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WORKING PAPER

NUTRIENT TRADING BY MUNICIPAL STORMWATER PROGRAMS IN MARYLAND AND VIRGINIA: THREE CASE STUDIES

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EXECUTIVE SUMMARY

Restoration of the Chesapeake Bay will require significant nutrient and sediment load reductions from the wastewater, agricultural, and urban stormwater sectors. The cost of doing so, particularly in the stormwater sector, is daunting. Previous analysis by World Resources Institute and others indicated that the economic benefits of a nutrient trading market could be significant in the Chesapeake Bay watershed for all three of these sectors (Jones et al. 2010). Working with three Maryland and Virginia counties facing significant stormwater runoff nutrient reduction requirements, we explored the feasibility and potential benefits that nutrient trading could offer them and sought to facilitate actual trades. A second goal of the project was to inform the development of new policy, regulation, and stormwater discharge permitting strategy where needed. While no trades were completed, Arlington County, Virginia, decided to purchase credits when needed; Queen Anne's County, Maryland, made a decision to issue a request for proposals for the potential purchase of nutrient credits; and Montgomery County, Maryland, is considering the purchase of credits in the future. We concluded three factors are critical to successfully introducing nutrient trading in the stormwater sector: the existence of a clear regulatory basis for trading, a stormwater discharge permitting strategy that allows and facilitates trading, and effective outreach to the agricultural community.

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THE CHALLENGE OF RESTORING THE CHESAPEAKE BAY

The Chesapeake Bay is the largest estuary in the United States and a vital economic, cultural, and ecological resource for the region and the nation. The bay is impaired by excess runoff and discharges of nitrogen, phosphorus, and sediment from farms, pavement, wastewater treatment plants (WWTPs) and atmospheric sources. Nutrient pollution drives the growth of large algal blooms and "dead zones" in the bay, which are areas with low or zero levels of dissolved oxygen (DO) (Chesapeake Bay Program 2009). On average, about 60 percent of the bay and its tidal rivers have insufficient levels of oxygen (Chesapeake Bay Commission, 2012). In addition, water clarity in the Chesapeake Bay has declined so that underwater grasses, critically important as fish and crab habitat, have decreased to roughly 25 percent of historic levels.

In response to these water-quality problems, the Environmental Protection Agency (EPA) promulgated a Total Maximum Daily Load (or TMDL) for the Chesapeake Bay in December 2010 (EPA 2010). The TMDL set pollution limits for nitrogen, phosphorus, and sediment in the bay designed to restore healthy levels of DO and water clarity. Meanwhile, the six Chesapeake Bay states and the District of Columbia released Watershed Implementation Plans (WIPs) describing the actions they would take to meet those limits by 2025. Together, the TMDL and the states' implementation plans comprise a clean water blueprint for the Chesapeake Bay, and its rivers and streams. The WIPs specify load reductions by the wastewater, agriculture, septic, and stormwater sectors by jurisdiction. The reductions for the wastewater and much of the stormwater sectors are being achieved via regulatory requirements under the Clean Water Act (CWA).

The scope and magnitude of the efforts needed to restore the bay and the requirements of the TMDL are challenging. Significant nutrient load reductions are required in all sectors—wastewater, agricultural, and urban stormwater, as well as atmospheric deposition. Furthermore, there are interim and final deadlines for achieving the reductions. While there are social and technical challenges to be met, the economic challenge is perhaps the largest. This is especially true of the stormwater sector.

Estimates of the total cost of bay cleanup range up to 28 billion dollars (Chesapeake Bay Watershed Blue Ribbon Finance Panel 2004). While the stormwater sector only contributes an estimated 16 percent of the nitrogen load and 17 percent of the phosphorus load, the estimated cost to the sector for complying with the TMDL requirements accounts for up to 67 percent of the total restoration costs (Chesapeake Bay Commission 2012), dwarfing the costs of other sectors. Estimated costs per pound for nutrient reductions are often much higher in the stormwater sector than any other sector, sometimes by an order of magnitude. A recent analysis commissioned by the Maryland Department of the Environment (MDE) assessed 23 stormwater best management practices (BMPs) in use in Maryland and estimated the annualized cost of each over 20 years (King and Hagan 2011). Table 1 shows the highest, lowest, and median costs per pound of reduction among the BMPs. Even if this study overestimates costs, as some believe, there is no doubt that the stormwater sector faces the highest unit costs for nutrient load reductions by a substantial margin. This high cost of stormwater load reductions has concerned many localities.

In addition, the stormwater sector also faces significant implementation challenges. Large numbers of new stormwater BMPs are needed, and it will be very difficult for municipalities to plan, design, and construct these practices by the 2025 implementation deadline for the TMDL. The larger urban jurisdictions also face regulatory deadlines contained in their CWA stormwater discharge permit.[1]

Table 1 | **Cost per Pound of Nitrogen and Phosphorus Load Reductions for Urban Stormwater Best Management Practices in Maryland Counties, 20-Year Annualized Costs**

	NITROGEN	PHOSPHORUS
Highest cost BMP, $	14,800	181,400
Lowest cost BMP, $	500	900
Median cost, $	1,500	3,500

Source: King and Hagan 2011

A ROLE FOR NUTRIENT TRADING

Nutrient trading is a market system in which sources that reduce their nutrient runoff or discharges below target levels can sell their surplus reductions or "credits" to other sources. This approach allows those that can reduce nutrients at low cost to sell credits to those facing higher-cost nutrient reduction options. Nutrient trading, therefore, could allow sources of pollution such as wastewater treatment plants and municipal stormwater programs to meet their pollution targets in a cost-effective manner and could create new revenue opportunities for farmers, entrepreneurs, and others who implement low-cost pollution reduction practices that exceed their TMDL requirements (Jones et al. 2010).

WRI's preliminary analysis of the potential benefits of nutrient trading found that the economic benefits of nutrient trading market for nitrogen could be significant for the agricultural, wastewater, and municipal stormwater sectors in the Chesapeake Bay watershed. Depending on credit prices, trading potentially could

- Generate new revenue for the agricultural sector and other credit generators at an amount comparable to current levels of annual public funding for agriculture conservation cost-share programs for the bay;
- Reduce nitrogen removal costs for some in the wastewater sector by as much as 60 percent; and
- Reduce the nutrient removal costs to the municipal stormwater sector by 10 to 50 percent, saving the sector hundreds of millions of dollars per year. (Jones et al. 2010).

A subsequent report, *Nutrient Credit Trading for the Chesapeake Bay: An Economic Study* (Chesapeake Bay Commission 2012), further assessed the potential economic benefits of nutrient trading in the Chesapeake Bay watershed. It evaluated scenarios based on which sectors could engage in nutrient trading and the impacts of various restrictions on geographic trading areas.

Expanding trading to all sectors had a far greater impact on cost savings than increasing the size of trading areas. Four sector scenarios were assessed:

1. No trading;
2. Trading between significant point sources;
3. Trading between significant point sources and agricultural nonpoint sources; and
4. Trading between significant point sources, urban stormwater, and agricultural nonpoint sources.

Table 2 shows the results for scenarios 1, 2, and 3. The annual costs are those of the wastewater and stormwater sectors.

This study estimated the total cost of needed stormwater controls at $1.09 billion per year, suggesting the importance of lower-cost solutions, including potential savings to the stormwater sector from trading.

The Chesapeake Bay Commission analysis was designed to estimate a range of possible savings, up to an unlikely maximum possible implementation scenario. However, the results indicate that even low implementation rates would produce huge cost savings. Hence, savings in the stormwater sector will depend mainly on the degree to which trading is used to meet TMDL requirements.

Table 2 | **Annual Cost Savings for Point Source to Point Source, Point Source to Agricultural Nonpoint Source, and Point Source to Point Source and Point Source/Urban Stormwater to Agricultural NPS Trading**

SCENARIO	ANNUAL SAVINGS (MILLION $/YR.)	ANNUAL SAVINGS (%)	ANNUAL COST (MILLION $/YR.)
No trading	—	—	385[a] / 1,090[b]
Point sources	77–108	20–28	277–308
Point sources and agricultural NPS	139–89	36–49	196–246
Point sources, urban stormwater, and agricultural NPS	1,160–210	79–82	263–310

Notes: a. Point sources b. Urban stormwater

For example, a 10 percent implementation rate would yield $74 million in savings per year. The basic finding of the study is that trading has the potential to provide substantial cost savings to both the wastewater and stormwater sectors.

Trading could also help reduce nutrient discharges to the bay more quickly by allowing municipal stormwater utilities to purchase credits as a gap-closing strategy for meeting timeline goals for reductions if they are unable to complete all of the necessary stormwater projects in time, or if they want to spread capital costs over a longer period. Trading as a permanent component of a strategy to meet reduction requirements could lower overall costs, but it also needs to be considered in the context of potential impacts to local water quality.

Stormwater planning, including engaging in nutrient trading, must include consideration of local TMDLs and local water-quality impairments. Trading across watershed boundaries to reduce nutrient loads to the Chesapeake Bay could potentially harm local water quality by shifting pollution reduction efforts away from locally impaired systems. Any proposed trade must be evaluated for its impact on local water quality. The EPA's technical memorandum on local water-quality protection provides guidance to the bay jurisdictions on this issue (EPA 2014), though it also gives the states flexibility in how they implement these recommendations. Since this is an issue of concern for many stakeholders, one important component is to ensure the decision-making rationale is documented and transparent to the public.

Pennsylvania, Virginia, and Maryland recognized the potential value of nutrient trading early on and implemented trading programs through various combinations of legislation, regulation, and policy. Provisions for trading by the stormwater sector were not included in the initial programs. That has changed in recent years, prompted in part by these studies. In 2012, the Virginia General Assembly passed legislation that continued to expand nutrient trading options, including authorizing Municipal Separate Storm Sewer Systems (MS4s) and other entities operating under National Pollutant Discharge Elimination System (NPDES) permits to acquire nutrient credits from either point or nonpoint sources (NPS) and to use those credits to comply with their permits' nutrient load reduction requirements.[2] Maryland initiated a process to develop policy and regulations for stormwater trading in 2015 and formed an advisory committee to formulate recommendations. Pennsylvania has indicated that it intends to add stormwater to its trading program, but as yet there has been no movement on policy or regulation development.

STORMWATER TRADING POTENTIAL IN THREE COUNTIES IN MARYLAND AND VIRGINIA

This study was undertaken by the Chesapeake Bay Foundation (CBF) and World Resources Institute to explore the feasibility and potential benefits of nutrient trading between the stormwater sector and the agricultural and wastewater sectors. It was conducted in partnership with three local jurisdictions and focused on their specified nutrient reduction requirements and stormwater programs and strategies. The three partners are Arlington County, Virginia, and Montgomery and Queen Anne's Counties in Maryland. The purposes of the studies were to assess and demonstrate the feasibility and potential benefits of nutrient purchases by stormwater programs. We hope the results of this study will inform trading policy development and MS4 discharge permitting strategies.

GENERAL METHODOLOGY

The methodology used varied somewhat between the three counties depending on conditions in the county. However, there were seven common steps in the methodology.

1. Determining the specific nutrient load reductions required by each jurisdiction's MS4 permit and/or its state or county Watershed Implementation Plan (WIP).
2. Examining each jurisdiction's stormwater management program and strategy for meeting the permit's local water-quality and bay-related WIP nutrient requirements.
3. Determining potential credit demand and developing methods for incorporating nutrient trading into county stormwater plans and strategies.
4. Analyzing potential credit supply by evaluating potential local credit supply for each county, focusing on local sources and evaluating willingness of potential credit suppliers to participate in a market. Potential sources are agricultural producers in Montgomery and Queen Anne's Counties and Arlington County's Water Pollution Control Plant.
5. Applying protocols for local water-quality protection.
6. Develop trading mechanisms and instruments.
7. Facilitating actual trades between the stormwater programs and the credit suppliers.

It is important to note that although state trading guidance and/or regulations do not necessarily constrain credit purchases to sellers within a county, all local partners expressed a preference for local credit sources instead of spending local government revenues in other jurisdictions.

RESULTS

Arlington County, Virginia

This entirely urban county will likely utilize nutrient credits from its wastewater treatment plant to meet nutrient reduction requirements on an interim basis. The treatment plant has a history of performing at an extremely high level, with discharge concentrations well below its permit requirement of 3 mg/l of total nitrogen. Such credits will be used in the short term to meet current MS4 permit timelines, while allowing the county time to implement an aggressive program to implement all necessary stormwater practices over the long-term.

Nutrient Credit Demand

Arlington County, Virginia, is a 26-square mile, entirely urban municipality that discharges stormwater under a Clean Water Act Phase I MS4 permit issued by the Virginia Department of Environmental Quality (DEQ).

The MS4 permit contains pollutant reduction requirements that are driven in large part by the Virginia Watershed Implementation Plan (WIP) developed by the commonwealth in response to the Chesapeake Bay TMDL. The load reduction requirements developed by the commonwealth for MS4 permittees in the Potomac River basin, based on the Chesapeake Bay Program Watershed Model Phase 5.3.2 L2 scoping run,[3] indicated that Arlington County needed to achieve a certain level of reductions in annual nutrient and sediment loads from the baseline year of 2009 by 2028.[4] The initial reduction levels were changed to the final numbers shown in Table 3, pursuant to the process for finalizing the MS4 permit described in the paragraph below.

The county's MS4 permit distributes the total required reductions shown in Table 3 over three MS4 permitting cycles. The county is required to achieve 5 percent of the overall required nutrient and sediment load reductions within the first five-year, post-Blueprint permit cycle, an additional 35 percent of the total reduction in the second cycle (2018–12), and the remainder, a full 60 percent of the overall reduction, in the third permit cycle (2023–27). The current permit, issued in 2013, required the county to develop a plan to meet the required 5 percent reductions, make it available for public comment, and submit it to the DEQ for approval. The draft plan, as submitted by the county in June 2015 (with final approval by the DEQ in September 2015), recalculated the MS4's service area pursuant to regulatory guidance, leading to the overall reduction requirements shown above in Table 3.

The county intends to eventually achieve all of the required reductions through stormwater projects that are designed to reduce urban runoff and increase its quality. However, planning, designing, financing, and constructing all of the necessary projects in time to meet the regulatory deadlines will be extremely challenging, even with planned budget increases and future enhancements in the county's stormwater tax. The planning level cost estimate for construction of the county's 159 current priority stormwater projects, along with six miles of stream restoration, is approximately $50 million.[5]

Table 3 | **Total Arlington County Cumulative Required Pollutant Load Reductions from 2009 Baseline Loads (pounds/year)[6]**

	CUMULATIVE REDUCTION	NITROGEN	PHOSPHORUS	SEDIMENT
End of 1st permit cycle 2013–18	5% of total	578	76	65,599
End of 2nd permit cycle 2019–23	40% of total	4,626	612	524,793
End of 3rd permit cycle 2024–28	100% of total	11,565	1,529	1,311,981

The stormwater program has already met all of the nutrient reduction requirements for the 2013–18 permit cycle, but reductions from planned stormwater improvements are expected to fall short in the second cycle. Planning level estimates are that about 70 percent of phosphorus reductions in the second cycle could be met, and meeting nitrogen requirements will be even more difficult. Larger shortfalls are expected in the third permit cycle, even with an increased pace of project implementation.

Arlington's County's plan is to purchase nitrogen and phosphorus credits from its water pollution control plant. Purchasing credits in the next two permit cycles will allow it to meet the short-term nutrient pollution load reductions required under the MS4 permit on an interim basis, until all of the stormwater projects necessary to fully achieve long-term benefits can be planned, designed, financed, and constructed. The number of credits that will be needed to enable the county to meet the permit requirements during the next two cycles is currently unknown since on-the-ground implementation of projects is continuing. It should also be noted that this trade will not address the county's sediment reduction requirements under the TMDL and its MS4 permit.

Nutrient Credit Supply

The county owns and operates a state-of-the-art water pollution control plant (WPCP) that treats most of the wastewater generated in the county. In 2001, the County Board authorized the upgrading and expansion of the WPCP at a cost of $568 million. The purpose of the project was to reduce the amount of nitrogen and phosphorus discharged by the plant in order to protect Four Mile Run, the Potomac River, and the Chesapeake Bay, and to ensure sufficient treatment capacity to serve future growth in the county. The upgrade was completed ahead of schedule and under budget.

The upgrade included installation of treatment processes capable of achieving very low levels of nitrogen and phosphorus, potentially levels that are significantly lower than the nominal limit-of-technology (LOT) requirements established by the Virginia Department of Environmental Quality (DEQ) and enforced through the General Permit for Total Nitrogen and Total Phosphorus Discharges and Nutrient Trading in the Chesapeake Watershed in Virginia (General Permit).[7] The load limits, calculated using the plant design flow and the concentration limits,[8] are derived directly from the DEQ's defined LOT concentration design requirements of 3 mg/L for total nitrogen (TN) and 0.18 mg/L for total phosphorus (TP).[9] In 2015 performance tests, the WPCP's actual concentration of total nitrogen was 1.3 mg/L, and 0.04 mg/L of total phosphorus. Since the upgrade was completed, the WPCP's performance has been outstanding, with a multiyear record of discharging nutrient loads that are much lower than its discharge permit allows.

As part of this project, the stormwater program explored whether it might obtain nutrient credits from the WPCP to help meet the pollution reduction requirements of the MS4 permit described above. This strategy would allow the county to stay in compliance with the nutrient reduction requirements of its permit until it completes installation of the stormwater projects needed to produce the reductions.

We evaluated the WPCP's current and future ability to supply nutrient credits to the stormwater program. Using projections and assumptions about future wastewater volumes and expected plant nutrient removal performance provided by WPCP staff, future potential credit generation was calculated for each year from 2014 through 2027—a period encompassing the current MS4 permit cycle and the following two five-year cycles. Results were averaged over each permit cycle using very conservative assumptions about future pollution removal performance. Even with such assumptions, the plant could theoretically provide credits to satisfy the entire amount of stormwater-related nitrogen and phosphorus load reductions required in the county, with a large number of credits to spare.[10]

Decision/Process for Trading

Arlington County has ambitious plans for meeting its MS4 permit nutrient pollution reduction requirements, which achieve the reductions specified in the Virginia Phase I WIP. However, as the necessary pollution reduction levels increase substantially with each of the next two permit cycles, the county will be both financially and functionally hard-pressed to implement all of the necessary practices within permit time frames. Internal county trading of some credits is a good interim method for meeting those demands—due to the state's well-articulated trading regulations and exchange process; multiyear, extremely high performance levels for the county wastewater treatment plant that exceed its permit and TMDL requirements; an MS4 permit that clearly specifies the amount of nutrient pollution which must be reduced from a baseline; and a county staff intent upon ultimately meeting both in-the-ground objectives for its stormwater program and near-

term permit timelines for nutrient reduction. A trade is likely toward the end of the next MS4 permit cycle.

The legal basis for this trading is legislation passed by the General Assembly in 2012 that expanded nutrient trading options, including authorized MS4s and other entities operating under NPDES permits, to acquire nutrient credits from either point or nonpoint sources and to use those credits to comply with permit nutrient load reduction requirements.

Trade Result/Current Status

Sometime in the next permit cycle, 2018 to 2023, Arlington County will decide on the internal financial arrangements for purchase of nutrient credits from the WPCP by the stormwater program. Under Virginia's trading program, the state's regulatory approval process consists of two relatively simple steps. First, the county must submit a "Compliance Plan" letter to the DEQ stating its intention to acquire point source credits from the Arlington County WPCP. The plan should identify the credit source, number of credits to be acquired, the dates of both anticipated credit generation and acquisition, and the anticipated compliance year. In the year after the credits are actually acquired, the county must submit a letter to the DEQ, as part of the county's annual report, which certifies the credit acquisition by the stormwater program.

Montgomery County, Maryland

Montgomery County is interested in utilizing nutrient credits purchased from local farmers to help meet regulatory requirements of its stormwater discharge permit and its nutrient pollution reduction goals under Maryland's Phase II WIP. The credits would be used as an interim measure until the county has implemented the stormwater projects needed to meet the requirements without trading. However, the county is unwilling to purchase credits until the state establishes a strong regulatory framework for trading in the stormwater sector.

Nutrient Credit Demand

Montgomery County is the most populous county in Maryland, with an estimated population in 2014 of 1,030,000. It is 507 square miles in area and borders the District of Columbia and northern Virginia. The county discharges stormwater under a Clean Water Act Phase I MS4 permit issued by the Maryland Department of the Environment (MDE).

Unlike in Virginia, the relationship between the nutrient reduction requirements of Maryland's Watershed Implementation Plan and the stormwater discharge requirements in current MS4 permits in the state is indirect, complex, and not well quantified. This is because the WIP requirements are expressed in terms of quantified, specific nutrient load reductions, while the MS4 permit requires the county to provide stormwater runoff treatment on a certain amount of developed area in the county that lacks stormwater treatment facilities, as described below. The MDE has stated that it believes that achieving the MS4 impervious surface treatment requirements would also achieve the WIP nutrient load reduction requirements, but it has provided little justification for this assumption.

Maryland's Phase II WIP was adopted in 2011 and established interim and final goals for nitrogen, phosphorus, and sediment load reductions, by sector. These goals were established on both a statewide basis and a county basis (Maryland Department of Natural Resources et al. 2012). Maryland counties and Baltimore City were requested to submit local plans that describe how the WIP goals would be met. These local plans were incorporated directly into the WIP. The nitrogen and phosphorus reduction requirements that the WIP established for Montgomery County are shown in Table 4.

Table 4 | **Montgomery County Stormwater Nutrient Load Reduction Targets**

	NITROGEN	PHOSPHORUS
2009 baseline load, lbs.	948,441	45,610
2017 target load, lbs.	832,502	36,691
Load reduction, lbs.	115,939	8,919
Load reduction, %	12.2	20.0
2025 target load, lbs.	782,814	32,869
Cumulative load reduction, lbs.	165,627	12741
Cumulative percent reduction, %	17.5	27.9

The local plan submitted by Montgomery County described the county's stormwater strategy and estimated that the percent reductions in nitrogen and phosphorus loads that the strategy would produce would meet or exceed the percentages shown in Table 4. These estimates were based on watershed modeling of the BMPs planned under the strategy. A major complication in defining progress

toward WIP goals is that the Chesapeake Bay Program and Montgomery County use different watershed models to estimate nutrient loads and reduction requirements. The Bay Program uses the Chesapeake Bay Watershed Model (CBWM) to estimate pollutant loads and has developed a planning tool, the Maryland Assessment and Scenario Tool (MAST), that allows users to run real-time scenarios with inputs and outputs that are consistent with the CBWM. All of Montgomery County's initial analysis was done using the older Watershed Treatment Model (WTM). Different models invariably produce different results, so there are some significant differences in the MAST and WTM results.

The county's MS4 permit status and requirements are likewise not straightforward. In 2010, MDE issued the county an MS4 permit that contained a requirement to provide stormwater management and treatment to 20 percent of the developed ("impervious") areas of the county that lacked stormwater treatment facilities. A total of 25,119 acres of the county are defined as impervious and lacking adequate stormwater management facilities. Montgomery County is responsible for 18,890 of these acres and was required by its MS4 stormwater discharge permit to treat 20 percent of these acres between 2010 and 2015. The MDE intends to require an additional percent coverage in each subsequent permit cycle until a sufficient level of treatment is attained. The Montgomery County MS4 permit was the first one in the state that contained the 20 percent impervious surface treatment requirement. Subsequently, the MDE proposed draft permits for all Phase I MS4s in the state containing this requirement.

Montgomery County's MS4 permit expired in February 2015, but the MDE administratively extended it for an indefinite period. The county fell short of the permit's 2015 impervious surface treatment goal as shown in Table 5. The work was not completed within the five-year time frame because of the magnitude of the required program as well as the complex permitting requirements involved.

Table 5 | **Impervious Surface Acreage Treatment Requirements in Remanded MS4 Permit**

PERMIT PERIOD	2010–15
Impervious acres to treat in permit period	3,778
Progress in impervious acres treatment	1,726
Shortfall in impervious acres treatment	2,051

Table 5 only covers the 2010–15 permit period because future permit requirements have not yet been established.

Montgomery County intends to ultimately meet all of the nutrient reduction requirements by implementing stormwater projects. Like Arlington County, it is interested in purchasing nutrient credits to help ensure compliance with WIP and MS4 permit requirements as an interim measure until all of the necessary stormwater projects can be completed. It is not willing to do so, however, until a transparent, robust, and reliable regulatory framework has been put in place.

Nutrient Credit Supply

Montgomery County's preferred source of nutrient credits is agricultural operations in the county that are outside of the area covered by the MS4 permit. Montgomery County has a diverse agricultural industry centered in a 93,000-acre agriculture reserve created in 1980 that comprises about one-third of the county land area.

The first step in assessing potential credit supply was outreach to farmers to inform them of the county's potential interest in purchasing nutrient credits, provide background information on nutrient trading, and seek farmer volunteers to participate in the credit supply analysis that could eventually lead to actual trades.

The outreach was initiated with the assistance of the Montgomery County Soil Conservation District (MCSCD). We first met with the MCSCD Board of Directors, which is comprised entirely of farmers, to explain the project and its goals and to request the MCSCD's assistance in communicating with county farmers. The board agreed to arrange and host a meeting for us with Montgomery County farmers.

While there were diverse opinions about trading among the farmers, the general consensus seemed to be a wariness of trading and what additional requirements it might put on them, and skepticism about whether

participation would really be in their best interests. These concerns were tempered somewhat by a degree of appreciation of the possible economic benefits.

The question farmers were most interested in was "How much will I be paid for my credits?" This question reflects farmer's experience with the global commodities market, where they simply have to accept a commodity price. Farmers ultimately accepted our contention that the trading market would operate differently than the commodities market and that they would be in a position to strongly influence credit prices as the market developed and credit demand increased. This was a key breakthrough in generating farmer willingness to work with us to explore trading in Montgomery County.

Some farmers requested that we speculate about what credit prices might be. Instead of doing so, we presented data on the unit costs (annualized cost per pound for nitrogen and phosphorus reductions) that Montgomery County and other stormwater utilities are facing, based on the King and Hagan study described above, the experience of the Virginia offset credit market, and Montgomery County staff's estimate of the unit costs for its planned stormwater projects of approximately $6,000 per pound of nitrogen reduction and $13,000 per pound for phosphorus. The very high unit prices that the county would incur without trading had a major impact on the farmer's willingness to consider trading (or perhaps more accurately, to not take it off the table at that point in time) and to engage with us to continue to explore actual trades with the county.

Several farmers volunteered at the meeting to allow us to assess their farms for potential ability to generate nitrogen and phosphorus credits, and others later contacted MCSCD staff to do so.

Five farms owned by three different farmers have been assessed to date, and another five farmers have expressed interest. The MDA's online Chesapeake Bay Nutrient Trading Tool (CBNTT) was used to assess baseline compliance and calculate the number of credits potentially generated under various farm practices and BMP scenarios.[11] With one exception, the assessments conformed to the requirements of the Maryland Department of Agriculture's credit certification regulations (COMAR 15.20.12) to ensure that the MDA would certify the estimated credits if requested. The exception is that the assessments performed for three of the farms evaluated only portions of the farms, one or several individual tracts. Maryland's trading regulations stipulate that the entire contiguous farm must meet the trading baseline before being able to generate credits. As a first step, the farmers preferred assessing a few individual tracts to determine their potential before making a decision on assessing the entire farm.

An assessment consists of

- Identification by the farmer of the tracts to assess;
- Inventory of current practices on the tracts;
- Discussion with the farmer to develop scenarios of alternate practices and/or installation of BMPs to assess;
- Assessment of the scenarios using the CBNTT and presentation of the results to the farmer; and
- Discussion with the farmer on additional scenarios or adding additional tracts to the assessment.

While this process is still ongoing for the farms being assessed, preliminary results for three of the farms are that the tracts assessed all meet baseline requirements for nitrogen and phosphorus loads and could generate credits for nitrogen, but not in large numbers. The estimated number of nitrogen credits produced per year by the tracts evaluated ranged from 0.9 to 6 lbs./acre. Estimates of phosphorus credits ranged from 0 to 0.2 lbs./acre.

These assessments constitute a preliminary analysis of the potential ability of agricultural producers in Montgomery County to supply nutrient credits. While the results for the individual tracts are promising, the next step of assessing the entire farms has not been undertaken. Before taking it, the farmers prefer to know more about what the county's approach to procuring credits would be. Hence, it is not possible at this point to estimate the number of credits county farmers might be able and willing to produce if a robust trading nutrient market existed in Maryland.

Decision/Process for Trading

Like Arlington County, Montgomery County intends to ultimately meet all MS4 permit and WIP requirements through local stormwater projects alone. However, it is uncertain if it will be able to meet the 2017 and 2025 WIP goals. It also did not meet the 20 percent impervious surface treatment requirement in the 2010–15 permit. The requirements of the next permit have not yet been established.

The county's interest in trading is in potentially using credit purchases as gap-closing measures in order to help meet permit and WIP goals. Since there is a 2017 WIP deadline approaching, the need for credits could be imminent.

At present, there is no legal or policy basis in Maryland that would allow the county to purchase credits and apply them toward the MS4 permit impervious surface treatment requirements, or technically even the WIP requirements.

Trade Result/Current Status

The county at this point is not willing to purchase credits without a strong, robust, and transparent regulatory framework in place. The MDE has stated that it intends in the future to allow the use of credits for this purpose, but the means of doing so first have to be evaluated as part of the development of new trading policy and regulations that the MDE recently initiated. This process is likely to take a year or two to complete.

County farmers are open to the idea of selling credits but want to know more about the processes the county would use to purchase credits and their obligations under trading contracts.

Queen Anne's County, Maryland

This largely rural county is not regulated under the CWA stormwater provisions and has no regulatory requirements for achieving the stormwater pollution reduction targets specified in the Phase II WIP. Nonetheless, Queen Anne's County is committed to making progress toward local and regional WIP goals, though it currently faces significant shortfalls in being able to achieve its WIP nitrogen and phosphorus reduction goals. While no final decision has been made, the county is actively exploring trading as an option to help close the gap.

Nutrient Credit Demand

Queen Anne's County (QAC), located on the Eastern Shore of Maryland, is bordered to the north by the Chester River and to the west by the Chesapeake Bay. The county's total land area is 518 square miles, of which roughly 87 percent is zoned agricultural. There is no MS4 permit in effect in QAC due to its relatively small population. Hence, there is no regulatory requirement for achieving the stormwater pollution reduction targets. QAC does, however, have target load reductions from the urban stormwater sector that are specified in the Phase II WIP. In particular, MDE distributed state pollution limits for nitrogen, phosphorus, and sediment by sector to the county level and required counties to develop plans to achieve those limits.[12] In QAC, the Department of Planning and Zoning staff lead and coordinate efforts to achieve the county's urban stormwater WIP goals.

The county's Department of Public Works and Parks Department both design and construct stormwater restoration projects. According to the county's 2011 "Current Capacity Analysis" (included in County Phase II WIP), the county completes approximately one to three stormwater management projects per year that typically treat 5 to 20 acres of land. The expenditure for these stormwater management projects was roughly $25,000 per year for 2012 and 2013. The funding for the projects is mainly provided by grants that come from a variety of sources. Starting in FY 2012 and for several subsequent years, the QAC commissioners appropriated $150,000 in local capital funding annually to accelerate progress toward WIP stormwater goals.

We used MAST to determine QAC's 2013 estimated urban nutrient loads, the target load reductions needed between 2013 and 2025, and estimated reductions that would occur with a rate of implementation reflected in the county's two-year milestone commitments. By 2025, QAC needs to achieve nitrogen and phosphorus annual loads of roughly 124,000 lbs. and 5,300 lbs., respectively. Under the projected rates of implementation, the county will fall short of its 2025 goals by roughly 70,000 lbs. of nitrogen and 4,500 lbs. of phosphorus. The actual gap will likely be smaller as the county commissioners recently appropriated a fivefold increase in expenditures on WIP projects. That said, there still will be significant shortfalls, and the county is interested in exploring trading as an option to help close the gap.

Nutrient Credit Supply

The farm assessment process was largely the same as in Montgomery County and also utilized the CBNTT. The first credit supply option explored was the potential for the county to generate agriculture nitrogen credits on county-owned farms. The county owns roughly 1,200 acres of farmland, mostly within the Chester River watershed. With assistance from the county agricultural specialist, three representative farms were chosen from the list of county-owned farms. These farms were selected because they would likely already meet the trading baseline with existing farming and conservation practices but might still have room for the implementation of additional conservation practices.

We found that the flat topography of the farms, the use of commercial fertilizer (in lieu of manure), as well as the extensive conservation practices currently in place resulted in low nutrient loads from the farms, which easily met the trading baseline, for example, farm loads were roughly 75 percent less than the trading baseline for nitrogen. As a result, the potential for the county to generate a significant amount of credits through further reductions on its own farms was determined to be low.

With assistance from the Chester River Association and county staff, we also explored a few private farms. These farms were also very well managed and easily met the nitrogen and phosphorus baselines as calculated by the CBNTT. By running a few sample "future" scenarios, it was evident that there was not a significant amount of credit-generating potential on the farms. On one farm, for example, simulating the conversion of entire fields to switchgrass, which is most likely not a realistic option, resulted in just over a two-pound-per-acre nitrogen reduction. It is worth noting that we believe our sample of QAC farms was likely biased toward "early actors" and high performers and therefore was not necessarily representative of all of the farms across the study area.

We also met with QAC Soil Conservation District (SCD) staff in an attempt to identify additional willing landowners. While the county SCD did not oppose the project, they were skeptical. Several years prior, SCD staff had conducted outreach about Maryland's nutrient trading program and potential opportunities for farmers, only to have no market materialize. Staff also shared concerns from the agricultural community that if additional reductions are required from agriculture in the future to achieve the Chesapeake Bay TMDL, those participating in trading would have "traded away" their surplus credits and would need to implement additional conservation measures. Lastly, because many key questions such as credit price and duration of a contract with QAC remained unanswered, we did not pursue a broader outreach effort via the SCD staff.

Decision/Process for Trading

Queen Anne's County faces a significant shortfall in achieving its WIP goals. While no final decision has been made, the county is exploring trading as an option to help close the gap.

As noted earlier, stormwater runoff in QAC is not regulated under the CWA, hence there is no regulatory requirement for achieving the stormwater pollution reduction targets specified in the Phase II WIP. Following a series of meetings we had with the MDE and MDA in 2014, both departments sent letters to the QAC commissioners expressing support for the potential trading and authorized the county to use nutrient credits to satisfy up to 50 percent of its WIP goals. This provision was subsequently included in a broader policy statement that the MDE issued regarding use of nutrient credits by all nonregulated stormwater entities and Phase 2 MS4s.

Trade Result/Current Status

In the fall of 2015 we proposed that the county consider the use of a credit aggregator to expand the pool of prospective credit-generating farms. As the party that would negotiate with landowners, construct, apply for certification, and maintain the credit-generating practices, an aggregator could also significantly reduce the county's administrative burden. The CBF and WRI invited aggregators active in the region to meet with the project team and explore options, and representatives from RES, Inc. responded with interest. As a result of that meeting, RES proposed entering into a letter of intent (LOI) with the county that would set expectations for the number, type, location, and approximate price of credits. RES indicated the LOI was necessary to protect its up-front investment in developing credit arrangements with landowners. Functionally, the LOI would have set up a sole-source procurement arrangement with the county. The discussion also developed into a conversation about a potentially large purchase of several thousand nitrogen credits, with the costs ranging from $50 to $100 per credit and the total county investment approaching $ 1 million dollars. Ultimately, the county decided against this approach for several reasons, including:

- The estimated price tag exceeded the county's interest in a small-volume "pilot" trade;
- The 10-year payment term would bind future boards of commissioners to annual appropriations in a manner inconsistent with past county practice; and
- The county does not customarily enter into sole-source procurement contracts for such a term and at such a price.

Based on this decision, we proposed that the county publish an open request for proposals (RFP) seeking proposals to provide nutrient credits. County staff indicated that an RFP would maintain consistency with accepted procurement practices. It would also maximize the county's control over the specifications, quantity, and location of credits.

At the time this report was submitted for publication, county staff, the CBF, and WRI were working collaboratively to develop an RFP for up to 150 nitrogen credits and 15 phosphorus credits. It is expected that this RFP will specify a preference for permanent credits (the equivalent of a property sale rather than a rental arrangement) located in the Queen Anne's County portion of the Chester River and Eastern Bay watersheds. These watersheds were prioritized because of the desire to ensure that trading not jeopardize progress to improve local water quality. There are eight incorporated towns in Queen Anne's County, most of which are located in the Chester River watershed or around Kent Island/Eastern Bay. In addition, the upper, middle, and lower Chester River segments, as well as two tributaries to the Chester (Southeast and Corsica Creeks) have local TMDLs for nutrients and/or bacteria. Most of the impacts of urban runoff are generated and experienced in these two watersheds. Hence, we recommended restricting the county's purchase of credits to these areas to ensure that pollution-reduction measures intended to mitigate urban stormwater benefit those areas impacted by urban stormwater and protect local water quality.

SUMMARY, OUTCOMES, AND LESSONS LEARNED

Purpose of Project

The purpose of this project was twofold: first, to explore the feasibility and potential benefits of nutrient trading between the stormwater sector and the agricultural and wastewater sectors, in order to facilitate its adoption and use by the stormwater sector; and second, to inform the development of new policy, regulation, and stormwater discharge permitting strategy where needed so that trading would be done in a manner that protects local water quality and provides for a transparent, verifiable trading process. We believe that allowing stormwater utilities (or any jurisdictions with stormwater water-quality impacts) to use nutrient credits under these conditions would contribute to the restoration of the Chesapeake Bay by reducing costs and accelerating progress.

Project Outcomes

The counties we partnered with face significantly different situations. While all three have stormwater-related nutrient reduction goals under their states' Watershed Implementation Plans, the similarities largely end there. They are located in two states with very different approaches to nutrient trading and stormwater discharge permitting. Arlington County is a completely urbanized area with no potential agriculture sources of credits, Queen Anne's County is a lightly populated and heavily agricultural county, and Montgomery County is heavily urbanized but also has substantial agricultural production. Arlington and Montgomery Counties are both MS4 Phase I dischargers with NPDES permits issued by Virginia and Maryland, respectively, while Queen Anne's County is not regulated for stormwater discharges. Trading policies and regulations in Virginia are relatively mature, while those in Maryland are still under development. These differences between the counties allowed us to explore trading under a variety of situations and provide lessons learned for each of them.

One of the original goals of the project was to facilitate actual trades by the counties. While this has not yet occurred, Arlington County made a preliminary decision to purchase nutrient credits. Arlington County does not need to purchase credits to maintain compliance with its MS4 permit until 2023, but its plan is to do so then. Queen Anne's County intends to release an RFP for the purchase of nutrient credits and is considering a small-volume purchase if suitable bids are received. Montgomery County is considering the purchase of credits but would not do so until a regulatory framework that allows MS4 jurisdictions to purchase credits and use them toward their impervious surface treatment goal is in place.

The project prompted new policy and regulatory developments in Maryland. At the beginning of the project, the MDE had not yet addressed whether urban stormwater sources, regulated or nonregulated, could use trading to meet their nutrient reduction obligations under the Chesapeake Bay TMDL or Maryland's Watershed Implementation Plan. Following a series of meetings we had with the MDE in 2014, the department issued a policy statement that authorized Phase 2 MS4s as well as nonregulated jurisdictions such as Queen Anne's County to use nutrient credits to satisfy up to 50 percent of their WIP requirements. The policy did not apply to Phase 1 MS4s because the MDE understandably felt that there were issues involved that required additional analysis, including if or

how credits would be applied to the percent impervious surface treatment requirement. In late 2015, the MDE formally announced its intention to allow trading by Phase I MS4s and formed a technical advisory committee to provide input in the development of a comprehensive nutrient-trading regulation.

An important result of the project is that a significant degree of interest in nutrient trading was created among Montgomery County farmers, despite a wariness toward potential new obligations and skepticism that it would work and be economically worthwhile.

Another finding of the credit supply analyses is that in rural counties like Queen Anne's, county-owned and managed agricultural land may be a source of nutrient credits for county stormwater programs. Utilizing this source may be logistically easier than working directly with private landowners or credit aggregators.

While none of the three counties have yet purchased credits, the project has achieved the primary goals of demonstrating the potential benefits and feasibility of trading by the stormwater sector and gaining support for it by the stormwater sector, government regulatory agencies, and tentatively by some representatives of the agricultural sector.

Lessons Learned

We conclude, based on our analysis and the outcomes achieved in the study, in attaining some of its goals and not others, that three factors are critical to successfully introducing nutrient trading as an additional tool that municipal stormwater programs could use to reduce nutrient loads and to comply with regulatory requirements. They are the existence of a clear regulatory basis for trading, an MS4 permitting strategy that allows and facilitates trading, and effective outreach to the agricultural community.

I. Clear Regulatory Basis

The presence of well-developed trading policy, regulation, or legislation is necessary in order to allow a full exploration of the feasibility of nutrient trading by the stormwater sector, the potential benefits to stormwater utilities, the economic benefits to both buyers and sellers, and the development of trading mechanisms. Without a clear legal foundation, making progress in assessment and planning is very difficult.

The Arlington County assessment was the least challenging of the three partnerships. A major reason is that Virginia has comprehensive, transparent, and clear trading rules and requirements in place, based on both legislation and regulation. Building on an established and successful trading program for wastewater treatment plants, the Virginia General Assembly passed legislation in 2012 that continued to expand nutrient trading options, including authorizing MS4s to acquire nutrient credits from either point or nonpoint sources and to use those credits to comply with their permits' nutrient load reduction requirements.

Prior to this study, Maryland had not provided local jurisdictions with any authorization for stormwater-related trading. As a result of the project, the MDE issued policy guidance in 2014 that allowed Phase II MS4s and nonregulated jurisdictions to purchase credits that can be applied toward their nutrient reduction targets. This facilitated Queen Anne County's decision to continue with this study.

The 2014 guidance did not apply to Phase 1 MS4s like Montgomery County, nor have any regulations yet been developed. Montgomery County will not purchase nutrient credits until a regulatory framework has been put in place. As a result, our ongoing work with county farmers to assess their farms credit generation potential and our exploration of potential credit procurement methods will likely stall.

Maryland did initiate a process to develop policy and regulations for stormwater trading in 2015 and formed an advisory committee to formulate recommendations. This will be a lengthy process', however, and adoption of policy or regulation did not occur in the time frame of this project.

II. MS4 Permitting Strategies and WIP Numerical Targets That Facilitate Trading

Arlington County again was the simplest case. Virginia's MS4 permitting strategy for nutrients is directly and quantitatively based on its WIP commitments and is straightforward and clear. The county's permit stipulates how 2009 baseline loads for nitrogen, phosphorus, and sediment are to be calculated, specifies load reductions from the baselines, and incorporates the WIP's time frame of three permit periods for achieving interim and final targets.

Queen Anne's County is not regulated for stormwater, hence it does not have an MS4 permit. The county does, however, have locally apportioned Chesapeake Bay TMDL targets for nutrient and sediment load reductions and an associated county-level WIP that specifies numbers of various stormwater BMPs that need to be implemented. Maryland was the only jurisdiction in the bay watershed to allocate local targets to the county level and request these jurisdictions to develop WIPs to meet these targets. The existence of these numerical goals was a key motivating factor for the county's interest in trading.

Montgomery County's MS4 permit predates the Chesapeake Bay TMDL and is silent on nutrient loads. It contains a requirement to provide stormwater management and treatment to 20 percent of urban areas that currently lack stormwater treatment facilities. The connection between the permit requirements for impervious surface treatment and the nutrient reduction targets in Maryland's Phase II WIP is indirect. The WIP established interim and final goals for nitrogen, phosphorus, and sediment load reductions, by sector, including for urban lands in MS4 jurisdictions. Subsequently, Phase I MS4s submitted local plans to the MDE describing how their WIP targets would be achieved. Montgomery County's local plan describes the steps the county plans to take to achieve the impervious acreage treatment required by its MS4 permit. The statewide WIP indicates that MDE believes that retrofitting 30 percent of the impervious acreage for Maryland's 10 largest counties and the State Highways Administration, all of which are Phase I MS4s, would achieve the WIP nutrient reduction targets for the stormwater sector.

In order for trading to occur, the treatment requirement would need to be translated into numeric reductions for nitrogen and phosphorus loads. Maryland recently addressed this need and proposed a translator between agricultural nutrient credits and impervious surface treatment requirements in a new "Maryland Trading and Offset Policy and Guidance Manual, Chesapeake Bay Watershed" which has not yet been published (Maryland Departments of Agriculture and the Environment 2016). The translator is based on the difference in pollutant load between one acre of urban impervious runoff and one acre of forested runoff. For nitrogen and phosphorus, these differences are 12.26 and 1.62 pounds, respectively. Hence, an MS4 would have to buy 12.26 nitrogen and 1.62 phosphorus credits to get credit for one acre of impervious treatment. Implementing a translator such as this one would remove a major barrier to MS4 trading.

III. Effectively Approaching the Agricultural Community

A major challenge in the outreach to the agricultural community was a prevailing skepticism toward trading among farmers. Farmers fear that additional pollution reduction requirements could be placed on them during the 2017 Bay Program midpoint assessment and that trading could monopolize remaining opportunities to meet those goals. Many farmers have a negative or wary attitude toward nutrient trading, suspecting that it is a way for municipalities to evade their pollution control responsibilities by exploiting the agricultural community.

Advocates of nutrient trading programs frequently assume that farmers will enter the market if credit prices are attractive enough; hence, outreach efforts merely need to advertise the potential economic benefits of trading. This approach is generally ineffective because it fails to understand that the decision-making process by farmers is not one-dimensional and that farmers will consider a range of factors, nonmonetary as well as monetary, in making a decision about entering the market. Prior research and the results of this study show that an approach by persons outside of the agricultural community based solely on potential revenues from credit sales is not likely to succeed (Mariola 2009). We worked through the Soil Conservation District in Montgomery County to successfully establish a working relationship with county farmers. Key factors in this success were the following:

USING A TRUSTED INTERMEDIARY

SCD Board members (farmers themselves) and staff are trusted by county farmers, so they served as "trusted intermediaries" (Mariola 2009) that were critical in creating farmer willingness to meet with us and to explore trading.

LISTENING

A willingness to elicit, listen to, and carefully consider farmer concerns early in the process was very helpful to our understanding of the best ways to proceed and helped build trust.

AVOIDING HAVING AN AGENDA

Our having no political agenda (other than development of sound policy) or financial interest in trading minimized farmer suspicion of our motives and helped build trust. Complete honesty was essential for building this trust; we made no sales pitches or general assertions that trading would be very beneficial to county farmers.

SHOWING THE ECONOMIC CASE

An important question for many farmers was "How much am I going to be paid for my credits?" This question could not be answered because it was early in the development of the Maryland market and there had been no price discovery. Speculation on our part would have been irresponsible, so we instead provided data on the extremely high unit costs for nitrogen and phosphorus load reductions produced by stormwater BMPs. While these costs that the county might avoid through credit purchases could not be described as realistic credit ceiling prices, the farmers readily understood that they have significant implications for credit pricing.

Giving the farmers a clear understanding of what the county was facing in the way of cost helped them understand and appreciate the county's motives, and also, as county taxpayers, appealed to their sense of civic responsibility.

Educating farmers that the trading market will not be like the global commodities market and that they will be in a position to influence credit prices through bids or negotiations was a major factor in generating more interest in exploring trading.

CONCLUSION

At the conclusion of this project, none of the three counties has yet purchased nutrient credits for the reasons discussed above. Working with the county partners, we successfully identified the benefits and demonstrated the feasibility of using nutrient trading to support the ongoing efforts of local municipal stormwater programs. The project also garnered general support for the usefulness and practicality of such trading from the three county partners, state regulatory agencies, a major point source in Arlington County, and some farmers. These results, and the lessons learned from this work, should be useful in the development of nutrient trading programs for the stormwater sector in the Chesapeake Bay area and beyond.

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ENDNOTES

1. Stormwater discharges by municipalities above a certain population size are considered point source discharges by the Clean Water Act and require a National Pollution Discharge Elimination System (NPDES) permit.
2. HB 176, 2012; amended and codified at Va. Code § 62.1-44.19:21.
3. The phrase "5.3.2 L2 scoping run" refers to the middle or second of three levels of effort analyzed for meeting the nutrient reductions specified in the bay-wide TMDL. The L2 scenario was modeled ("scoped") in 2010 using the Chesapeake Bay Program's computer model version 5.3.2. L2 was ultimately adopted into the Virginia Phase I WIP as the level of action the state would be implementing for MS4s.
4. Chesapeake Bay TMDL commitments require bay states to have programs in place by 2025 to achieve TMDL objectives. However, Arlington County's MS4 permit was not finalized until 2013. The DEQ-issued fact sheets accompanying Virginia's recent MS4 permits have stated, however, that "Virginia will adjust its commitments, if necessary, as part of its Phase III WIP to ensure that practices are in place by 2025 that are necessary to meet water quality standards in the Chesapeake Bay and its tidal tributaries."
5. Arlington County Stormwater Master Plan, 2014.
6. Arlington County Chesapeake Bay TMDL Action Plan, approved by the Virginia DEQ September 2015. The Action Plan is the county's plan to meet the first permit cycle pollution requirements of the Chesapeake Bay TMDL, as required by the county's MS4 permit.
7. 9VAC25-820-70.
8. The equation for this calculation is Total Permitted Annual Load (lbs./yr.) = Design Flow (million gallons/day) x Concentration Limit (mg/L) x 8.344 x 365.
9. The DEQ's nominal definition of the TP LOT is actually 0.30 mg/L and is used in all of the river basins discharging to the Chesapeake Bay except for the tidal portion of the Potomac River and the Occoquan and Dulles watersheds. The General Permit does not include any limits necessary to protect local water quality; those are contained in the WPCP's individual VPDES permit (VA0025143) that is enforced along with the General Permit. The VPDES permit contains concentration limits of 3 mg/L for total nitrogen (TN) and 0.18 mg/L for total phosphorus (TP) designed to protect local water quality in the Potomac River.
10. According to calculations by the Arlington County WPCP, it will have available nitrogen credits for exchange: 171,760 credits (lbs.) in the first permit cycle (where just 578 lbs. must be reduced in the MS4 permit); 202,706 credits during the second permit cycle (where a cumulative 4,626 lbs. must be reduced); and 195,661 credits in the third permit cycle (where a cumulative 11,565 lbs. must be reduced).
11. The use of the CBNTT for this purpose is mandatory if the credits are to be certified in Maryland.
12. http://www.mde.state.md.us/programs/Water/TMDL/TMDLImplementation/Pages/FINAL_PhaseII_WIPDocument_Main.aspx.

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