

WRI FACT SHEET

Comparison Tables of State Nutrient Trading Programs in the Chesapeake Bay Watershed

Evan Branosky, Cy Jones, and Mindy Selman

Version 1 | May 2011

TABLE OF CONTENTS

Acronyms	2
Definitions	3
1. Legal Authorities and Guidance Documents	5
2. Pollutants and General Eligibility Requirements	6
3. Point Source Participation Requirements	7
4. Market Functionality	8
5. Baseline Requirements	9
6. Trading Ratios	10
7. Credit or Offset Restrictions	11
8. Certification and Verification Processes	11
9. Septic Hookup Provisions	13
10. Compliance and Enforcement Provisions	13
11. Risk Management Provisions	14
12. Registry Vehicles and Oversight Agencies	14
References	15
Acknowledgments	15

Over the last ten years, four Chesapeake Bay states—Maryland, Pennsylvania, Virginia, and West Virginia—introduced nutrient trading programs to provide wastewater treatment plants with flexible options for meeting and maintaining permitted nutrient load limits. At least one other bay state, Delaware, also convened a work group to discuss developing such a program. Through these programs, wastewater treatment plants may purchase credits or offsets generated by other wastewater treatment plants or farms that reduce the nutrients they release to impaired water bodies. States are also exploring options for construction and urban stormwater programs to buy and sell credits and offsets.

To date, most credit transactions have occurred between buyers and sellers in the same state. Efforts to enact the recent Chesapeake Bay total maximum daily loads (TMDLs), however, could provide more opportunities for interaction by trading partners from different states. For example, regulated entities could seek credits or offsets from other states when the supply in their own state has been exhausted. In addition, entities in states that do not have a trading program could seek credits or offsets from entities in states that do have such a program.

Although the elements of many of the trading programs are identical or very similar, such as calculation platforms, included pollutants, and allowable participants, there are several differences as well. Examples are the time period that defines the life of a credit or offset and the varying types and values of trading ratios. States may need to address these and other differences before permitting more cross-state transactions. Regardless of how these differences are resolved, government regulations require credit transactions to be documented in the public record.

The World Resources Institute (WRI) has compiled into comparison tables the key design elements of the four state trading programs. The tables comprise a reference document for policymakers and others addressing the programs' differences. These design elements are grouped into twelve categories based on their common characteristics. All the information is current as of May 2011; was paraphrased directly from the statute, regulation, policy, or guidance documents; and has been reviewed by trading experts. Nonetheless, this information will undoubtedly change as the states refine their strategies for implementing the TMDLs.

ACRONYMS

AFL	Above fall line	OSDS	On-site sewage disposal system
BFL	Below fall line	PADEP	Pennsylvania Department of Environmental Protection
BMP	Best management practice	TMDL	Total maximum daily load
CBP	Chesapeake Bay Program	TN	Total nitrogen
CBWM	Chesapeake Bay Watershed Model	TP	Total phosphorus
DNREC	Delaware Department of Natural Resources and Environmental Control	USDA	US Department of Agriculture
EDU	Equivalent dwelling unit	USEPA	US Environmental Protection Agency
ENR	Enhanced nutrient removal	VADCR	Virginia Department of Conservation and Recreation
GPD	Gallons per day	VADEQ	Virginia Department of Environmental Quality
LA	Load allocation	VAWQIF	Virginia Water Quality Improvement Fund
MDA	Maryland Department of Agriculture	VNCEA	Virginia Nutrient Credit Exchange Association
MDE	Maryland Department of the Environment	VPDES	Virginia Pollutant Discharge Elimination System
MEP	Maximum extent practicable	VSWMP	Virginia Stormwater Management Program
MGD	Million gallons per day	WLA	Waste load allocation
MS4	Municipal separate storm sewer system	WVDEP	West Virginia Department of Environmental Protection
NPDES	National Pollutant Discharge Elimination System	WWTP	Wastewater treatment plant
NRCS	Natural Resources Conservation Service		

DEFINITIONS

Note: The definitions of some terms in this section differ among states and government agencies.

Additionality: A concept in which credits sold by a nonpoint source to a point source must be the result of load reductions that would not have been made without the trade (i.e., they must be in addition to expected “no-trade” load reductions) (Jones et al. 2006).

Best management practices (BMPs): Methods, measures, or practices determined to be the most reasonable and cost-effective means for landowners to meet certain, generally nonpoint source, pollution control needs. BMPs include structural and nonstructural controls and operation and maintenance procedures (USEPA 2011c). The states’ specific definitions vary.

BMP verification: Procedures for ensuring that BMPs reduce nutrients and/or sediments in compliance with the trading program’s rules.

Bubble permit: A NPDES permit covering multiple wastewater treatment plants, which collectively must meet the “bubble.”

Credit: Unit of pollutant discharge expressed in the mass-per-unit time created when a discharger reduces its discharge of the pollutant below its baseline requirement (Jones et al. 2006). The mass-per-unit time used to define a credit in all the bay states’ trading programs is one pound of nitrogen or phosphorus delivered to the bay’s tidal waters each year.

Credit certification: The application and approval process for a project intended to generate credits.

Credit registration: The process of assigning a registration number to a verified and certified credit.

Critical areas: A term specific to Maryland for all waters of the Chesapeake Bay, the Atlantic coastal bays, and their tributary streams; all lands under these waters; and all lands within one thousand feet of the landward edge of tidal waters or adjacent tidal wetlands (adapted from MDOT 2011).

Delivery ratio: A trading ratio accounting for the amount of each pound of pollutant that is naturally removed as it travels from the edge of a CBWM segment to tidal waters. The states’ definitions vary.

Design flow: The average flow that a wastewater treatment plant is designed to treat in order to comply with effluent limitations.

Edge-of-segment ratio: A trading ratio accounting for the amount of each pound of pollutant that is naturally removed as it travels from the geographic point where it is discharged to the boundary of a CBWM segment. The states’ definitions vary.

Enhanced nutrient removal (ENR): The technologies for wastewater treatment plants that can reduce average effluent concentrations to 3 mg/L TN and 0.3 mg/L TP.

Everywhere else: A term specific to Maryland for that state’s Chesapeake Bay drainage beyond the Patuxent and Potomac rivers, which includes the Eastern Shore, the Susquehanna River, and the Western Shore.

Fall line: The geological boundary where the coastal plain meets the Piedmont region. Pollutants discharged “above the fall line” have less impact on the bay’s water quality than do those pollutants discharged “below the fall line.”

General permit: A NPDES permit covering a category of dischargers rather than an individual facility.

Landowners: Properties other than crop farms that can generate nonpoint source credits.

Load allocation (LA): The portion of the pollutant loading capacity from a total maximum daily load attributed to existing or future nonpoint sources of pollution (adapted from USEPA 2011a).

Maximum extent practicable (MEP): The standard for MS4 compliance with NPDES permits. The states’ definitions vary.

Municipal separate storm sewer system (MS4): A defined stormwater area regulated under a NPDES permit. MS4s may be phase I (an urban area of 100,000 or more people) or phase II (a US Census–designated “urbanized area” with fewer than 100,000 people) (adapted from USEPA 2011b).

National Pollutant Discharge Elimination System (NPDES): A national program for issuing, modifying, revoking and reissuing, terminating, monitoring, and enforcing operating permits for some sources of pollutant discharge into surface waters (adapted from USEPA 2011a).

Nonpoint source: An undefined, nondiscrete pollution source covering a large area (e.g., septic tanks, animal-keeping practices, crop farms, forestry practices, urban and rural runoff) (adapted from USEPA 2011a).

Nonsignificant point source: The approximately 4,700 wastewater treatment plants that collectively emit substantially less pollution than do significant WWTPs. Some nonsignificant plants thus do not face nutrient load limits.

Offset: A pound of reduction can be either a credit or an offset, depending on how it is used. Reductions used to offset discharges caused by new growth are frequently referred to as *offset credits*, or just *offsets*. Credits used to achieve a cap or to prevent year-to-year operational violations are usually known merely as *credits*.

On-site sewage disposal system (OSDS): A self-contained treatment unit used in areas without access to a public sewer; also referred to as *septic systems* and/or *on-lot systems*.

Point source: A discrete conveyance that emits pollution (e.g., a municipal WWTP, an industrial WWTP, MS4s) (adapted from USEPA 2011a).

Reserve ratio: A trading ratio that allocates a portion of each credit into a credit insurance pool. The states' definitions vary.

Retirement ratio: A trading ratio that discounts each credit to ensure that a trade results in a net improvement of water quality. The states' definitions vary.

Significant point source: The approximately 480 wastewater treatment plants responsible for most of the pollutants from wastewater treatment entering Chesapeake Bay. The bay states' definitions of design flow for significant wastewater treatment plants vary.

Third parties: Those entities other than government agencies and market participants—such as aggregators, consulting firms, soil and water districts, and environmental organizations—that help administer trading programs.

Total maximum daily load (TMDL): The sum of the individual waste load allocations for point sources, load allocations for nonpoint sources and natural background, and a margin of safety expressed in terms of mass per time, toxicity, or other appropriate measures (adapted from USEPA 2011a).

Tributary strategies: Those plans developed by Chesapeake Bay jurisdictions in the early 2000s to demonstrate their progress toward meeting voluntary pollutant-reduction goals.

True-up period: The designated time period when point sources may purchase credits to meet the previous year's obligations.

Uncertainty ratios: Those trading ratios that account for the variability in nutrient removal efficiencies for agricultural best management practices that may be based on scientific uncertainty or random weather fluctuations. The states' definitions vary.

Waste load allocation (WLA): The portion of the receiving water's loading capacity allocated to one of its existing or future point sources of pollution (adapted from USEPA 2011a).

Table 1. LEGAL AUTHORITIES AND GUIDANCE DOCUMENTS

All state trading programs in the Chesapeake Bay watershed offer flexible options to point sources for meeting or maintaining the load limits of their National Pollutant Discharge Elimination System (NPDES) permits. The states are delegated authority to run their own NPDES programs when they meet the minimum criteria established by the US Environmental Protection Agency. For this reason, the state trading programs reflect each state's policy preferences and legal obligations. Table 1 compares the states' legal authorities to enact trading programs and the available reference documents, and table 2 compares the general information about the pollutants of concern and the trading programs' participation.

State	Statute
Maryland	<ul style="list-style-type: none"> Act of May 4, 2010, ch. 447, §§ 8–901 through 8–904, Md. Agriculture Code Ann. (regarding a voluntary agricultural nutrient credit certification program).
Virginia	<ul style="list-style-type: none"> Act of March 24, 2005, ch. 62.1, §§ 62.1-44.19:12 through 62.1-44.19:19, 2005 Va. Acts (establishing nutrient exchange or trading program). Act of March 27, 2009, ch. 364, § 10.1-603.8:1, 2009 Va. Acts (establishing stormwater nonpoint nutrient offsets).
Regulation	
Pennsylvania	<ul style="list-style-type: none"> Pennsylvania Nutrient Credit Trading Regulation, 25 Pa. Code § 96.8 (relating to use of offsets and tradable credits from pollution reduction activities in the Chesapeake Bay watershed). Available at http://www.pabulletin.com/secure/data/vol40/40-41/1927.html.
Virginia	<ul style="list-style-type: none"> General VPDES Watershed Permit Regulation for TN and TP Discharges and Nutrient Trading in the Chesapeake Bay watershed in Virginia, 9 VAC 25-820-10 et seq. Available at http://www.deq.state.va.us/export/sites/default/vpdes/pdf/9VAC25-820-NutrientDischargesGP2007-Amd2008.pdf.
Policy	
Maryland	<ul style="list-style-type: none"> MDE. 2008. Maryland Policy for Nutrient Cap Management and Trading in Maryland's Chesapeake Bay Watershed. Available at http://www.mde.state.md.us/assets/document/NutrientCap_Trading_Policy.pdf. MDA. 2008. Maryland Policy for Nutrient Cap Management and Trading in Maryland's Chesapeake Bay Watershed Phase II-A: Guidelines for the Generation of Agricultural Nonpoint Nutrient Credits. Draft, Annapolis. Available at http://www.mdnutrienttrading.com/docs/Phase%20II-A_Crdt%20Generation.pdf. MDA. 2008. Maryland Policy for Nutrient Cap Management and Trading in Maryland's Chesapeake Bay Watershed Phase II-B: Guidelines for the Exchange of Nonpoint Credits Maryland's Trading Market Place. Draft, Annapolis. Available at http://www.mdnutrienttrading.com/docs/Phase%20II-B_Crdt%20Purchase.pdf.
Guidance	
Maryland	<ul style="list-style-type: none"> MDA. 2011. Producing and Selling Credits in Maryland's Nutrient Trading Market: Guidance for Agricultural Producers and Landowners in the Chesapeake Bay Watershed.
Virginia	<ul style="list-style-type: none"> VADEQ. 2008. Trading Nutrient Reductions from Nonpoint Source Best Management Practices in the Chesapeake Bay Watershed: Guidance for Agricultural Landowners and Your Potential Trading Partners. Available at http://www.dcr.virginia.gov/documents/lrswoTradingGuidance.pdf. VADCR. 2009. Virginia Soil and Water Conservation Board Guidance Document on Stormwater Nonpoint Nutrient Offsets. Available at http://www.dcr.virginia.gov/documents/lrOffsetPolicyFinal.pdf.
West Virginia	<ul style="list-style-type: none"> WVDEP. 2009. West Virginia Water Quality Nutrient Credit Trading Program. Charleston.^a Available at http://www.wri.nrce.wvu.edu/programs/pwqb/pdf/WVDEP_Trading_Guidance_finalDEP8%2015%2009.pdf.

Note
a. The parent document provides guidance for all current or future nutrient trading programs in the state of West Virginia. Appendix A contains specific rules for trading in the Potomac River basin of West Virginia.

Table 2. POLLUTANTS AND GENERAL ELIGIBILITY REQUIREMENTS

Feature	Maryland	Pennsylvania	Virginia	West Virginia
Pollutants that can be traded^a	<ul style="list-style-type: none"> Nitrogen Phosphorus Sediment 	<ul style="list-style-type: none"> Nitrogen Phosphorus Sediment 	<ul style="list-style-type: none"> Nitrogen Phosphorus 	<ul style="list-style-type: none"> Nitrogen Phosphorus Sediment
Eligible market participants	<ul style="list-style-type: none"> Agricultural operations Nonsignificant point sources Other landowners Significant point sources Third parties 	<ul style="list-style-type: none"> Nonpoint sources (e.g., agricultural operations, other landowners) Nonsignificant point sources Significant point sources Third parties 	<ul style="list-style-type: none"> Agricultural operations Construction stormwater projects Nonsignificant point sources Other landowners Phase I MS4s Phase II MS4s Significant point sources Third parties 	<ul style="list-style-type: none"> Agricultural operations Nonsignificant point sources^b Other landowners Significant point sources^b Third parties
General eligibility requirements for credit purchases	<ul style="list-style-type: none"> Existing significant point sources must have ENR in operation before purchasing credits or offsets. Point sources accommodate growth by purchasing offsets generated by point or non-point sources. 	<ul style="list-style-type: none"> Existing point sources may purchase credits generated by point or nonpoint sources to meet annual load limits subject to additional conditions of NPDES permits. 	<ul style="list-style-type: none"> Existing point sources may purchase credits generated by other point sources to meet annual load limits subject to additional conditions of NPDES permits. Point sources accommodate growth by purchasing offsets in the form of WLAs from other point sources or offsets from nonpoint sources. 	<ul style="list-style-type: none"> Existing point sources must have NPDES permits and may purchase credits generated by point or nonpoint sources to meet annual load limits subject to conditions of the permits.
General eligibility requirements for credit and/or offset sales	<ul style="list-style-type: none"> Significant point sources must have ENR in operation before selling credits. WLA cannot be sold until it has been adopted in a NPDES permit through the public review process. Nonsignificant point sources must have annual load limits for nutrients.^c Sellers must meet baseline requirements. Facilities trading excess credits based on excess capacity must demonstrate consistency with water and sewerage plans. 	<ul style="list-style-type: none"> Sellers must meet baseline and applicable threshold requirements before selling credits. 	<ul style="list-style-type: none"> WLAs or compliance credits and offsets cannot be sold unless the facility for which the WLA was granted has been constructed and is operating. Sellers must meet baseline requirements before selling offsets. 	<ul style="list-style-type: none"> Point sources must have NPDES permits that contain annual load limits for nutrients and/or sediment. Sellers must meet baseline requirements before selling credits.

Notes

a. Pollutants must be traded individually.

b. The West Virginia guidance document does not use the terms *nonsignificant point sources* and *significant point sources*. Rather, it allows “point sources facing nutrient or sediment allocations” (i.e., both significant and nonsignificant point sources with NPDES permits that contain numeric nutrient and/or sediment load limits) and “point sources not facing nutrient or sediment allocations” (i.e., entities such as municipal stormwater programs that operate under a general MS4 permit that contains monitoring, reporting, and/or management requirements and not numeric nutrient and/or sediment load limits) to participate.

c. The cutoff discharge for nonsignificant dischargers to participate in the Maryland trading program is 6,100 lbs TN and 457 lbs TP or more per year.

Table 3. POINT SOURCE PARTICIPATION REQUIREMENTS

Point sources such as wastewater treatment plants (WWTPs) and municipal separate storm sewer systems (MS4s) are major sources of nutrient pollution impairing Chesapeake Bay. At the same time, these entities face the source sectors' highest costs of reducing their nutrient discharge (Jones et al. 2010). The purpose of nutrient trading programs is therefore to provide regulated point sources with less expensive and more flexible options for complying with discharge requirements. Federal and state laws designed to improve water quality, however, require point sources to adhere to certain standards that could affect their participation in state trading programs. Table 3 compares those requirements that could affect the point sources' participation in trading programs.

Feature	Maryland	Pennsylvania	Virginia	West Virginia
Existing point sources subject to nutrient and sediment requirements	<ul style="list-style-type: none"> • Sewage treatment facilities with annual average design flows of ≥ 0.5 MGD • Industrial WWTPs that discharge ≥ 75 lbs TN and 25 lbs TP per day • Expanding nonsignificant WWTPs with annual average design flows of < 0.5 MGD 	<ul style="list-style-type: none"> • Sewage treatment facilities with annual average design flows of ≥ 0.4 MGD as of August 29, 2005 • Industrial WWTPs 	<ul style="list-style-type: none"> • Sewage treatment facilities above the fall line with annual average design flows of ≥ 0.5 MGD or industrial facilities with an equivalent load • Sewage treatment facilities below the fall line with annual average design flows of ≥ 0.1 MGD or industrial sources with an equivalent load 	<ul style="list-style-type: none"> • Sewage treatment facilities with annual average design flows of ≥ 0.05 MGD^a
Types of point source permits	<ul style="list-style-type: none"> • Individual NPDES permit • Bubble permits for owners of multiple WWTPs 	<ul style="list-style-type: none"> • Individual NPDES permit 	<ul style="list-style-type: none"> • General VPDES watershed permit for TN and TP discharges and nutrient trading in the Chesapeake Bay watershed in Virginia • Individual construction and/or MS4 NPDES permit 	<ul style="list-style-type: none"> • Individual NPDES permit
Effective date of point source nutrient and sediment requirements	<ul style="list-style-type: none"> • Varies based on individual ENR construction schedules and other NPDES requirements 	<ul style="list-style-type: none"> • Occurs in three phases:^b <ul style="list-style-type: none"> – Phase 1 is October 1, 2010.^c – Phase 2 is October 1, 2012. – Phase 3 is October 1, 2013. <p>Facilities with design flows of 0.2 to 0.4 MGD will be permitted after 2013.</p>	<ul style="list-style-type: none"> • Currently January 1, 2011,^d for all basins, including the Eastern Shore and the James, Potomac, Rappahannock, and York rivers 	<ul style="list-style-type: none"> • Based on NPDES permit renewal beginning in 2005
New or expanding point source allocations and requirements	<ul style="list-style-type: none"> • New or expanding point sources must offset increased loading. • Expanding nonsignificant WWTPs will be assigned loading caps in NPDES permits.^e • New point sources of design flow ≥ 0.1 MGD must use ENR technology. • New point sources of design flow < 0.1 MGD require secondary treatment at a minimum. 	<ul style="list-style-type: none"> • New or expanding point source of any design flow must offset increased loading. 	<ul style="list-style-type: none"> • New municipal point sources initiating a discharge after December 31, 2010, of design flow ≥ 0.0001 MGD must offset increased loading. • Expanding municipal point sources of design flow ≥ 0.04 MGD and new or expanding industrial point sources with an equivalent load must offset increased loading. • New stormwater discharges subject to phosphorus controls under the VSWMP must offset increased loading. 	<ul style="list-style-type: none"> • New or expanding point sources of design flow ≥ 0.05 MGD^a must offset increased loading.

Notes

- a. If necessary, the design flow value could change in order to implement the bay TMDLs.
- b. In the final permits, the effective dates will vary.
- c. Phase 1 represents all significant dischargers.
- d. The date could change if the TMDLs require greater reductions in the James and York river basins.
- e. The cutoff discharge for nonsignificant dischargers to participate in the Maryland trading program is 6,100 lbs TN and 457 lbs TP or more per year.

Table 4. MARKET FUNCTIONALITY

Nutrient trading programs are essentially markets for exchanging nutrient reductions. Like most markets, nutrient markets face restrictions on the geographic areas where they can operate, have standards for exchanged commodities, support price discovery, and affect interactions among market participants. Table 4 compares the markets' functionality of the state trading programs.

Feature	Maryland	Pennsylvania	Virginia	West Virginia
Trading areas	<ul style="list-style-type: none"> Patuxent Potomac "Everywhere else" 	<ul style="list-style-type: none"> Potomac Susquehanna 	<ul style="list-style-type: none"> Eastern Shore^a James Rappahannock Potomac-Shenandoah York River 	<ul style="list-style-type: none"> Potomac
Base credit and/or offset calculation	<ul style="list-style-type: none"> One pound per year delivered to tidal waters 			
Life of credit and/or offset	<ul style="list-style-type: none"> Credits and offsets last one year. BMPs generate credits or offsets for the full year after they are installed.^b 	<ul style="list-style-type: none"> Credits last one compliance year (October 1 to September 30). PADEP may provide a 60-day or shorter true-up period for additional credit purchases after end of compliance year. 	<ul style="list-style-type: none"> Credits and offsets last one calendar year (January 1 to December 31). 	<ul style="list-style-type: none"> Credits last one calendar year (January 1 to December 31). WVDEP provides a two-month true-up period for additional credit purchases after end of calendar year.
Minimum offset requirement	<ul style="list-style-type: none"> Point sources must secure offsets for at least 10 years and submit a plan for an additional 10 years. 	<ul style="list-style-type: none"> Point sources must secure credits for at least five years. 	<ul style="list-style-type: none"> Point sources must secure credits for at least 10 years. 	<ul style="list-style-type: none"> Point source offset obligations are determined on a case-by-case basis.
Credit and/or offset price setting mechanism	<ul style="list-style-type: none"> The trading market sets the credit and offset price. 	<ul style="list-style-type: none"> The trading market sets the credit price.^c 	<ul style="list-style-type: none"> The trading market sets the price for offsets generated by nonpoint sources and WLAs exchanged between point sources outside the VAWQIF. VNCEA sets the price of compliance credits generated by point sources and exchanged within it. VADEQ sets the price for last-resort compliance credits and offsets.^d 	<ul style="list-style-type: none"> The trading market sets the credit price.
Platform for calculating generated credits and/or offsets from nonpoint sources^e	<ul style="list-style-type: none"> Maryland Nutrient Trading Tool that combines WRI NutrientNet platform and USDA-NRCS Nutrient Tracking Tool 	<ul style="list-style-type: none"> WRI NutrientNet 	<ul style="list-style-type: none"> Lookup tables based on CBWM runs for various levels of BMP implementation 	<ul style="list-style-type: none"> WRI NutrientNet
Market structure^f	<ul style="list-style-type: none"> Exchange Bilateral 	<ul style="list-style-type: none"> Exchange Bilateral Clearinghouse 	<ul style="list-style-type: none"> Bilateral for compliance credits and offsets exchanged through the VAWQIF or outside the VNCEA Clearinghouse for compliance credits exchanged through the VNCEA 	<ul style="list-style-type: none"> Exchange Bilateral

Notes

- Act of February 26, 2010, § 62.1-44.19:18, 2010 Va. Acts (nutrient allocation compliance and reporting) allows Eastern Shore point sources to purchase point source compliance credits from the Potomac and Rappahannock river basins.
- Depending on the BMP, generated credits could expire either after one full year or at the end of a calendar year (i.e., December 31).
- The Pennsylvania Infrastructure Investment Authority (PENNVEST) serves as a clearinghouse for nutrient credit transactions in the Pennsylvania program. PENNVEST supports price discovery through bilateral negotiations and forward and spot auctions.
- The prices for last-resort compliance credits are equal to the cost of reducing the equivalent load from municipal WWTPs in Virginia. The prices for last-resort offsets are equal to the greater of (1) the cost of reducing the equivalent load from the facility securing the allocation or an equivalent facility or (2) two times the cost of reducing the equivalent load from nonpoint sources.
- Through a USDA Conservation Innovation Grant, the World Resources Institute is developing an interstate platform. The platform will link existing NutrientNet platforms, integrate with the NRCS Nutrient Tracking Tool, and expand to jurisdictions in the bay watershed that do not currently use NutrientNet.
- Woodward, Kaiser, and Wicks (2002) identified four types of interaction among participants (i.e., structures) in nascent water quality trading programs. They are (1) exchange markets characterized by open information and fluid transactions between buyers and sellers; (2) bilateral negotiations requiring substantial interaction between buyers and sellers to exchange information and negotiate a transaction; (3) clearinghouses where the interaction between buyers and sellers is brokered by an intermediary; and (4) sole-source offsets characterized by a project implemented to reduce pollution offsite. Sole-source offsets do not include a commodity transaction between a buyer and a seller.

Table 5. BASELINE REQUIREMENTS

Point sources acquire credits or offsets in a nutrient trading program to meet or maintain limits on their nutrient discharge. Therefore, the credits or offsets must demonstrate a real reduction in the amount of nutrient pollution entering Chesapeake Bay. The states take different approaches to ensuring that credits and offsets achieve additionality. Generally, the source of the credit or offset must demonstrate that it has met its own bay-related nutrient reduction requirements or goals, which we refer to here as “baseline,” before generating credits or offsets for sale. Table 5 compares the nutrient reduction requirements for each state’s point and nonpoint sources.

Feature	Maryland	Pennsylvania	Virginia	West Virginia
Basis for determining point source baseline^a	<p>Facilities with design flow \geq 0.5 MGD face a floating cap and</p> <ul style="list-style-type: none"> Annual WLAs are based on concentrations of 4 mg/L TN and 0.3 mg/L TP at April 30, 2003, design flow. <p>Facilities with design flow < 0.5 MGD receive NPDES permit limits of 6,100 lbs or less TN and 457 lbs or less TP.</p> <p>Significant industrial facilities receive NPDES permit limits.</p>	<ul style="list-style-type: none"> Annual WLAs are based on annual average concentrations of 6 mg/L TN and 0.8 mg/L TP at annual average flow as of August 29, 2005. 	<p>Concentrations for annual WLAs for significant facilities vary by river basin. All are at 2010 design flow:</p> <ul style="list-style-type: none"> Eastern Shore is 4 mg/L TN and 0.3 mg/L TP. Potomac River AFL is 4 mg/L TN and 0.3 mg/L TP. Potomac River BFL is 3 mg/L TN and 0.1 to 0.3 mg/L TP. James River is 6 mg/L TN and 0.5 mg/L TP. Rappahannock River is 4 mg/L TN and 0.3 mg/L TP York River is 6 mg/L TN and 0.4 mg/L TP. 	<ul style="list-style-type: none"> Annual WLAs are based on annual average concentrations of 5 mg/L TN and 0.5 mg/L TP at 2010 design flow.
Baseline for agricultural operations	<p>Before generating credits or offsets, agricultural operations must first achieve their portion of the state nutrient reduction goal for nonpoint agriculture as defined as</p> <ul style="list-style-type: none"> A per-acre annual loading rate (lbs N/acre, lbs P/acre) calculated from the applicable TMDL allocations.^b <p>In addition, agricultural operations must</p> <ul style="list-style-type: none"> Comply with all applicable regulations. Develop and implement a current nutrient management plan. Develop and implement a soil and water conservation plan including, if applicable, a waste management system plan. 	<p>Before generating credits, agricultural operations must first</p> <ul style="list-style-type: none"> Comply with all applicable regulations for nutrient management, manure management, and erosion control.^c <p>In addition, agricultural operations must meet a threshold requirement beyond the state baseline^d by (1) implementing a 100-foot manure setback, (2) implementing a 35-foot vegetative buffer, or (3) reducing the farm’s total nutrient balance by 20 percent below the reductions achieved through regulations.</p>	<p>Before generating offsets, agricultural operations must first fulfill their portion of the state nutrient reduction goal for nonpoint agriculture defined as implementing the following BMPs (as applicable):</p> <ul style="list-style-type: none"> Soil conservation plan Nutrient management plan Cereal cover crops Exclusionary livestock fencing Vegetative buffers 	<p>Before generating credits, agricultural operations must first fulfill their portion of the state nutrient reduction goal for nonpoint agriculture defined as</p> <ul style="list-style-type: none"> The Tributary Strategies per acre annual loading rate (lbs N/acre, lbs P/acre, lbs S/acre)^e and implementation of a whole-farm nutrient management plan.
Additional baseline for nonpoint sources other than agricultural operations^f	<ul style="list-style-type: none"> Currently not defined 	<ul style="list-style-type: none"> Comply with all applicable regulations 	<ul style="list-style-type: none"> Currently not defined 	<p>Before generating credits on urban/mixed open lands, the landowner must</p> <ul style="list-style-type: none"> Achieve loadings associated with existing land uses as of 2005 or Implement management practices to comply with applicable regulations. <p>In addition, forestry operations cannot violate timber license regulations.^g</p>

continued next page

Table 5. BASELINE REQUIREMENTS (continued)

Feature	Maryland	Pennsylvania	Virginia	West Virginia
Baseline for MS4s	<ul style="list-style-type: none"> Currently not applicable, but MDE is evaluating trading program opportunities for MS4s. 	<ul style="list-style-type: none"> Currently not established. 	<ul style="list-style-type: none"> Currently not established, but VADEQ retains authority to approve MS4 trades on a case-by-case basis. 	<ul style="list-style-type: none"> MS4s must achieve MEP compliance with their NPDES permits before trading.

Notes

a. The actual baseline is the permitted annual load of an individual facility. Facilities must discharge less than their permitted annual load in order to generate credits or offsets.

b. Baseline requirements are calculated as a per-acre annual loading rate based on the TMDL goals for cropland in the watershed where the credits are generated.

c. The applicable regulations could include 25 Pa. Code §§ 83.201 through 83.491 regarding nutrient management plans, manure storage facilities, and financial assistance and incentives to develop nutrient management plans; 25 Pa. Code § 91.36 establishing pollution control and prevention requirements for animal manure storage facilities, liquid manure application, and pollutant discharge; 25 Pa. Code § 92a.29 establishing the permitting process for concentrated animal feeding operations (CAFOs), including having a nutrient management plan; or 25 Pa. Code §§ 102.1 through 102.8 regarding erosion and sediment control.

d. Pennsylvania defines the baseline as the applicable regulations. After an agricultural operation meets the baseline, it must meet the threshold requirements before it can implement BMPs to generate credits.

e. The per-acre annual loading rate is based on the edge-of-field nutrient load goal for the specific land use (e.g., high and low till, hay, pasture, and manure) in the relevant CBWM segment. The per-acre annual loading rate is subject to change based on TMDL allocations.

f. The category includes forests, fallow, and vacant lands.

g. W. Va. Code § 19-1B-5 establishes conditions for revoking timber licenses from operators that fail to protect life and/or prevent soil erosion and water pollution.

Table 6. TRADING RATIOS

State programs contain trading ratios that discount each pound of nutrient eligible for exchange in the market. The ratios exist to protect market participants and improve water quality. Ratios are expressed as percentages when they indicate less than one full credit or offset value. Alternatively, numeric ratios (e.g., 2:1, 1:1) are used when trading partners must buy or sell more than one full credit or offset value. Table 6 lists the five trading ratios used in some or all of the existing state programs: edge-of-segment ratios, delivery ratios, retirement ratios, reserve ratios, and uncertainty ratios (see the definitions for more information on trading ratios).

Feature	Maryland	Pennsylvania	Virginia	West Virginia
Delivery ratio	<ul style="list-style-type: none"> The CBWM provides each trading program's delivery ratio. 			
Edge-of-segment ratio	<ul style="list-style-type: none"> The CBWM provides each trading program's edge-of-segment ratio. 			
Reserve ratio	<ul style="list-style-type: none"> None 	<ul style="list-style-type: none"> 10 percent for all certified credits 	<ul style="list-style-type: none"> None 	<ul style="list-style-type: none"> 10 percent for credits generated by point sources 20 percent for credits generated by nonpoint sources, MS4s, and septic hookups
Retirement ratio	<ul style="list-style-type: none"> 5 percent for credits generated by point sources 10 percent for credits generated by nonpoint sources 	<ul style="list-style-type: none"> None 	<ul style="list-style-type: none"> None 	<ul style="list-style-type: none"> None
Uncertainty ratio	<ul style="list-style-type: none"> ≥ 10 percent for credits generated by nonpoint sources using BMPs not approved by the CBP 	<ul style="list-style-type: none"> None 	<ul style="list-style-type: none"> 100 percent for offsets generated by nonpoint sources (i.e., 2:1 ratio) 	<ul style="list-style-type: none"> ≥ 10 percent for credits generated by nonpoint sources using BMPs not approved by the CBP

Table 7. CREDIT OR OFFSET RESTRICTIONS

State programs restrict trading behavior that could undermine other policy goals. Since policy goals vary from state to state, these restrictions differ as well. For example, some states do not allow best management practices (BMPs) financed through cost-share funding to generate credits or offsets based on the assumption that the available funding is sufficient to implement the practice. Other states have taken the position that cost-share funding provides an additional incentive beyond the revenue from credit sales for farmers to implement BMPs. Hence, more BMPs will be implemented. Table 7 shows the restrictions on credit or offset generation in each state program.

Feature	Maryland	Pennsylvania	Virginia	West Virginia
Credit for BMPs financed through state and/or federal cost-share funds	<ul style="list-style-type: none"> • Cost-shared BMPs are not eligible to generate credits or offsets.^a • Cost-shared BMPs may be used to meet baseline requirements. 	<ul style="list-style-type: none"> • Cost-shared BMPs are eligible to generate credits unless the cost-share agency places restrictions on the funds. • Cost-shared BMPs may be used to meet baseline requirements. 	<ul style="list-style-type: none"> • Cost-shared BMPs are not eligible to generate offsets. • Cost-shared BMPs may be used to meet baseline requirements. 	<ul style="list-style-type: none"> • Cost-shared BMPs are eligible to generate credits. • Cost-shared BMPs may be used to meet baseline requirements.
Farmland preservation measures	<ul style="list-style-type: none"> • Credits or offsets will not be approved for idling whole or substantial portions of farms. • Credits or offsets cannot be generated when farmland is converted to new development. • Credits or offsets may be approved for land use conversions to other types of agricultural operations. 	<ul style="list-style-type: none"> • Credits will not be approved for idling whole or substantial portions of farms. 	<ul style="list-style-type: none"> • None 	<ul style="list-style-type: none"> • Credits cannot be generated when farmland is converted to other land uses.

Note

a. Cost-shared BMPs may be allowed to generate credits once contracts covering their implementation and maintenance have expired.

Table 8. CERTIFICATION AND VERIFICATION PROCESSES

Credit or offset purchases help states achieve their clean water goals. For this reason, reported reductions (i.e., generated credits and offsets) must actually improve water quality. The authorizing documents (i.e., statutes, regulations) for each state program detail the processes of certifying credits and offsets and verifying the BMPs and actions used to produce them. Table 8 summarizes the certification and verification processes for credits and offsets generated under each state program and the methods used to verify the program's success.

Feature	Maryland	Pennsylvania	Virginia	West Virginia
Agency responsible for credit and/or offset certification	<ul style="list-style-type: none"> • MDA^a • MDE^b 	<ul style="list-style-type: none"> • PADEP 	<ul style="list-style-type: none"> • VADEQ 	<ul style="list-style-type: none"> • WVDEP
Project status before certification and verification are conducted	<ul style="list-style-type: none"> • Projects that are proposed may be certified. • Project must be implemented before verification. 	<ul style="list-style-type: none"> • Projects that are proposed may be certified. • Project must be implemented before verification and registration. 	<ul style="list-style-type: none"> • Projects that are proposed may be certified. • Project must be implemented before verification. 	<ul style="list-style-type: none"> • Projects that are proposed may be certified. • Project must be implemented before verification.

continued next page

Table 8. CERTIFICATION AND VERIFICATION PROCESSES (continued)

Feature	Maryland	Pennsylvania	Virginia	West Virginia
General credit and/or offset certification	<ul style="list-style-type: none"> Applicants prepare and submit a Maryland Agricultural Nutrient Credit Certification form explaining how their project meets the trading policy's requirements. MDA reviews the project baseline and proposal for complying with the trading policy. MDA can require additional documentation, an on-site inspection, and/or other information before certifying credits and offsets. 	<ul style="list-style-type: none"> Applicants prepare and submit certification requests. PADEP staff members and other experts review certification requests. PADEP certifies credits for certification requests that comply with the nutrient trading regulation and do not need further clarification. 	<ul style="list-style-type: none"> Applicants plan and implement projects. VADCR and VADEQ staff members review project proposals.^c VADEQ certifies offsets for project proposals that include required information and comply with program requirements. Approved projects are certified annually by the applicant. Point sources report to VADEQ on trades before February 1 of the year following the calendar year in which offsets were generated. 	<ul style="list-style-type: none"> Applicants prepare and submit project proposals. Technical experts approved by WVDEP review the proposal for compliance with the trading guidance. WVDEP responds in writing to the applicant with its determination.
General credit and/or offset verification	<ul style="list-style-type: none"> Trading contracts require provisions for annual verification and reporting. Third parties^d inspect annual BMPs twice per year. Third parties^d inspect structural BMPs once per year. MDA performs annual spot checks on a minimum of 10 percent of all agricultural projects. Baseline, operation, and maintenance requirements are verified annually. 	<ul style="list-style-type: none"> Certification requests must include a plan to verify nutrient and/or sediment reductions annually. Types of verification depend on the pollutant reduction activity. Verification may occur at any time during the life of the credit. Verification must demonstrate that the pollutant reduction activity has been implemented and that other requirements, such as baseline and threshold, have been met. PADEP may conduct other verification activities, such as monitoring and conducting inspections and compliance audits. 	<ul style="list-style-type: none"> Nutrient reduction certificate and point source reports describe how project complies with trading regulations. Types of verification depend on the individual project proposal. Verification may occur at any time. 	<ul style="list-style-type: none"> Project proposals must include a credit sale or purchase agreement with a plan for a third party to verify annual nutrient and/or sediment reductions. Types of verification depend on the individual project proposal. Verification may occur at any time during the life of the credit. Third parties that meet qualification criteria outlined in the trading guidance may complete the required inspection. WVDEP, a Soil Conservation District, or a WVDEP-approved entity reviews the plans required by law and regulation.^d WVDEP, a delegated entity, the applicant, or a combination thereof ensures compliance with baseline requirements.
Verification of program's success	<ul style="list-style-type: none"> Water quality monitoring 	<ul style="list-style-type: none"> Water quality monitoring 	<ul style="list-style-type: none"> VADEQ has statutory responsibility to audit program. 	<ul style="list-style-type: none"> Water quality monitoring and modeling are based on accounting of verified BMP applications.

Notes

- a. MDA certifies credits generated by nonpoint sources.
- b. MDE certifies credits generated through septic hookups or upgrades to nonsignificant point sources.
- c. Nonpoint source offsets must be acquired through a public or private entity acting on behalf of the landowner.
- d. Third parties may include Certified Crop Advisers, Maryland Professional Engineers, USDA-NRCS Technical Service Providers, or Soil Conservation Districts.

Table 9. SEPTIC HOOKUP PROVISIONS

Several states encourage wastewater treatment plants (WWTPs) to connect on-site sewage disposal systems (OSDS) or stand-alone septic systems to their public sewer systems. Septic systems emit nitrogen that migrates into ground and surface waters and eventually into tributaries entering Chesapeake Bay. When septic systems are connected to a WWTP, the utility receives an increase in its waste load allocation (WLA). Several trading programs allow these WWTPs to sell part of the increased WLA as credits. If the WWTPs choose to do so, the WLA would be subject to several criteria of each state's trading programs (e.g., trading ratios, certification and verification processes).

Feature	Maryland	Pennsylvania	Virginia	West Virginia
WLA increase for septic hookups	<ul style="list-style-type: none"> OSDS in critical areas generate 12.2 lbs TN per year. OSDS within 1,000 feet of perennial waters generate 7.5 lbs TN per year. OSDS not located in critical areas or within 1,000 feet of perennial waters generate 4.6 lbs TN per year. Commercial OSDS are considered on a case-by-case basis. 	<ul style="list-style-type: none"> Increased point source loads can be offset by the equivalent of a 25 pound TN reduction from on-lot systems.^a 	<ul style="list-style-type: none"> Septic hookups are evaluated on a case-by-case basis. 	<ul style="list-style-type: none"> Failed systems generate 9.5 lbs of TN per capita per year. Functioning systems generate 5.7 lbs of TN per capita per year minus the discharge level of the receiving system.

Note
a. To calculate the equivalent, a point source divides the design flow (in MGD) by 262.5 and multiplies the quotient by 25. The result, in pounds per year, can be used to offset an increased point source TN load.

Table 10. COMPLIANCE AND ENFORCEMENT PROVISIONS

Credits and offset purchases are a compliance service to point sources. When credits or offsets fail to be generated, the point source is responsible for complying with the provisions of its National Pollutant Discharge Elimination System permit. For this reason, point sources are likely to require contractual agreements when they purchase credits or offsets. States and third parties that broker trading agreements may also take action to mitigate participating point sources' noncompliance. Table 10 lists the compliance and enforcement provisions in each state program.

Feature	Maryland	Pennsylvania	Virginia	West Virginia
Agency responsible for enforcement of NPDES permits	<ul style="list-style-type: none"> MDE 	<ul style="list-style-type: none"> PADEP 	<ul style="list-style-type: none"> VADEQ 	<ul style="list-style-type: none"> WVDEP
Liability for credit and/or offset implementation	<ul style="list-style-type: none"> Permit holders retain liability for compliance with NPDES permits. Credit and offsets transactions must have a legally enforceable contract. Contracts between credit generators and users must include provisions for violation of terms. Contracts between credit generators and aggregators must include provisions for violation of terms. Trading policies suggest contract elements. Trading policies suggest that aggregators self-insure by maintaining large credit inventories. 	<ul style="list-style-type: none"> Permit holders retain liability for compliance with NPDES permits. Credit transactions must have a legally enforceable contract that addresses requirements of Section 98.6(e). 	<ul style="list-style-type: none"> Point sources retain liability for compliance with VPDES permits. Contracts are at discretion of offset generators, brokers, and/or permit holders, with no involvement from VADEQ. 	<ul style="list-style-type: none"> Permit holders retain liability for compliance with NPDES permits. Project proposals must include a credit sale or purchase agreement. When used to negotiate a sale, brokers are responsible for ensuring that credit supplier complies with purchase agreement. WVDEP may decertify credits from a supplier that fails to comply with a purchase agreement.

continued next page

Table 10. COMPLIANCE AND ENFORCEMENT PROVISIONS (continued)

Feature	Maryland	Pennsylvania	Virginia	West Virginia
Compliance period for NPDES permits	<ul style="list-style-type: none"> Compliance period spans 12 months from issue date. Requirements for 10-year offset purchases and additional 10-year offset plans ensure point source's compliance. 	<ul style="list-style-type: none"> Compliance period spans one compliance year (October 1 to September 30). 	<ul style="list-style-type: none"> Compliance period spans one calendar year (January 1 to December 31). 	<ul style="list-style-type: none"> Compliance period spans 12 months beginning one month from issue date.
Point source sanction for noncompliance with offset program	<ul style="list-style-type: none"> MDE may undertake standard non-compliance action. 	<ul style="list-style-type: none"> PADEP may undertake standard noncompliance action. PADEP may avoid non-compliance situations by allowing permit holders to acquire credits after compliance period ends. 	<ul style="list-style-type: none"> VADEQ may undertake standard noncompliance action. 	<ul style="list-style-type: none"> WVDEP may undertake standard noncompliance action.

Table 11. RISK MANAGEMENT PROVISIONS

States generally expect point sources to take action to mitigate their own liability when credits or offsets that they planned to purchase are not generated. In some circumstances (e.g., natural disasters, reporting errors), however, the states provide risk management services. Risk management also helps increase market volume by attracting cautious market participants. Table 11 summarizes each state program's risk management provisions.

Feature

Feature	Maryland	Pennsylvania	Virginia	West Virginia
Risk management strategies	<ul style="list-style-type: none"> Contract provisions dictate risk management. 	<ul style="list-style-type: none"> Reserve ratio capitalizes credit reserve pool. Permit holder may be granted credits through reserve pool if uncontrollable or unforeseeable circumstances such as extreme weather conditions causes pollutant reduction activity to fail.^a 	<ul style="list-style-type: none"> VAWQIF serves as a creditor of last resort for point sources that fail to acquire credits elsewhere. 	<ul style="list-style-type: none"> Reserve ratio capitalizes credit reserve pool. Permit holder may be allowed to obtain credits from the credit reserve pool if natural disaster or unforeseen circumstance causes BMP to fail.

Note

a. PADEP will grant credits if it receives timely notice of failure, deems that the failure is not due to negligence or willingness by the permit holder, replacement credits are available, and credits comply with the trading program's rules.

Table 12. REGISTRY VEHICLES AND OVERSIGHT AGENCIES

State programs promote market activity by posting eligible credits and offsets to a registry to which buyers may refer when seeking credits or offsets. Registries also provide transparency and enable transactions to be tracked. Most states use the registry provided in NutrientNet, an online tool that includes a marketplace function in which buyers and sellers can negotiate trades and that also provides credit calculation tools for farmers. Table 12 lists the registries and state agencies that oversee them.

Feature	Maryland	Pennsylvania	Virginia	West Virginia
Type of registry	<ul style="list-style-type: none"> NutrientNet 	<ul style="list-style-type: none"> NutrientNet 	<ul style="list-style-type: none"> VPDES permits VADEQ records 	<ul style="list-style-type: none"> NutrientNet
Agency in charge of registry	<ul style="list-style-type: none"> MDA/MDE 	<ul style="list-style-type: none"> PADEP 	<ul style="list-style-type: none"> VADEQ 	<ul style="list-style-type: none"> WVDEP

REFERENCES

- Act of March 24, 2005, ch. 62.1, §§ 62.1-44.19:12 through 62.1-44.19:19, 2005 Va. Acts (establishing nutrient exchange or trading program).
- General VPDES Watershed Permit Regulation for TN and TP Discharges and Nutrient Trading in the Chesapeake Bay Watershed in Virginia, 9 VAC 25-820-10 et seq.
- Jones, C., L. Bacon, M.S. Keiser, and D. Sheridan. 2006. *Water-Quality Trading: A Guide for the Wastewater Community*. Water Environment Federation and Water Environment Research Foundation. New York: McGraw-Hill.
- Jones, C., E. Branosky, M. Selman, and M. Perez. 2010. How Nutrient Trading Could Help Restore the Chesapeake Bay. WRI Working Paper. Washington, DC: World Resources Institute.
- MDA. 2008a. Maryland Policy for Nutrient Cap Management and Trading in Maryland's Chesapeake Bay Watershed Phase II-A: Guidelines for the Generation of Agricultural Nonpoint Nutrient Credits. Draft, Annapolis.
- MDA. 2008b. Maryland Policy for Nutrient Cap Management and Trading in Maryland's Chesapeake Bay Watershed Phase II-B: Guidelines for the Exchange of Nonpoint Credits Maryland's Trading Market Place. Draft, Annapolis.
- MDA. 2009. *Producing and Selling Credits in Maryland's Nutrient Trading Market: Guidance for Agricultural Producers and Landowners in the Chesapeake Bay Watershed*. Annapolis.
- MDE. 2011. Maryland Nutrient Trading. Available at <http://www.mda.state.md.us/nutrad/> (accessed March 3, 2011).
- MDE. 2008. *Maryland Policy for Nutrient Cap Management and Trading in Maryland's Chesapeake Bay Watershed*.
- MDOT (Maryland Department of Transportation). 2011. The Chesapeake and Atlantic Coastal Bays Critical Area Act. Available at http://www.mdot.maryland.gov/Planning/Environmental_Permits-Construction/Critical_Areas.html#COMAR (accessed April 12, 2011).
- PADEP. 2011. PA Nutrient Trading. Available at http://www.dep.state.pa.us/river/Nutrient_trading.htm (accessed March 3, 2011).
- PADEP. 2007. Pennsylvania's Chesapeake Bay Tributary Strategy Implementation Plan for Sewage Facilities Planning.
- Pennsylvania Nutrient Credit Trading Regulation, 25 Pa. Code § 96.8 (relating to use of offsets and tradable credits from pollution reduction activities in the Chesapeake Bay watershed). Available at <http://www.pabulletin.com/secure/data/vol40/40-41/1927.html>.
- State of Maryland. Maryland Nutrient Trading Website: What Is Maryland's Trading Program? Available at <http://www.mda.state.md.us/nutrad/ntwhat1s.php#PointSource> (accessed January 28, 2010).
- Talberth, J., C. Jones, M. Perez, M. Selman, and E. Branosky. 2010. How Baywide Nutrient Trading Could Benefit Pennsylvania Farms. WRI Working Paper. Washington, DC: World Resources Institute.
- USEPA. 2011a. Impaired Waters and Total Maximum Daily Loads Glossary. Available at <http://www.epa.gov/owow/TMDL/glossary.html> (accessed March 3, 2011).
- USEPA. 2011b. Stormwater Discharges from Municipal Separate Storm Sewer Systems (MS4s). Available at <http://cfpub.epa.gov/npdes/stormwater/munic.cfm> (accessed April 12, 2011).
- USEPA. 2011c. TMDL Primer. Available at <http://www.epa.gov/reg3wapd/tmdl/glossary.htm> (accessed April 4, 2011).
- VADCR. 2009. *Virginia Soil and Water Conservation Board Guidance Document on Stormwater Nonpoint Nutrient Offsets*.
- VADEQ. 2008. *Trading Nutrient Reductions from Nonpoint Source Best Management Practices in the Chesapeake Bay Watershed: Guidance for Agricultural Landowners and Your Potential Trading Partners*.
- West Virginia University, West Virginia Water Research Institute. WV Potomac Water Quality Bank and Trade Program. Available at <http://www.wri.nrcce.wvu.edu/programs/pwqb/index.cfm> (accessed March 3, 2011).
- Woodward, R.T., R.A. Kaiser, and M.B. Wicks. 2002. The Structure and Practice of Water Quality Trading Markets. *Journal of the American Water Resources Association* 38(4):967–80.
- WVDEP. 2009. *West Virginia Water Quality Nutrient Credit Trading Program*. Charleston.

ACKNOWLEDGMENTS

The authors thank the Linden Trust for Conservation, David and Lucille Packard Foundation, Red Crane Foundation, and David Blood for their generous support of this fact sheet.

For their helpful comments on the content and structure of this fact sheet, the authors also thank Allan Brockenbrough (VADEQ), Todd Gartner (WRI), Patricia Gleason (USEPA), Elizabeth Goldbaum (DNREC), Erin Gray (WRI), Richard Herd (GreenVest LLC), Oliver Houck (Tulane University), Marya Levelev (MDE), Susan Payne (MDA), Michelle Perez (WRI), John Rhoderick (MDA), Ann Roda (PADEP), David Tomberlin (WRI), Sara Walker (WRI), and Robert Winterbottom (WRI).

The authors also thank Hyacinth Billings and Ashleigh Rich for coordinating the publications process and Margaret B. Yamashita for editing this fact sheet.

Finally, the authors thank Alyse Schrecongost for sharing her comparison of state trading programs. In 2008, Ms. Schrecongost created comparison tables of the Pennsylvania, Virginia, and draft Maryland programs to help in the development of the West Virginia program.

CONTACTS

Evan Branosky is an associate and Cy Jones and Mindy Selman are senior associates in the People and Ecosystems Program at WRI. Contact ebranosky@wri.org, +1 (202) 729-7630.

ABOUT WRI

The World Resources Institute is an environmental think tank that goes beyond research to find practical ways to protect the earth and improve people's lives. Our mission is to move human society to live in ways that protect Earth's environment for current and future generations.

Copyright 2011 World Resources Institute.



This work is licensed under the Creative Commons Attribution-NonCommercial-NoDerivative Works 3.0 License. To view a copy of the license, visit <http://creativecommons.org/licenses/by-nc-nd/3.0/>