Accounting for Uncertainty in Offset and Trading Programs

EPA Technical Memorandum

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CONTENTS

ABBREVIATIONS AND ACRONYMS

BMP .... Best management practice

CBP... Chesapeake Bay Program

EPA... United States Environmental Protection Agency

MS4 .... Municipal separate storm sewer system

NPS... Nonpoint source

NPDES .... National pollutant discharge elimination system

TMDL.. Total maximum daily load

WIP .... Watershed implementation plan

WSM .... Watershed Model

WWTP .... Wastewater treatment plant

SCOPE

This Technical Memorandum identifies EPA's expectations for how the Chesapeake Bay jurisdictions[1] should address the issue of uncertainty in their respective offset and/or trading programs. This Technical Memorandum is not official agency guidance and is applicable only in the Chesapeake Bay Watershed. Its purpose is to elaborate on EPA's expectations, set out in Appendix S and Section 10 of the Chesapeake Bay Total Maximum Daily Load (Bay TMDL), for the Bay jurisdictions' offset and trading programs. Those programs are expected to be consistent with and supportive of the water quality goals of the Chesapeake the Bay TMDL, including its allocations and assumptions and the common elements of Appendix S. This Technical Memorandum may be revised in the future.

EXECUTIVE SUMMARY

This Technical Memorandum addresses methods to reduce uncertainty in the calculation of credits used for offsets or trading in the Chesapeake Bay watershed. Uncertainty in trading or offsets has multiple sources, including variability in best management practice (BMP) effectiveness, weather, soils, and BMP maintenance and success.

BMP effectiveness values were developed by subject area experts working with the Chesapeake Bay Program. When each effectiveness value was developed, the effectiveness value was discounted for certain types of uncertainty that include: operational conditions, implementation date and time to maturity, and variation in natural conditions. The effectiveness values implicitly address those sources of uncertainty.

Other sources of uncertainty exist that are not implicitly addressed in credit generation and calculation. Such sources of uncertainty include, but are not limited to, lag times, land use changes, soils, and failed credit generation. Given that uncertainty is unavoidable, EPA expects the Bay jurisdictions to incorporate an uncertainty ratio as described in this Technical Memorandum in their offset and/or trading programs.

Where a transaction is between a credit generating nonpoint source and a credit purchasing point source, EPA expects an uncertainty ratio of at least 2:1 to be used. Where direct and representative monitoring of a nonpoint source is performed at a similar level as is performed at traditional national pollutant discharge elimination system (NPDES) point sources (WWTP and Industrial sources), and there is a consistency in operation and direct and representative monitoring of the nonpoint source, an uncertainty ratio as low as 1:1 may be appropriate, provided the jurisdiction can demonstrate that adoption of a 1:1 ratio is justified in such circumstances. Verification of practice implementation does not substitute for direct monitoring of runoff. An uncertainty ratio of 1:1 is acceptable for point source to point source transactions between the same type of point sources that have a NPDES permit, i.e., a direct and representatively monitored source to a direct and representatively monitored source. Under no circumstances is an uncertainty ratio less than 1:1 advisable, and EPA therefore expects that Chesapeake Bay jurisdictions accept no lower than a 1:1 uncertainty ratio.

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[1] The Bay jurisdictions are: Delaware, Maryland, Pennsylvania, New York, Virginia, West Virginia, and the District of Columbia.

The recommendations in this Technical Memorandum are consistent with the Bay TMDL, regulations, guidance and EPA trading policy, recognizing that nonpoint source discharges are more uncertain than direct and representatively monitored traditional NPDES point sources, and are readily influenced by storm events, seasonal variations, and site-specific physical and chemical characteristics, in contrast to point source discharges which are relatively constant and more readily quantifiable.

INTRODUCTION

The establishment of the 2010 Chesapeake Bay Total Maximum Daily Load (Bay TMDL) created limits (caps) on total nitrogen, phosphorus and sediment loads into the Bay.[2] After 2010, any new or increased load above those limits is expected to be offset by an equal reduction of that pollutant by an existing source or sources. This applies to existing sources (for example, a wastewater treatment plant that adds additional subdivisions to its effluent intake) and new sources (for example, new development that generates stormwater runoff). Credits can be used for offsetting purposes.

The Bay TMDL also contemplates the use of trading for existing sources to meet TMDL allocations. In principle, such activities may offer a more cost-effective way of meeting allocations, as those sources that can reduce their loads more cheaply can sell credits to those sources for which the same reduction would be more expensive. Using credits offer a viable means for achieving overall reductions in loads in a more efficient way through market interactions (trades and offsets) among buyers and sellers of credits.

Water quality offset and trading programs are expected, under the Bay TMDL, to be consistent with the Clean Water Act,[3] its implementing regulations, EPA's 2003 Water Quality Trading Policy,[4] and the 2007 Water Quality Trading Toolkit for NPDES Permit Writers.[5]

SAFEGUARDS IN OFFSETS AND TRADES

Accounting for uncertainty is one form of safeguard. Safeguards generally take the form of ratios that require pollutant reductions in amounts greater than those that would otherwise be needed. Safeguards are necessary to ensure that credits generated result in actual pollutant reductions. Chesapeake Bay jurisdictions' offset and trading policies and regulations, non-governmental organizations, and EPA have all recognized and defined multiple types of safeguard mechanisms, which generally may be categorized by the policy goal of the ratio. Four important ratio-categories are listed below. Different ratio-specific definitions are associated with each, as each performs a different function and has a different policy goal, and therefore should not be conflated.

1. **Location adjustments**—account for different locations between the credit generator and buyer.

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[2] Full text of the Bay TMDL is available at http://www.epa.gov/reg3wapd/tmdl/ChesapeakeBay/tmdlexec.html. Last accessed 11/30/2012.
[3] Clean Water Act, 33 U.S.C. §§ 1251 et seq.
[4] United States Environmental Protection Agency, Water Quality Trading Policy (2003), available at http://www.epa.gov/owow/watershed/trading/finalpolicy2003.pdf. Last accessed 11/30/2012.
[5] United States Environmental Protection Agency, "Water Quality Trading Toolkit for Permit Writers," Updated June 2009. Available online at http://water.epa.gov/type/watersheds/trading/WQTToolkit.cfm. Last accessed 11/30/2012.

2. **Pollutant type**—accounts for various exchanges between nitrogen and phosphorus or different forms of the same pollutant (e.g., phosphate and total phosphorus).
3. **Water quality improvement**—sets aside a portion of credits for improving water quality.
4. **Uncertainty**—accounts for variability or the unknown in the calculation of credits used for offsets or trading.[6]

This Technical Memorandum addresses accounting for uncertainty in offset and trading programs, and therefore focuses on number four in the list above. Other Technical Memoranda are expected to address location adjustments and accounting for exchanges between pollutant types.

For purposes of consolidated quick reference and clarity, the four categories above are subdivided based on the purpose of the ratio into category-specific ratios and are listed along with their source-specific definitions in Appendix A to this Technical Memorandum.

The Bay jurisdictions may include additional or stronger safeguards in their offset and/or trading programs than the expectations set out herein, although any such additional components should be consistent with EPA's expectations laid out in the Bay TMDL and these Technical Memoranda.

PURPOSE OF ACCOUNTING FOR UNCERTAINTY

The purpose of accounting for uncertainty in the calculation of credits in the Chesapeake Bay watershed is to prevent total nitrogen, sediment, and phosphorus loads from increasing when an expected load reduction fails to be realized. Accounting for uncertainty in the application of BMP offsets and trading in a regulatory approach could be accomplished by the model's explicit incorporation of conservative assumptions in the simulated BMPs - conservative assumptions are less likely to be violated, so that any management policy based on trades and offsets in the regulatory approach would have a high probability of success. If the regulatory approach fails to incorporate conservative BMP assumptions then it cannot be said to account for BMP management uncertainty. In this case the CBP Watershed Model Phase 5.3.2 does not incorporate conservative management assumptions for BMPs that would necessarily result in a nutrient and sediment load reduction that would be less under a given BMP. The Chesapeake Bay Watershed Model (CBP Partnership WSM) is calibrated to conditions that will provide the <u>best estimates</u> of nutrient and sediment loads under applied BMPs.

The CBP relies upon a process of convening expert panels to evaluate BMP effectiveness for a range of BMPs that are being implemented in Chesapeake Bay watershed jurisdictions.[7] The process is based on a uniform set of guidelines and criteria and a rigorous scientific process set forth in a 2009 report by Simpson and Weammert.[8] The approach referenced small watershed monitoring studies and was designed to remove unwarranted optimism in the research values relative to real-world implementation.

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[6] See, e.g., Cynthia Morgan and Ann Wolverton, Water Quality Trading in the United States, Working Paper# 05-07 for the National Center for Environmental Economics, U.S. EPA, at 15-16 (June, 2005); World Resources Institute (WRI), Water Quality Trading Programs: An International Overview, at 9-11 (March 2009).

[7] The CBP Partnership BMP Protocol sets forth how BMP effectiveness values are established, and is available at http://www.chesapeakebay.net/about/programs/watershed_implementation_plan_tools/#1.

[8] Simpson and Weammert Report available at http://archive.chesapeakebay.net/pubs/BMP_ASSESSMENT_REPORT.pdf.

The WSM incorporates BMP effectiveness values derived from Simpson and Weammert, but this does not account for BMP uncertainty in offsets and trades. The approach used by Simpson and Weammert in establishing BMP effectiveness was designed to arrive at BMP effectiveness values that were unbiased and realistic. As noted in the report, BMP effectiveness values have an inherent uncertainty that is addressed by Simpson and Weammert in order to better represent realistic BMP efficiencies:

> "Uncertainty in nonpoint source pollution reduction estimates is due to variability in natural landscape conditions, degree of management, and spatial and temporal changes among BMPs and their location. Examples include precipitation, hydrology and geology, lag time between implementation of practices and full performance, and between implementation and observed water quality benefits. **To minimize uncertainty in BMP efficiency estimation, and to more realistically estimate operational pollutant removals from BMPs, one must examine this suite of spatial and temporal factors. These factors should be used to adjust efficiencies estimated from research plots.** Not every BMP will be subject to all the conditions, but a research project will not capture the entire suite of factors that determine efficiencies when practices are widely implemented across natural landscapes."[9] [**Emphasis Added**]

Like the BMP effectiveness values estimated by Simpson and Weammert, the CBP Partnership WSM was developed and applied to address the inherent variability in BMP effectiveness and to provide unbiased and realistic estimates of nutrient and sediment loads under NPS management actions, rather than conservative estimates. Accordingly, the CBP Partnership WSM does not account for the type of management uncertainty that the uncertainty ratio advanced in this Uncertainty TM attempts to mitigate.

CAUSES OF UNCERTAINTY

A number of factors may cause a credit to reduce loads less than the amount expected, including, but not limited to:

1. **BMP Effectiveness**
   - **Operational conditions**—variations in how a BMP is operated and maintained
   - **Implementation date and time to maturity**— Lag times between BMP implementation and a response in water quality
   - **Natural condition variation**— heterogeneity in soils, topography, and management
2. **Accounting for meteorological variation in runoff loads** — temperature, evapotranspiration, wind, solar radiation, dew point, cloud cover, precipitation timing and intensity affect runoff
3. **Failed credit generation**—planned credits are not generated at all

While this list is not intended to be exhaustive, it does represent the predominant causes of uncertainty. Each is addressed in greater detail in the sections below.

BMP EFFECTIVENESS

BMP effectiveness values express the percent pollutant reduction achieved by implementing a particular BMP compared to the load that would have been delivered before BMP implementation. For example, if a BMP is assigned an effectiveness value of 60% for nitrogen, then the nitrogen load from the modeled land use on which

[9] *Id.* at 22.

the BMP is applied is decreased by 60%, and 40% of what would have been delivered without the BMP reaches the water body.

Several factors may affect BMP effectiveness, including operational conditions, implementation date and time to maturity, and variation in natural conditions such as heterogeneity in soils, topography, and management. Each of these types of uncertainty was taken into account when expert teams coordinated by the Chesapeake Bay Program (CBP) partnership[10] established BMP effectiveness values for use in the CBP Watershed Model (WSM).[11] BMPs and their effectiveness values are modified using a protocol that requires involvement by experts and members of the partnership.[12] As of January 2013, the Chesapeake Bay partnership has approved over 130 BMPs for use in the Bay watershed and has established effectiveness values for nitrogen, sediment, and phosphorus for those BMPs, as applicable.

As indicated above, BMP effectiveness values were developed by subject area experts working with the Chesapeake Bay Program. When each effectiveness value was developed, the effectiveness value found in literature was commonly from well-managed research plots on experimental farms. These effectiveness values were discounted for operational conditions. Teams of subject-matter experts that established the effectiveness values "adjusted the effectiveness estimates to be more conservative; mentioning what effectiveness estimate they had initially calculated based solely on research scale data calculated and explained the level of conservatism they are recommending to reflect operational conditions."[13] The effectiveness values vary across the Chesapeake Bay watershed for natural condition variations such as implementation date, growth rate of crops, and physiographic region. The effectiveness values implicitly address those sources of uncertainty. Appendix B provides more information on the considerations in BMP effectiveness value development. These discounts were to ensure the BMP effectiveness values were *unbiased and realistic*. The CBP partnership-approved BMPs and their effectiveness values were established using realistic estimates for load reductions, which do not reflect additional sources of uncertainty.

BMP effectiveness values are used in a variety of ways in the Chesapeake Bay watershed. The Bay jurisdictions' Watershed Implementation Plans (WIPs)[14] include BMP implementation and predicted loads based on the established BMP effectiveness values. The Bay jurisdictions also have developed two-year milestones that

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[10] The CBP is a unique regional partnership that includes Maryland, Pennsylvania, Virginia, the District of Columbia, the Chesapeake Bay Commission, EPA, federal agencies, and participating advisory groups. The headwater states of Delaware, New York, and West Virginia participate as full partners on issues related to water quality. Each of the CBP partners agrees to use its own resources to implement projects and activities that advance Bay and watershed restoration.

[11] See, e.g., Simpson and Weammert, 2009. Developing Best Management Practice Definitions and Effectiveness Estimates for Nitrogen, Phosphorus and Sediment in the Chesapeake Bay Watershed. Available at: http://archive.chesapeakebay.net/pubs/BMP_ASSESSMENT_REPORT.pdf. Last accessed 12/13/2012.

[12] Protocol for Development, Review, and Approval of Loading and Effectiveness Estimates for Nutrient and Sediment Controls in the Chesapeake Bay Watershed Model. http://www.chesapeakebay.net/about/programs/watershed_implementation_plan_tools#1, last accessed 12/13/2012.

[13] Simpson and Weammert, 2009. Developing Best Management Practice Definitions and Effectiveness Estimates for Nitrogen, Phosphorus and Sediment in the Chesapeake Bay Watershed. Available at: http://archive.chesapeakebay.net/pubs/BMP_ASSESSMENT_REPORT.pdf. Last accessed 12/13/2012. pp. 14.

[14] Phase II WIPs are accessible at http://www.epa.gov/reg3wapd/tmdl/ChesapeakeBay/EnsuringResults.html?tab2=7.

include various BMPs and levels of implementation to achieve target loads. The milestones use the established BMP effectiveness values in predicting loads. In addition, through an annual review process, actual BMP implementation is reported to determine load reductions using the established BMP effectiveness values. This Annual Progress Review assesses each jurisdiction's progress toward the Bay TMDL goals. The WIPs, milestones, and Annual Progress Review all use the more than 130 established BMPs and their established effectiveness values.

The Bay jurisdictions that currently have offset and/or trading programs (Maryland, Pennsylvania, and Virginia) use the established BMPs and their effectiveness values in their offset and/or trading programs. Those Bay jurisdictions also have accommodations for additional BMPs not approved by the CBP partnership. As described in the Technical Memorandum on Components of Credit Calculation, EPA expects Bay jurisdictions to generate credits (either for offset or trade purposes) using only those practices approved by the Chesapeake Bay Program Partnership.

Given that the BMP effectiveness values are unbiased and realistic, and that the partnership-approved BMPs are widely used for multiple load reduction calculations including milestones, WIPs, and the Annual Progress Review, it is not necessary to add an additional uncertainty factor to the BMP effectiveness values.

ACCOUNTING FOR METEOROLOGICAL FACTORS IN RUNOFF AMOUNTS

Meteorological factors are significant sources of uncertainty that are otherwise unaccounted for and have an impact in at least two ways:

1) *Monitored Versus Modeled (or Unmonitored) Loads* - The uncertainty ratio addresses the difference between monitored and modeled loads. Because NPDES point sources are typically monitored for flows and concentrations and also have multiple layers of municipal, state, and federal review of operations and monitoring typically associated with a NPDES facility, the estimated management reductions are relatively certain. By contrast, nonpoint source BMPs are typically modeled estimates that introduce additional uncertainties associated with the outcome of any particular BMP.

2) *Hydrologic Uncertainty* – this Uncertainty TM indicates that the uncertainty ratio is designed partially to account for the annual variability in loads and BMP effectiveness as a result of annual variation in meteorological factors. These factors include: precipitation, temperature, evapotranspiration, wind, solar radiation, dew point, and cloud cover. The CBP Partnership WSM uses a constant 10-year simulation hydrology, but additional uncertainty arises from the actual hydrologic and weather conditions of the year of the particular offset or trade as compared to the constant hydrology of the WSM simulation because the fixed ten year simulated hydrology in the model is replaced by the more stochastic actual hydrologic and weather conditions.

The amount of rainfall in a given year has a substantial impact on loads for all sources. Wastewater treatment plants (WWTP) have a measurable and monitored load, which allow for relatively easy and accurate credit calculations. Loads from nonpoint sources (e.g., agriculture) and sources where the loads are generated from diffuse locations (e.g., stormwater from municipal separate storm sewer systems (MS4s)) are not as easily measured.[15]

Yet for both stormwater and agricultural nonpoint sources, rainfall and other annual changes are not taken directly into account by monitoring as with WWTPs. When loads cannot be directly monitored, then a model is used. An average hydrology takes into account wet and dry years, as well as extreme events. Trades between unmonitored sources require an uncertainty ratio in case any one year has a high variance with the average. Models are used to estimate the loads to account for factors that affect <u>annual</u> variation. For example, years in which precipitation is relatively high typically produce more runoff and loads than do dry years. Rainfall can affect the performance of BMPs such as less than full growth or coverage of a cover crop. Timing and intensity of rainfall events are major factors in the annual variability of BMP effectiveness.

The WSM uses a constant, known, average hydrology over a period of 10 years because the WSM is designed and intended as a management tool for representing consistent hydrologic conditions over a constant 10-year period (1991-2000) and the effect of rainfall is averaged over the 10-year period of wet and dry weather as well as extreme events during the 1991-2000 period. Annual variation due to a current specific year's actual meteorological conditions adds uncertainty that is unaccounted for in the standard, constant WSM 1991-2000 simulated loads.

To effectively use credits, buyers must know with as much certainty as possible how many credits will be generated and that these credits are real and quantifiable. It is impractical to monitor every BMP to quantify accurately the amount of credits generated. The use of an uncertainty ratio allows a buyer to purchase credits with greater certainty. Given that certainty is higher for traditional NPDES point sources (WWTP and industrial sources), and that certainty is lower for nonpoint sources, uncertainty ratios are expected to be applied to credits generated by nonpoint sources. In a review of over 20 water quality trading programs across the Unites States, EPA found that a 2:1 uncertainty ratio was most widely adopted, although uncertainty ratios as high as 4:1 were observed. EPA believes that 2:1 represents an uncertainty ratio that is adequately conservative and protective of water quality while not being unduly restrictive so as to discourage transactions. <u>**Therefore, EPA expects an uncertainty ratio equal to or greater than 2:1 be applied to transactions involving credits generated by nonpoint sources to mediate any uncertainty generated by assuming average hydrology.**</u>

Additionally, to ensure that there is consistency in the credit calculation and that the amount of credits available for use is clear to buyers when applying an uncertainty ratio, <u>**EPA expects that the uncertainty ratio will be applied at the point of credit generation rather than at the point of sale.**</u>

The 2:1 uncertainty ratio advanced in this Uncertainty Technical Memorandum addresses uncertainty related to offsets and trading between measured point source loads and model estimates of nonpoint source loads. That uncertainty is unaddressed by the CBP Partnership WSM or by the values for BMP effectiveness used in the CBP Partnership WSM. In offsets and trading, additional uncertainty is introduced in the exchange of a model

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[15] Information on MS4s is available at: http://cfpub.epa.gov/npdes/stormwater/munic.cfm, last accessed 10/21/2012.

estimated NPS load with a monitored load of flow and concentration measurement, which is typical for point sources.

Where direct and representative monitoring of a nonpoint source is performed at a similar level as is performed at traditional NPDES point sources and there is a consistency in operation and direct and representative monitoring of the nonpoint source, an uncertainty ratio as low as 1:1 may be appropriate, provided the jurisdiction can demonstrate through monitoring data that adoption of a 1:1 ratio is justified in such circumstances.

FAILED CREDIT GENERATION

A situation could arise in which planned credits are not generated at all. An example of failed credit generation is when a practice such as cover crops is used in an attempt to reduce nutrient and sediment loads, but the cover crop fails to grow. In this example, the credits were not actually produced although they may be under contract. In another example, a grassed waterway could have been installed but washed out by a heavy rainfall event. This would result in a practice that is not functioning and therefore not generating any credits. The seller would be unable to meet the terms of the contract, while the purchaser may have a permit requiring credit purchase. **Liability on the part of the credit generator may be handled using the accountability and tracking provision articulated in Appendix S of the TMDL that documentation of agreements between parties to the transaction is expected.[16] Ultimately, the permit holder is held accountable for meeting the permit by enforcing the written record of the transaction.**

Some state offset or trading programs have established a reserve ratio that may be used as an insurance pool for failed credit generation. **However, the existence of a reserve ratio is not a substitute for an uncertainty ratio, which addresses uncertainty for reasons other than solely failed credit generation.**

POINT SOURCE UNCERTAINTIES

Direct and representative sampling of point sources is required as part of the federal NPDES program, which helps to establish a certain level of certainty. In most cases, the NPDES program is administered by authorized states.[17] To assist Bay jurisdictions in ensuring that point sources are directly and representatively monitored, EPA plans to issue a separate Technical Memorandum to address representative sampling.

EPA expects the Bay jurisdictions to apply an uncertainty ratio of at least 1:1 for point source to point source transactions (offsets or trades) since point sources are directly and representatively monitored in a regulatory context.

EPA expects that the Bay jurisdictions will use no less than a 1:1 uncertainty ratio when use of a 1:1 ratio is justified under the circumstances described in this Technical Memorandum – i.e. where direct and representative monitoring of a nonpoint source is performed at a similar level as is performed at traditional NPDES point sources and there is a consistency in operation and direct and representative monitoring of the

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[16] Appendix S of the TMDL, 8(h) at S-5 available at: http://www.epa.gov/reg3wapd/pdf/pdf_chesbay/FinalBayTMDL/AppendixSOffsets_final.pdf, last accessed on 3/4/2013.

[17] NPDES regulatory information may be found here: http://cfpub.epa.gov/npdes/. Last visited 1/25/2013. For specific authorizations, see http://cfpub.epa.gov/npdes/statestats.cfm.

nonpoint source, provided the jurisdiction can demonstrate through monitoring data that adoption of a 1:1 ratio is justified in such circumstances.

MONITORING INCENTIVE FOR DECREASING UNCERTAINTY

Where uncertainty can be decreased substantially under the circumstances described in this TM, then the uncertainty ratio may also be decreased, although in no event should the ratio be lower than 1:1. Transactions involving credits generated by sources that monitor pollutant loads directly at the source may not require an uncertainty ratio[18] because there is little uncertainty for which to account. Monitoring should meet the expectations described in the Representative Sampling Technical Memorandum that are applied to point sources. These data should be provided to the permitting authority for review on a regular basis. Where actual discharges do not match anticipated discharges, a "true-up" or reconciliation process should be employed. If a "true-up" is not possible, then additional credits generated cannot be sold. If monitored discharges are greater than anticipated discharges, then those anticipated credits have not been generated. If the converse is true, then more credits may be sold.

If not able to directly monitor discharges as described above, then an uncertainty ratio of at least 2:1 should be applied.

VERIFICATION AND ASSESSMENT

Verification of on-the-ground BMP implementation is a critical component of trading and offset programs. EPA expects the Bay jurisdictions to have a comprehensive system in place for credit verification whereby BMPs are routinely evaluated to ensure that they are installed, performing and maintained as designed. This is because verification assures that a practice was installed according to standard. However, ensuring that BMPs are implemented according to standards is not equivalent to measuring runoff loads because verifying on the ground implementation does not address all causes of uncertainty – for example, other sources of uncertainty may include accounting for meteorological variation in runoff loads or a situation where verification occurred at a point in time but that verified BMP became non-functional shortly thereafter due to a rain event that washed it out or suffered some other significant change. **Therefore, the presence of an offsets and trading verification or assessment program does not negate the expectation that an uncertainty ratio is utilized.**

EPA plans to publish a separate Technical Memorandum on verification measures.

CONCLUSIONS

EPA expects the Bay jurisdictions to address uncertainty in offsets and trades. Given the uncertainty of nonpoint sources due to many factors, EPA expects that Bay jurisdictions will utilize an uncertainty ratio equal to or greater than 2:1, unless the jurisdiction can demonstrate, through sufficient direct and representative monitoring, that the factors leading to uncertainty can be addressed. The use of verification of practice implementation does not negate the expectation for an uncertainty ratio.

For point source to point source offsets or trades, a 1:1 ratio may be used. An uncertainty ratio as low as 1:1 may also apply to nonpoint sources that have the characteristics of traditional NPDES point sources in that

[18] "No uncertainty ratio" is the same as using an uncertainty ratio of 1:1.

direct and representative monitoring of a nonpoint source is performed at a similar level as is performed at point sources and there is a consistency in operation and direct and representative monitoring of the nonpoint source, provided the jurisdiction can demonstrate through monitoring data that adoption of an uncertainty ratio as low as 1:1 is justified in such circumstances.

EPA expects that the Bay jurisdictions will use no less than a 1:1 uncertainty ratio when use of a 1:1 ratio is justified under the circumstances described in this Technical Memorandum.

EPA expects the Bay jurisdictions to provide:

- Explicit purpose of the uncertainty ratio,
- Justification for the uncertainty ratio adopted,
- Calculation of uncertainty for each transaction, and
- Description of how the credits are tracked.

EPA also expects that the uncertainty ratio will be applied at the point of credit generation rather than at the point of sale. This will help to ensure that there is consistency in the calculation and that the amount of credits available for trades is clear to buyers.

APPENDIX A: SUMMARY OF TERMINOLOGY AND DEFINITIONS IN POLICIES AND REGULATIONS

Safeguards generally take the form of ratios that are applied to credits. The purpose of this appendix is to catalogue the terms and definitions of the multiple types of safeguard mechanisms in the form of ratios that are found in offset and trading policies and regulations of the Bay jurisdictions, non-governmental organizations, and EPA. These terms and definitions vary across jurisdictions; for purposes of consolidated quick reference and clarity, they are provided here.

Generally, the various types of ratios may be divided into four major categories based upon the purpose of the ratio, as follows:

1. **Location adjustments**—account for different locations between the credit generator and buyer
2. **Pollutant type**—accounts for various exchanges between forms of nitrogen and phosphorus or between nitrogen and phosphorus
3. **Water quality improvement**—sets aside a portion of credits for improving water quality
4. **Uncertainty**—accounts for variability or the unknown in credit generation

This Technical Memorandum focused on number four, above – uncertainty. This appendix lists and defines the types of ratios that fall under each of the five categories above. Appendix C lists the various safeguards adopted in each Bay jurisdiction's offset and/or trading program and the purpose of the safeguard adopted.

TYPES OF RATIOS OR SAFEGUARDS

The terms and definitions discussed herein are taken from existing policies, guidelines, and other documents published by EPA; Chesapeake Bay jurisdictions with offset and/or trading programs (Maryland, Virginia, and Pennsylvania); and non-governmental organizations. A summary of the ratios, corresponding definitions, and the source of the terms are listed in Table 1.

Terms and definitions are taken verbatim from existing source documents and are meant to serve <u>solely</u> as a resource articulating the different types of offset and trade-related ratios as defined by the respective sources.

Table 1: Ratios Names, Purposes, and References

Purpose of Ratio	Name of ratio	Reference
Location Adjustment	Delivery ratio	WRI, 2011; EPA Toolkit, 2009; Pennsylvania Trading Policy and Guidelines, December 2006; Maryland Trading Policy, 2008; CBP Trading Fundamentals and Guidelines, 2001[19]
	In-stream delivery factor	Maryland Nutrient Cap Management Phase II-A, April 2008
	Location ratio	EPA Toolkit Glossary, 2009

[19] To the extent that there are inconsistencies between the CBP Trading Fundamentals and Guidelines, 2001 and the TMDL, regulations and EPA Trading Policy, the latter three govern.

	Trading ratio (Maryland)	Maryland Trading Policy, 2008
	Edge-of-stream ratio	WRI, 2011; Pennsylvania Trading Policy and Guidelines, December 2006; Maryland Nutrient Cap Management Phase II-A; 2008
Between Pollutant Types	Equivalency ratio	EPA Toolkit Glossary, 2009
Water Quality Improvement	Retirement ratio	WRI, 2011; EPA Toolkit Glossary, 2009; Maryland Trading Policy, 2008; CBP Trading Fundamentals and Guidelines, 2001
	Special needs (concerns) ratio	CBP Trading Fundamentals and Guidelines, 2001
	Water quality ratio	CBP Trading Fundamentals and Guidelines, 2001
	Trading ratio (Maryland)	Maryland Trading Policy, 2008
Uncertainty	Reserve ratio	WRI, 2011; Pennsylvania Trading Policy and Guidelines, December 2006
	Trading ratio	CBP Trading Fundamentals and Guidelines, 2001; Maryland Trading Policy, 2008; Virginia Trading Guidance
	Uncertainty ratio	WRI, 2011; EPA Toolkit Glossary, 2009; Maryland Trading Policy, 2008; CBP Trading Fundamentals and Guidelines, 2001

LOCATION ADJUSTMENT RATIOS

Ratios often are used to adjust the load between the buyer and the seller based on the relative position of one to the other. Landscape features and in-stream processes vary throughout the Chesapeake Bay Watershed. Models provide factors that make adjustments to loads based on these factors. The various types of location adjustment ratios are: delivery ratio, in-stream delivery factor, location ratio, trading ratio (as defined by Maryland), and edge-of-stream ratio. Each is discussed below except the trading ratio which is defined in the Uncertainty Section.

DELIVERY RATIO

The purpose of delivery ratios is to normalize a load based on delivery to the Chesapeake Bay segment. This ratio accounts for the in-stream processes that attenuate nutrients and sediment. As an example, if a seller has a delivery ratio of 0.80, and the buyer needs 100 credits, then the seller must produce 120 credits. In this example, the buyer would be located near the Bay segment and have a delivery ratio of 1.0. The Bay segment refers to one of the 92 Chesapeake Bay segments that have an associated TMDL. In the example above, the credit purchaser is physically located in the tidal portion of the Bay watershed adjacent to that segment. This ratio comes from the Chesapeake Bay Program's Watershed Model, and the term used in the Model is "delivery factor."

- (WRI, May 2011) Percent of a pollutant that is naturally removed in transport from the edge of a CBP Partnership WSM segment to its tidal waters.

- (Pennsylvania Trading Policy and Guidelines, December 2006) Delivery Ratios apply discount factors to compensate for a pollutant's travel over land or in water (or both) and may be applied to point, as well as, nonpoint sources. Delivery ratios generally account for attenuation (i.e., the rate at which nutrients are reduced through natural processes, such as hydrolysis, oxidation, and biodegradation, on their way through tributaries to the mainstem of the water body). The ratio varies depending on the location of the source from the mainstem. Generally, the greater the distance the pollutant has to travel, the greater the pollutant loss will be. This ratio would work to equalize a trade between a source in the headwaters and one near the mainstem. This ratio is also often termed a "location ratio." Delivery ratios will be based on information from applicable and accepted data sources, such as the Chesapeake Bay Watershed Model.

- (EPA Toolkit Glossary, June 2009) Factor applied to pollutant reduction credits when sources are directly discharging to a waterbody of concern that accounts for the distance and unique watershed features (e.g., hydrologic conditions) that will affect pollutant fate and transport between trading partners.

- (Maryland Trading Policy, April 2008) Delivery Ratios apply discount factors to compensate for a pollutant's travel over land or in water (or both) and may be applied to point and nonpoint sources. Delivery ratios generally account for attenuation (i.e., the rate at which nutrients are reduced through natural processes, such as hydrolysis, oxidation, and biodegradation, on their way through tributaries to the mainstem of the water body). The ratio varies depending on the location of the source relative to the mainstem. Generally, the greater the distance the pollutant has to travel, the greater the pollutant loss will be. This ratio would work to equalize a trade between a source in the headwaters and one near the mainstem. This ratio is also often termed as "location ratio." Delivery ratios will be based on information from applicable and accepted data sources, such as the Chesapeake Bay Watershed Model.

- (CBP Trading Fundamentals and Guidelines, March 2001) Delivery ratios apply discount factors to compensate for a pollutant's travel over land or in water (or both) and may be applied to point, as well as, nonpoint sources. Delivery ratios generally account for attenuation (i.e., the rate at which nutrients are reduced through natural processes, such as hydrolysis, oxidation, and biodegradation, on their way through tributaries to the mainstem of the water body). The ratio varies depending on the location of the source from the mainstem. The general idea is that the greater the distance the pollutant has to travel, the greater the pollutant loss will be. This ratio would work to equalize a trade between a source high in the tributary and one near the mainstem. This ratio is also often termed a "location ratio."

IN-STREAM DELIVERY FACTOR

While this factor has a different name than the delivery ratio, the "in-stream delivery factor" definition indicates that it is the same as the delivery ratio.

- (Maryland Nutrient Cap Management Phase II-A, April 2008) The In-Stream Delivery Factor is a function of the distance from the edge of the watershed segment and the fall line of the Chesapeake Bay. This represents the pollutant effect of the nutrient reductions between upstream and downstream points. The delivery factor is derived from the Chesapeake Bay Watershed Model.

LOCATION RATIO

This is a generalized term defined by EPA.

- (EPA Toolkit Glossary, June 2009) Factor applied to pollutant reduction credits when sources are upstream of a waterbody of concern that accounts for the distance and unique watershed features between a pollutant source and the downstream waterbody (e.g., bay, estuary, lake, reservoir) or area of interest (e.g., a hypoxic zone in a waterbody).

EDGE-OF-SEGMENT RATIO

The edge-of-segment ratio is a factor applied to the nutrients and sediment remaining on the land after best management practices (BMPs) reductions are calculated, but before in-stream processes are accounted for. This Watershed Model factor is applied to other models for calculating credits. The edge of segment ratio is generally called the edge-of-stream factor in the Chesapeake Bay Program's Watershed Model.

- (WRI, May 2011) percent of each pound of pollutant that is naturally removed in transport from the geographic point where it is discharged to the boundary of a Chesapeake Bay Watershed Model segment.
- (Pennsylvania Trading Policy and Guidelines, December 2006) A ratio that identifies the amount of a pollutant expected to reach the surface waters at the boundary of a Chesapeake Bay Watershed Model segment through surface runoff and groundwater flows from a pollutant source within a watershed segment.
- (Maryland Nutrient Cap Management Phase II-A, April 2008) Edge of Segment Delivery Factor is the amount of land-applied nutrients expected to reach the surface waters at the boundary of the Chesapeake Bay Watershed Model segment through surface runoff, groundwater flows, and atmospheric deposition. The EOS factor is derived from the Chesapeake Bay Watershed Model.

BETWEEN POLLUTANT TYPES

The EPA Toolkit Glossary (June 2009) provides a ratio for trading between nitrogen and phosphorus. The definition is described below.

EQUIVALENCY RATIO

- (EPA Toolkit Glossary June 2009) Factor applied to pollutant reduction credits to adjust for trading different pollutants or different forms of the same pollutant.

WATER QUALITY IMPROVEMENT

Water quality improvement ratios provide a set-aside of credits to ensure water quality improvement. These set-aside credits are not to be used for any reason. They serve as a guarantee that a transaction does not simply shift the load from the seller to the buyer, but rather result in an overall decrease in pollutants. The ratios that specify that the purpose is for water quality improvement include the retirement ratio, special needs or special concerns ratio, water quality ratio, and the trading ratio as defined by Maryland. There is a trading ratio defined by WRI, EPA, and the Chesapeake Bay Program partnership, but none of those sources specify the purpose as water quality improvement. Each of the water quality improvement ratio terms and definitions are discussed below except the trading ratio, which is defined in the Uncertainty Section.

RETIREMENT RATIO

- (WRI, May 2011) A ratio that discounts each nutrient credit to ensure that a trade results in a net improvement in water quality.
- (EPA Toolkit Glossary, June 2009) Factor applied to pollutant reduction credits to accelerate water quality improvement. The ratio indicates the proportion of credits that must be purchased in addition to the credits needed to meet regulatory obligations. These excess credits are taken out of circulation (retired) to accelerate water quality improvement.
- (Maryland Trading Policy, April 2008) Retirement ratios are applied to implement policy-driven or programmatic decisions to require that buyers or sellers donate part of all credit purchases or sales to the state or some other entity that will not apply the credits to offset loadings above its cap. The [Maryland] Department will seek a five (5) percent retirement ratio for all point source to point source trades. The percent retirement ratio may be adjusted over time. (Nonpoint source trades have a 10% retirement ratio.)
- (CBP Trading Fundamentals and Guidelines, March 2001) A certain percentage of an available credit may be retired (i.e., excluded) from trading in order to increase the potential for a water quality benefit or to provide a margin of environmental safety (similar to an uncertainty ratio) for the overall trading program. Some programs require, for example, that 10% of the available credits for sale be taken off the market before any trades are negotiated. When evaluating the potential use of retirement ratios, it is important to also consider issues of cost, equity, and future economic growth. Options for retirement ratios include the following:
    - Requiring that a portion (e.g., 10%) of all credits traded by both point and nonpoint sources is contributed to the state. This is a fairly equitable approach, and, if the percentage is small, should not impose too onerous a cost on participants.
    - Requiring that BMP credits expire at the end of the rated life of the installation. This is a reasonable requirement; however, difficulties may arise in multiple BMPs installed over an extended period of time and in the case of BMPs functioning efficiently beyond their rated life spans.
    - Requiring that all credits be retired at the end of 5 years. This is the approach taken in the Michigan program. It establishes a level playing field for all participants. In addition, the duration is sufficiently long enough for planning and assessment purposes.
    - State agencies, citizen groups, or environmental nonprofits may purchase credits with the express purpose of immediately retiring them. Such action may be warranted in locations or periods of worsening water quality. It is, however, a costly option for all concerned and, by removing credits from the market place, may serve to dampen the market for trading and restrictive growth.
    - Entities that cease to operate may be required to retire all or a portion of their credits. This policy may be pursued in areas in which growth is being discouraged for environmental reasons.
    - Credits may be retired as part of penalties imposed on entities that continue to violate their terms of trade for an extended period of time (e.g., over two years).

SPECIAL NEEDS RATIO

This ratio is defined in the CBP Trading Guidelines and Pennsylvania guidelines and appears to be a catchall for issues not addressed elsewhere.

- (Pennsylvania Trading Policy and Guidelines, December 2006) Special Needs Ratios would account for issues not addressed in other trading ratios; for example, sensitive waters or areas needing additional protection. Special needs ratios will be developed and utilized on an as-needed basis.

- (CBP Trading Fundamentals and Guidelines, March 2001) See "Water Quality Ratios".

WATER QUALITY RATIO

The CBP's 2001 trading guidelines define this ratio as protecting against location differences and special concerns related to particularly sensitive areas.

- (CBP Trading Fundamentals and Guidelines, March 2001) Water quality ratios may be included to account for the effect a source has on local water quality, or to relate the relative impact of pollutant reductions in any given watershed segment (e.g., tributary) to mainstem water quality goals, such as indicators of dissolved oxygen and living resources. Water quality ratios would account for situations, including nonattainment areas or sensitive areas such as wetlands, lakes, or wildlife sanctuaries that may require additional water quality considerations. The increase in loads in such areas could have a greater impact than in less sensitive areas. In such cases, sources could have their reductions discounted by a factor (e.g., 10%) to achieve greater water quality protection. The water quality ratio and the delivery ratio are similar in that both involve location, but a delivery ratio addresses attenuation and considers source location relative to the distance from the water body of concern. A water quality ratio addresses location relative to special conditions in the receiving water; if needed, it may exist in addition to delivery ratios.

UNCERTAINTY

There are three ratios that specify the purpose as serving for uncertainty—reserve ratios, trading ratios, and uncertainty ratios. This uncertainty can be related to scientific issues such as lack of information or variability in scientific literature, abnormal weather, or geographic variability.

There is uncertainty around the number of credits that should be created from any given practice. While this uncertainty partly is taken into account in the establishment of the BMP effectiveness values, the uncertainty ratios also provide a buffer against this uncertainty. The uncertainty ratios generally are to be applied to transactions involving credits generated by nonpoint sources.

These ratios also can be insurance against failed credit generation. In this case, the number of credits that are above what the buyer needs is put in a pool that may be accessed in case of failed credit generation. An example of failed credit generation is where a practice such as cover crops is used to reduce nutrient and sediment loads, but the cover crop fails to get established due to lack of rain. In this example, the credits were not actually produced although they may be under contract. The seller finds they are unable to meet the terms of the contract and the buyer may have a permit requiring credit purchase.

RESERVE RATIO

A reserve ratio sets aside a percent of each nutrient credit allocated into a credit insurance pool. It appears as if the reserve ratio serves the purpose of providing insurance for failed credit generation, rather than addressing all types of uncertainty in credit generation.

- (WRI, May 2011) Percent of each nutrient credit allocated into a credit insurance pool.
- (Pennsylvania Trading Policy and Guidelines, December 2006) A 10% ratio that is applied to the pollutant reductions generated, which establishes the credits to be set aside for the Department's credit reserve.

TRADING RATIOS

- (CBP Trading Fundamentals and Guidelines, March 2001) To account for the uncertainty regarding the effectiveness and monitoring of nonpoint source controls, trading ratios are applied in the cases in which nonpoint sources are involved. For example, a trading ratio of 2:1 means that for every pound increase in pollutant traded by a point source, there must be a corresponding two-pound trade from a nonpoint source.
- (Maryland Trading Policy, April 2008) Discount factors applied to pollutant reductions to account for uncertainty, water quality, delivery or special need concerns.
- (Virginia Trading Guidance) Two pounds of nonpoint load reductions, of either total nitrogen or total phosphorus, to be acquired by a point source, to offset one pound to be discharged.

UNCERTAINTY RATIOS

- (WRI, May 2011) Trading ratios that account for the variability in nutrient removal efficiencies for agricultural BMPs. May be based on scientific uncertainty or random weather fluctuations.
- (EPA Toolkit Glossary, June 2009) Factor applied to pollutant reduction credits generated by nonpoint sources that accounts for lack of information and risk associated with BMP measurement, implementation and performance.
- (Maryland Trading Policy, April 2008) Uncertainty Ratios are intended to account for variation in the expected reliability and efficiency of the source or type of reduction being applied toward credit for another. They are calibrated to create a margin of safety or otherwise attempt to ensure that the credited practice provides a minimum level or reductions, even if actual reduction efficiencies and units removed are on the low end of an expected range. In some instances uncertainty ratios will not be employed because they are already accounted for in quantification methods. Trades involving nonpoint sources may use uncertainty ratios of greater than 1:1.

- (CBP Trading Fundamentals and Guidelines, March 2001) Point source nutrient discharges are relatively constant and easily quantified. By contrast, nonpoint source nutrient discharges are more uncertain and are readily influenced by storm events, seasonal variations, and site-specific physical and chemical characteristics. In addition, the BMPs applied to nonpoint sources generally provide a reduction potential that is an estimate rather than a measured value … To accommodate for this range of potential efficiencies, most trading programs attempt to address nonpoint reduction uncertainties by assigning a rate greater than 1:1 (i.e., requiring that more than one nonpoint credit be traded for one point source credit).

APPENDIX B: BMP EFFECTIVENESS VALUE DEVELOPMENT

The process for establishing the effectiveness values took into account the variation in the operational conditions of BMPs. In scientific studies, the BMP operation and maintenance is managed under ideal conditions without regard to the multitude of demands of a working agricultural operation. This level of BMP operation and maintenance can result in increased load reductions than what would otherwise be achieved in a working agricultural operation. This variability was accommodated by discounting operational manuals, which often provide aspirational assumptions for operations and maintenance. The instructions given to every expert panel for each BMP was to provide an effectiveness value that reflects average operational conditions across the entire watershed.[20]

The development of BMP effectiveness values also takes into account the implementation date and time to maturity.[21] Consider the example of a forest buffer. In an agricultural operation, a farmer takes the land out of production, which means that fertilizer is no longer applied. Next, the farmer plants trees. These trees take many years to mature. Yet, there is a single effectiveness value for forest buffers. That is because the effectiveness value is annualized over the life of a buffer. In the early years, that annualized effectiveness accounts primarily for the discontinuation of fertilizer. In the later years, the effectiveness value is accounting for the excess nutrients taken up by the trees.

The BMP effectiveness values also take into account the natural condition variation.[22] Natural conditions vary due to heterogeneity in soils, topography, weather, and management. The effectiveness values were established using research on specific conditions. Many of the agricultural and urban BMPs have varying effectiveness values depending on hydrogeomorphic region and soils. Much discussion and determination was dedicated to considering the effect of natural variability on BMP effectiveness, which is why several of the BMPs vary depending on the natural condition. Moreover, the Watershed Model takes into account natural conditions for runoff and in-stream processes for delivered loads, beyond that which already is accounted for by the BMP effectiveness value.

APPENDIX C: STATE SUMMARY

In the Chesapeake Bay watershed, three states currently have trading or offset programs—Maryland, Pennsylvania, and Virginia. These existing programs and their methods for accounting for uncertainty are reviewed in this section. This information is accurate at the time of this Technical Memorandum's publication. There may be subsequent changes to the states' offset and trading programs.

The existing Chesapeake Bay jurisdictional offset and trading programs have used two methods to address uncertainty.

1) Ratio applied to each credit that discounts the value of the credit. For example, a credit buyer may need 30 credits to meet a permit requirement. The credit seller may create 30 credits, and then a ratio of 2:1 is applied. Thus, the seller has only 15 credits available to be sold.

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[20] Simpson and Weammert, 2009. p. 22-23
[21] Simpson and Weammert, 2009. p. 25-26
[22] Simpson and Weammert, 2009. p. 23-24

2) Pool of credits may be created through a ratio. A fixed percent or number of generated credits, such as 2:1, is transferred to a reserve controlled by the state. The seller may generate 20 credits but only may sell 10, with 10 going into the reserve. This reserve pool of credits is managed by a jurisdiction's offset or trading program and is withdrawn as the need arises, such as when credit generation fails.

In these three Bay jurisdictions, three terms for ratios specify the purpose as serving for uncertainty—reserve ratios, trading ratios, and uncertainty ratios. This uncertainty can be related to scientific issues such as lack of information or variability in scientific literature, abnormal weather, or geographic variability.

Whichever name is used for the ratio, its purpose is meant to account for uncertainty in credit generation. Following CBP Trading Fundamentals and Guidelines, March 2001, uncertainty regarding the effectiveness and monitoring of nonpoint source controls, trading ratios are applied in the cases in which nonpoint sources are involved. For example, a trading ratio of 2:1 means that for every pound increase in pollutant traded by a point source, there should be a corresponding two-pound trade from a nonpoint source.

Reserve ratio	Pennsylvania Trading Policy and Guidelines, December 2006
Trading ratio	Virginia Trading Guidance
Uncertainty ratio	WRI, 2011; EPA Toolkit Glossary, 2009; Maryland Trading Policy, 2008; CBP Trading Fundamentals and Guidelines, 2001

Safeguards may take the form of a trading ratio (Virginia), reserve ratio (Pennsylvania), retirement ratio (Maryland) and also an uncertainty ratio applied to specific BMPs (Maryland). Virginia also has a fund of credits that are to serve as water quality improvement.

Virginia has a ratio whose purpose is explicitly for uncertainty. Maryland's uncertainty ratio is for specified practices, not the overall uncertainty associated with nonpoint source trades. Maryland's retirement ratio is not for uncertainty, but for water quality benefit. Pennsylvania's reserve ratio is for failed credit generation, which is not the sole cause of uncertainty. A reserve ratio alone is inadequate to account for uncertainty.

Table 2: Safeguards in use in existing state trading programs. The numeric value is specified for nonpoint sources where it was in the policy. If it was solely defined, it is indicated by an "X".

State Program	Reserve Ratio	Retirement Ratio	Trading Ratio	Uncertainty Ratio (for specified practices only)	Reserve Fund
Maryland		10%		≥20% (for specified practices only)	
Pennsylvania	10%				
Virginia			2:1	X	Water Quality Improvement Fund

MARYLAND

Maryland uses a retirement ratio of five percent for point sources and 10 percent for nonpoint sources. This means that for a farmer, or other nonpoint source, to sell 100 credits, they must produce 110 credits. There is also an additional factor to guarantee water quality improvement for those credits generated by BMPs not yet approved by the Chesapeake Bay Program. For unapproved BMPs, credits are discounted by at least 20 percent.

PENNSYLVANIA

Pennsylvania established a reserve ratio that sets aside 10 percent of all credits. Additional safeguards are built into the reduction credit calculations by taking a conservative approach to the factors used in the calculations. Pennsylvania also places a cap on the number of credits that may be sold overall. This cap is termed the "tradable load."

VIRGINIA

Virginia uses an uncertainty factor of a two to one ratio for nonpoint source generated credits. This means that to sell 100 credits, 200 must be created. In addition, Virginia has created a Water Quality Improvement Fund into which some permit holders may be required to pay. Credits from this fund may be used as a safeguard for point sources unable to acquire credits elsewhere.

REFERENCES FOR STATE TRADING PROGRAMS

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.

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 October 31, 2012).

PA-DEP. 2006. Final Trading of Nutrient and Sediment Reduction Credits - Policy and Guidelines (Revisions to the Interim Final Trading of Nutrient and Sediment Reduction Credits - Policy and Guidelines). http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-48501/01%20392-0900-001.pdf. Last accessed October 31, 2012.

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. Last accessed October 31, 2012.

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.