing equivalent non-point source offsets (discussed further in the following section). An annual waste load allocation would also provide point sources with the option of engaging in demand-side activities that reduce or prevent pollution at the source. For example, a point source may find it economically feasible to reduce the amount of waste reaching its facility by engaging in pollution prevention activities at the source of the pollution rather than reduce its effluent concentration level. The proposed regulations restrict the choices available to point sources to one option, lowering effluent concentration levels to the required limit.

As long as there are economies of scale among point sources and pollution control cost differentials between point and non-point sources, the increased flexibility is likely to enhance trading opportunities, resulting in cost savings for point sources and the creation of economic incentives for innovation, emerging technology, voluntary pollution reductions, and greater efficiency in improving water quality for point and non-point sources. In the presence of economies of scale and pollution control cost differentials, trading for an equivalent waste load reduction from another point source or buying equivalent non-point source offsets is likely to provide a lower cost alternative for achieving the required reductions than implementing individual technology-based effluent concentration limits. In the absence of any economies of scale and pollution control cost differentials, replacing individual technology-based effluent concentration limits with an equivalent annual load allocation will produce the same outcome as the proposed regulations. In other words, there will be no trading among point sources and between point and non-point sources and each point source will choose reduce its effluent concentration to the prescribed limit. Thus, eliminating individual technology-based effluent concentration limits and replacing them with an equivalent annual waste load allocation will provide point sources with additional flexibility to seek out the lowest cost means of reducing waste load while still maintaining the same level of environmental protection.

The proposed regulations do establish annual waste load allocations for existing significant dischargers. The sum of the individual annual waste load allocations of all existing significant dischargers releasing nutrients into a river basin is the total annual waste load allocation for that river basin. However, according to DEQ, the proposed total annual waste load allocation is not likely to produce effluent reductions equivalent to those likely to be achieved by individual technology-based effluent concentration limits, at least in the short-term. With all existing design flow capacity being used, the proposed annual waste load allocation is equivalent to effluent concentration limits of 3.0 mg/l or 4.0 mg/l for nitrogen and 0.3 mg/l or lower for most significant dischargers for phosphorus. However, not all of the existing design flow capacity is currently being used. According to DEQ, at the current usage level, reductions achieved by the proposed annual waste load allocation are less than those achieved by the individual technology-based effluent concentration limits. The agency believes that until more of the existing design flow capacity is used, individual technology-based effluent concentration limits are likely to produce waste load reductions greater than those produced by the annual waste load allocation.

However, there are more cost effective ways of achieving waste load reductions equivalent to those achieved by the individual technology-based effluent concentration limits. One way would be to make only a portion of a point source's annual waste load allocation, based on its use of existing capacity, available to it initially. For example, the available portion of a point source's annual waste load allocation could be based on its current capacity use and the proposed effluent concentration level. As more and more of the existing capacity gets used up, the available portion of a point source's annual waste load allocation could then be increased in increments deemed appropriate by DEQ (these increments could be designed to be equivalent to or greater than the reductions achieved by the individual technology-based effluent concentration limits). Such a system would allow point sources the flexibility to choose the lowest cost means of achieving the required reductions and would allow the state to reap all the benefits of trading while still producing overall effluent reductions equivalent to those produced by the proposed individual technology-based effluent concentration limits.

While existing literature does point to significant economies of scale and pollution control cost differentials among point sources and between point and non-point sources, estimates of both vary widely. It is precisely due to the uncertainty surrounding these estimates that a trading program is needed. Trading provides an incentive to seek out the lowest cost means of achieving the required waste load reduction. A case in point is North Carolina's Tar Pamlico Nutrient Trading Program. It was initially estimated that it would cost point sources approximately $100 million to meet the prescribed waste load allocation. However, once the program was implemented, point source costs were found to be less than one-tenth the original estimate. Thus, enhancing trading opportunities by replacing individual technology-based effluent concentration limits with an equivalent annual waste load allocation will provide point sources with the flexibility to seek out the lowest cost means of achieving the required waste load reduction, many of which may not be known to us at this time. If economies of scale and pollution control cost differentials are found not to be significant, replacing individual technology-based effluent concentration limits with an equivalent annual waste load allocation will produce the same outcome as the proposed regulations.

Allow existing significant dischargers to buy non-point source offsets at a trading ratio determined by DEQ. Under the proposed regulations, point sources identified as existing significant dischargers are allowed to buy non-point source offsets only when they expand beyond their current design flow capacity. Thus, existing significant dischargers cannot buy non-point offsets as an alternative to reducing their effluent concentration limits or trading with other point sources at their current design flow capacity. If existing significant dischargers expand their design flow capacity, the proposed regulations allow discharges in excess of the assigned waste load allocation resulting from the expansion to be offset by trading with other significant point sources or by buying non-point source reductions.

According to DEQ, uncertainty regarding non-point source reductions was the primary reason for restricting the purchase of non-point source offsets to new and expanded significant dischargers. In its 2003 final water quality trading policy, EPA acknowledges the uncertainty in non-point source reductions and attributes it to several factors including but not limited to variability in precipitation, variable performance of land management practices, time lag between implementation of some practices and full performance, and the effects of soils, cover, and slope on pollutant load delivery to receiving waters. EPA supports a number of approaches to deal with the uncertainty in non-point source reductions including monitoring to verify load reductions, the use of trading ratios greater than 1:1 between non-point and point source reductions, using demonstrated performance values or conservative assumptions in estimating the effectiveness of non-point source best management practices, using site- or trade-specific discount factors, and retiring a certain percentage of non-point source reductions for each transaction.

The proposed regulations establish a trading ratio of 2:1 between non-point and point source reductions for discharges from new and expanded significant dischargers. The same ratio could be applied to discharges from existing significant dischargers. Or trading ratios could be based on the type of non-point source reductions being bought (urban non-point reductions to point source reductions, agricultural non-point reductions to point source reductions, etc.). Regardless of how the trading ratios are set, provisions could be included that would provide DEQ with the flexibility to raise or lower these ratios based on the degree to which required basin-wide waste load reductions are achieved or based on the use of techniques such as better monitoring that lower the uncertainty associated with non-point reductions. If implementation and maintenance of non-point source best management practices is found to be a major source of uncertainty, the state could choose to undertake this task. Point sources could be required, based on an established trading ratio, to pay a fee for every unit discharged over their annual waste load allocation. The fees so collected could then be used by the state to implement the required non-point source best management practices. A program similar to the one described above is in place in North Carolina’s Tar-Pamlico River Basin. Dischargers exceeding their waste load allocation pay a certain amount into a fund set up to implement agriculture and forestry best management practices. The fee amount is $29 times the excess loading (in kilograms). The $29 estimate is based on a 3:1 trading ratio between crop best management practices and point source reductions and a 2:1 trading ratio between animal best management practices and point source reductions.

Once a mechanism is in place that addresses the uncertainties associated with non-point source reductions, allowing existing significant dischargers to buy non-point source offsets could result in significant cost savings to point sources. In addition, it could create economic incentives for innovation, emerging technology, voluntary pollution reductions, and greater efficiency in improving water quality on the part of point and non-point sources. Creating the incentive to seek out low cost ways of achieving non-point reductions is particularly significant when we consider the fact that non-point sources are unregulated and, consequently, have no incentive to reduce their discharge. By allowing point sources to purchase non-point source offsets, an incentive is created to investigate and research low cost ways of achieving non-point source reductions.

As long as there are significant pollution control cost differentials between point and non-point sources, restrictions on point sources buying non-point source offsets could result in point sources not being able to choose the lowest cost means of achieving the required reductions. For example, it may be cheaper for a point source to purchase equivalent non-point source offsets than to implement individual effluent concentration limits or trade with another point source for an equivalent reduction. In the absence of pollution control cost differentials, allowing existing significant dischargers to buy equivalent non-point source offsets will produce the same outcome as the proposed regulations, i.e., point sources will not to buy any non-point source offsets. Thus, allowing existing significant dischargers to buy equivalent non-point source offsets will provide point sources with additional flexibility to seek out the lowest cost means of reducing waste load. Having a mechanism in place to tackle the uncertainty associated with non-point source reductions will allow these cost savings to be reaped without reducing the level of protection to state waters.

Estimates of the pollution control cost differential between non-point and point reductions vary widely. According to DEQ, point source reductions are estimated to cost a little under $12 per pound, compared to approximately $11 per pound for non-point agricultural discharges and $377 per pound for non-point urban discharges. However, other estimates indicate that reduction of a unit of non-point discharge is likely to be significantly cheaper than the reduction of a unit of point source discharge. It is precisely due to the uncertainty surrounding pollution control cost differentials between point and non-point sources that a trading program is useful. Trading provides an incentive to seek out the lowest cost means of achieving the required waste load reduction. Prior to the implementation of the Tar Pamlico Nutrient Trading Program, being able to purchase non-point source offsets was estimated to reduce point source costs by approximately $10 million. However, once the program was implemented, non-point source reductions were determined not to be cheaper than point source reductions. Consequently, point sources chose not to purchase any non-point source offsets. Thus, enhancing trading opportunities by allowing existing significant dischargers to buy non-point source offsets will provide point sources with the flexibility to seek out the lowest cost means of achieving the required waste load reductions, many of which may not be known to us at this time. If pollution control cost differentials are found not to be significant, replacing allowing existing significant dischargers to purchase equivalent non-point source offsets will produce the same outcome as the proposed regulations.

Ensure the establishment of a watershed-based VPDES permit. The proposed regulations require that all trading occur through VPDES permits. In addition, the proposed regulations require all point source purchases of non-point source offsets to also occur through VPDES permits. However, without the establishment of a VPDES watershed permit, all trades between point sources and all point source purchases of non-point source offsets will have to occur through modifications to individual VPDES permits. Trading and buying offsets through individual VPDES permits is likely to impose high transaction costs and raise potential legal problems for the state, localities, and industries discharging into the Chesapeake Bay watershed.

Without a watershed permit, each time a trade is to be made or non-point offsets are to be purchased permitees will be required to modify their VPDES permit. The process for modifying a VPDES permit is time-consuming and burdensome. The high transaction cost involved in modifying VPDES permits is, in turn, likely to reduce the incentive for point sources to undertake trades or purchase non-point source offsets. In fact, given the time and effort required to modify a permit, the proposed regulations will effectively restrict trading and purchase of non-point source offsets to satisfying long-term capacity needs. Trading and purchase of non-point source offsets to satisfy short-term compliance needs, such as the need to cover a temporary shortfall, will not be feasible due to the time taken to modify a permit. According to Woodward and Kaiser (2002)[32], six programs across the United States have clearly established bilateral nutrient credit trading programs. However, these programs were found to impose substantial transaction costs on participants and regulators. For example, in Wisconsin's Fox River program, each trade was subject to a review process that could take up to six months before a permit modification was granted. Despite substantial cost savings potential, the transaction costs were found to be so great that they have been blamed for the failure to generate any trades.[33]

In addition to the high transaction costs, the lack of a watershed permit could raise legal issues relating to federal anti-backsliding and anti-degradation provisions. In a letter to state environmental heads dated March 14, 2003, the American Rivers, the National Wildlife Federation, the Natural Resources Defense Council, and the Sierra Club state that, "Although the Policy (EPA trading policy) says that trading to meet water quality standards is acceptable, we believe state programs that take this approach would be illegal and subject to successful legal challenge. Legally, a point source cannot violate its water quality-based limits in exchange for a reduction elsewhere". In short, anti-backsliding provisions might prevent DEQ from modifying an individual permit to reflect higher loads that would result from the purchase of waste load reductions from another source, point or non-point. In addition, it might prevent a point source whose permit was modified to reflect excess reductions (which were then traded to another point source) from returning to its original discharge levels. According to Steinzor (2003)[34], local environmentalists have filed suit against trading sources in California for relying on illegal transactions to meet their permit obligations. Attempting to implement a trading program though individual VPDES permits might expose Virginia agencies, municipalities, and industry to legal risks and lawsuits.

Establishing a watershed permit and requiring all trades among point sources and all point source purchases of non-point source offsets to occur through the watershed permit would reduce transaction costs and would remove any concerns relating to the legality of modifying a VPDES permit to reflect higher loads. There would be no need to go through the permit modification process each time a trade occurred or a non-point source offset was purchased. A

[32] Woodward, R.T., and R.A. Kaiser, 2002. Market Structure for U.S. Water Quality Trading. *Review of Agricultural Economics* v24 n2: 366-83.
[33] Hahn, R.W., and G. Hester, 1989. Marketable Permits: Lessons for Theory and Practice. *Ecology Law Quarterly* 16: 361-406.

watershed permit, while establishing enforceable total waste load limits on the group of dischargers, would also allow dischargers to cost effectively allocate loads to other dischargers under the permit. Because the permit applies to the group as a whole, individual dischargers under a watershed permit would not be exposed to anti-backsliding risks. If reductions are purchased from non-point sources, the non-point sources should be brought under the watershed permit and waste load limit should be increased to reflect the inclusion of a new source.[35] In its 2003 final water quality trading policy, EPA states that effluent trading allowed under a watershed plan will generally satisfy the anti-backsliding provisions of the Clean Water Act. In North Carolina, the Tar-Pamlico river basin and the Neuse river basin have watershed permits for point sources. They also have a non-point source offset program in case point sources exceed their collective cap. The watershed permit makes references to the effect that point sources are responsible for securing equivalent reductions elsewhere.

Establish a cap-and-trade mechanism for trading. Trading under a watershed permit can occur in a number of ways. One approach is to set up a nutrient credit exchange program. Such programs provide tradable credits to point sources that reduce their discharge to below their waste load allocation and allow those credits to be counted toward compliance by other point sources who face high costs or other difficulties in complying with their waste load allocation. Credits are created through an administrative process that requires them to be pre-certified before they are traded. While it might be less burdensome than allowing trades only through modifications to individual VPDES permits, such a program still has significant transaction costs and uncertainty associated with it. Buyers and sellers incur significant transaction costs due to the additional administrative layer of getting credits pre-certified before they are bought or sold. Moreover, as credits are created only after reductions have been made, a nutrient credit exchange program involves significant uncertainty regarding the availability of credits to trade in the future. Thus, buyers seeking to purchase credits are not completely sure of their availability until they have been created and certified. Specifically, given the magnitude of the investment involved in the establishment of new sources and the expansion of existing sources of discharge, uncertainty about the availability of credits to cover additional discharge is likely to act as a

[34] Steinzor, R., 2003. Emissions Trading Moves to Water, But It's Not As Simple. *Environmental Forum* (ELI), p. 69.

[35] Bringing a non-point or unregulated source under a permit and increasing the waste load limits will not trigger ant-backsliding provisions as a new source is being added.

significant barrier to entry. The investment will have to be undertaken without complete certainty that the credits will be available to cover the excess discharge. High transaction costs and uncertainty regarding the ability to buy and sell credits, in turn, reduces the incentive to trade and prevents the full realization of all the benefits of trading.

The most efficient trading mechanism is a cap-and-trade system. Under such a system, an overall cap or a maximum waste load is set on discharges into a river basin. The cap, in turn, determines the total number of discharge allowances for the river basin. A discharge allowance provides its owner with the right to discharge a unit of effluent. The initial distribution of discharge allowances for a river basin could be based on the proposed annual waste load allocation for existing significant dischargers. Once allocated out, sources are free to buy and sell allowances amongst each other. There are no restrictions on trading other than each source covered by the cap-and-trade program having enough allowances to cover their discharge. The weight of economic literature finds cap-and-trade programs to impose lower transaction costs and have less uncertainty associated with them compared to nutrient credit exchange programs. In contrast to a nutrient credit exchange program, cap-and-trade programs do not require pre-certification of allowances. Allowances are handed out based on a source's waste load allocation and are effectively certified when they are distributed. Thus, once a point source purchases an allowance, it knows with certainty that the allowance will be available to cover its discharge. The only costs incurred under a cap-and-trade system are the costs associated with monitoring effluent discharge and in tracking allowances traded between point sources. A cap-and-trade program can also allow for point source purchase of non-point source offsets. Once non-point source offsets are purchased, the non-point source should be brought under the cap, i.e., the cap or the total annual waste load limit should be increased to reflect the inclusion of a new source.

A basic outline of a cap-and-trade program is as follows: [36]

- Define the water quality goal: This has already been done as part of 9 VAC 25-260 (Water Quality Standards)
- Calculate the waste load limit for Virginia's portion of the Chesapeake Bay watershed in order to achieve the water quality goal: EPA has already calculated Virginia's waste load allocation such that water quality goals are achieved.

[36] Courtesy Dr. William S. Shobe, Director of Business and Economic Research, Weldon Cooper Center for Public Service, University of Virginia.

- Define an allowance: It should be defined as a unit of mass such as pounds or in terms of a percentage of the maximum waste load in a given year.
- Establish watershed permits with waste load limits by watershed: EPA has already calculated waste load allocation by river basin such that water quality goals are achieved
    - Apply watershed permit to applicable sources (existing, new, and expanded point sources)
    - Allocate allowances to individual point sources: The individual waste load allocations are established in the tributary strategy document for each of the five river basins. The allowances should be allocated for several years into the future, with some allowances possibly being retained to auction at a later date.
- Establish an allowance-tracking database: The database may be privately managed or could be managed by DEQ or some third party.
- Establish monitoring and enforcement standards: The key regulatory standard would be to require one allowance to be retired for each mass unit of effluent. At the end of the year, each source should be required to have enough allowances to cover their discharge.
- Establish penalties for non-compliance: Such penalties an automatic financial consequence for each exceedance.
- Establish rules for including non-covered sources: Non-covered sources include smaller point sources and non-point sources. In order to trade, these sources should come under the total annual waste load limit.

The Virginia Association of Municipal Wastewater Agencies (VAMWA) has proposed a draft regulation that envisions trading under a watershed permit. However, the VAMWA proposal is an example of a nutrient credit exchange program. It envisages the establishment of a Virginia Nutrient Credit Exchange Association to implement and manage the program. The association would be responsible, among other things, for setting the price of credits, assisting permittees in identifying buyers and sellers, and ensuring compliance with the total annual waste load allocation. Such a program is similar to Connecticut’s Nitrogen Credit Trading Program. However, as discussed in this section, a cap-and-trade program is likely to be more cost effective than a nutrient credit exchange program. In addition, under the VAMWA proposal, members of the Virginia Nutrient Credit Exchange Association are restricted to permitted entities discharging nutrients into the Chesapeake Bay watershed. By limiting third-party participation (such as purchase of allowances by brokers or even environmental groups), this proposal restricts trading and prevents all the benefits of trading from being realized.

Thus, a cap-and-trade program that does not restrict third party participation is likely to be the most cost effective trading mechanism. While cap-and-trade mechanisms have been used in the context of air quality, their use in the achievement of water quality goals is not as widespread. An example of a cap-and-trade system being implemented in the context of water quality is North Carolina's Tar Pamlico Nutrient Trading Program. The state assigns a fixed number of nutrient allowances to an association of dischargers. The association is responsible for allocating the allowances amongst its members. Once individual allowances are allocated, members are allowed to trade freely under the association's exchange rules. Enforceable financial penalties exist for instances when the association's aggregate discharge exceeds the total nutrient allowance. Third party participation in trading may be limited under this program as all trading activity occurs within the association, a private organization that could restrict membership.

Conclusion:

The proposed regulations are likely to generate significant costs and benefits. Point sources are likely to incur significant costs in meeting the requirements of the proposed regulations. On the other hand, industries that depend on the Chesapeake Bay and the state in general are likely to reap significant benefits from improvement in water quality.

Due to the magnitude of the costs associated with meeting the requirements of the regulations, it is worthwhile to investigate all means of achieving the required waste load reductions at the lowest possible cost. Effluent trading is one way that would allow water quality goals to be achieved at significant cost savings compared to more traditional regulatory approaches such as command and control.

The proposed regulations do include provisions for effluent trading. However, there is room for trading opportunities to be enhanced. Replacing individual technology-based effluent concentration limits with an equivalent annual waste load allocation, eliminating restrictions on point source purchases of non-point source offsets and instead addressing the uncertainty of non-point source reductions directly, establishing a watershed permit through which all trading and purchase of non-point source offsets is to occur, and establishing a cap-and-trade mechanism for trading are likely to enhance opportunities for trading. This, in turn, is likely to produce significant additional cost savings and create an additional economic incentive for increased investment into ways of reducing effluent discharge, point and non-point, potentially allowing water quality goals being achieved sooner than they would have been achieved otherwise.

Businesses and Entities Affected

The proposed regulations are likely to have a negative impact on certain point sources currently discharging into the Chesapeake Bay watershed. Point sources defined as significant dischargers will be subject to both the technology-based effluent concentration limits and the total annual waste load allocation. Point sources not defined as significant dischargers, but authorized under a VPDES permit issued prior to July 1, 2004 to discharge 40,000 gallons or more per day will be subject to the technology-based effluent concentration limits. In addition, new and expanded point sources authorized to discharge 40,000 gallons or more per day will be required to meet technology-based effluent concentration limits and the total annual waste load allocation.

According to DEQ, there are 120 existing significant dischargers, 95 municipal wastewater treatment plants and 25 other facilities. The agency also estimates that there are 117 municipal wastewater treatment plants that are not defined as significant dischargers, but who will be required to meet technology-based effluent concentration limits. A number of smaller industrial plants may also now be required to meet technology-based effluent concentration limits. Based on a review of facility design capacity (and not nutrient data), DEQ estimates the maximum number of such facilities to be 174.

The proposed regulations are also likely to have a positive impact on some businesses and entities in industries that depend on the Chesapeake Bay and its tidal tributaries. These industries include commercial fisheries, tourism and recreation, and boat building and repair. Businesses and entities involved in such industries are likely to benefit from any improvement in water quality in Chesapeake Bay or its tidal tributaries. The beneficial effect of water quality on these industries is, in turn, likely to have a secondary beneficial effect on related support and value-added industries. The number of such businesses and entities is not known at this time.

Localities Particularly Affected

The proposed regulations are likely to affect all cities and counties within the Chesapeake Bay watershed area. These localities are likely to incur additional costs of meeting the technology-based effluent concentration limits and/or the total annual waste load allocation. DEQ's best estimate of affected entities is 212, 95 municipal wastewater treatment plants categorized as significant dischargers and 117 municipal wastewater treatment plants that are not defined as significant dischargers, but who will be required to meet technology-based effluent concentration limits. Some of the costs to localities of implementing nutrient control are likely to be met by federal and state cost-share programs. Some or all of the remaining costs to localities are likely to be passed on to rate payers in the form of higher user fees for waste disposal.

Some localities are also likely to benefit from economic development due to improvements in water quality of the Chesapeake Bay and its tidal tributaries. Industries such as commercial fisheries, tourism and recreation, and boat building and repair are likely to benefit directly from water quality improvements. Related support and value-added industries are, in turn, likely to reap secondary benefits. This is likely to have a positive effect on output and employment in localities in and around Chesapeake Bay and its tidal tributaries.

Projected Impact on Employment

The proposed regulations could affect employment in industries with significant discharges into Chesapeake Bay and its tidal tributaries. Examples of these industries include the food processing industry, the chemical industry, and the pulp and paper industry. The increased costs to these industries could reduce the profitability, potentially reducing the number of people employed in these sectors.

On the other hand, the proposed regulations could have a beneficial effect on employment in industries such as commercial fisheries, tourism and recreation, and boat building and repairs that are likely to benefit from improvements in water quality in the Chesapeake Bay area. Related support and value-added industries are, in turn, also likely to reap benefits and this could have a beneficial effect on employment in these industries.

Effects on the Use and Value of Private Property

The proposed regulations are likely to impose additional costs on businesses and entities with significant point source discharges into Chesapeake Bay and its tidal tributaries. These businesses are likely to incur significant capital and other costs related to nutrient removal. This, in turn, is likely to increase operating costs and lower the asset value of these businesses.

On the other hand, the proposed regulations are likely to have a positive effect on businesses involved in industries such as commercial fisheries, tourism and recreation, and boat building and repairs that are likely to benefit from improvements in water quality. Improved water quality is likely to increase revenues and raise the asset value of these businesses. In addition, improvements in water quality and any subsequent increase in economic activity in surrounding areas could also have a positive impact on related support and value-added industries and on property values in the area.