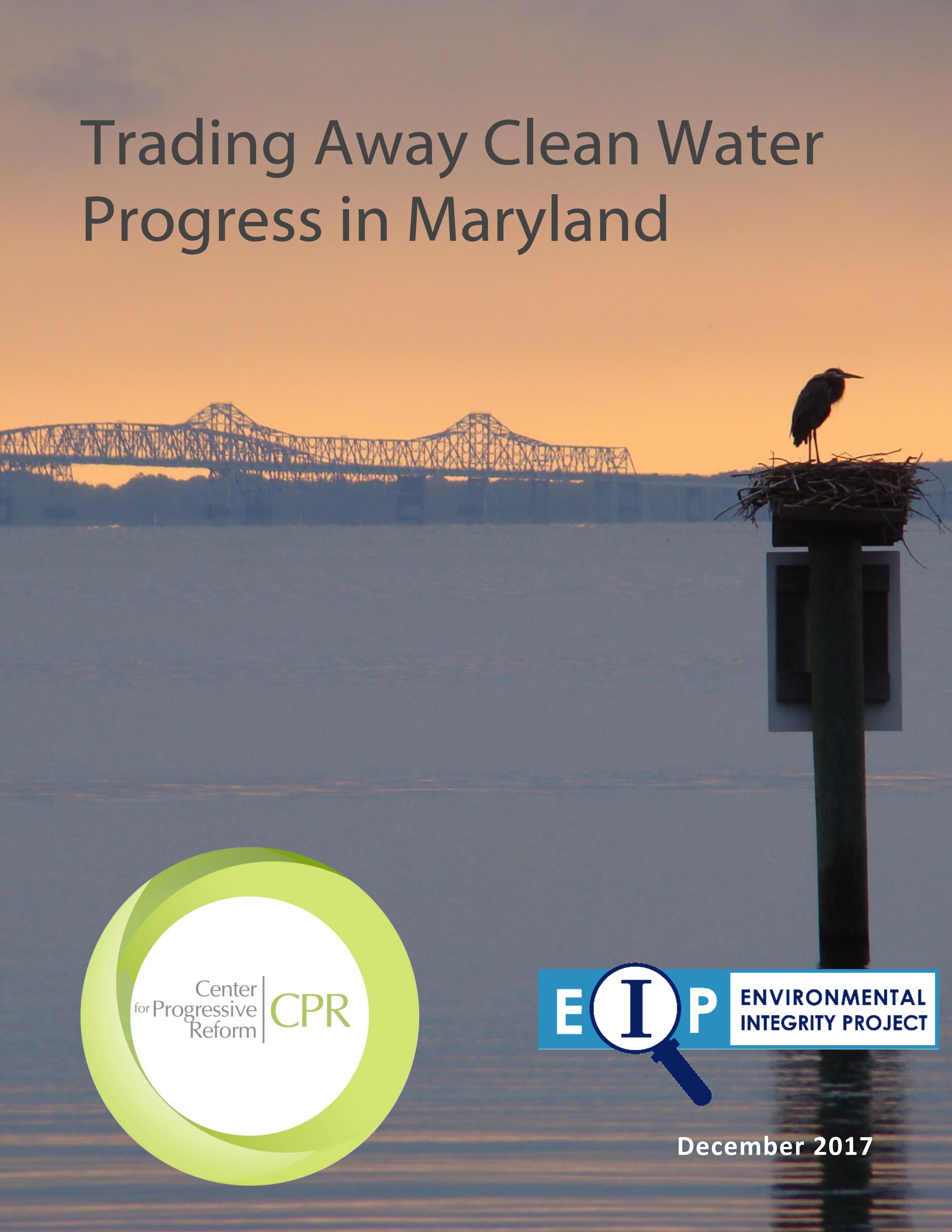
Trading Away Clean Water Progress in Maryland



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Executive Summary

The Chesapeake Bay watershed covers parts of eight states and the District of Columbia. It is home to an aquatic ecosystem so diverse and historically productive that it is studied by scientists from around the world. But years of pollution have left the Bay in poor health, prompting the Environmental Protection Agency (EPA) to establish a landmark watershed cleanup plan in coordination with the six watershed states and the District of Columbia. Begun in 2010, the ambitious goal of this plan was to have practices in place by 2025 that would eventually reduce the quantity of nitrogen, phosphorus, and sediment pollution entering the Bay by 25 percent, 24 percent, and 20 percent, respectively. To be sure the effort stayed on track, the plan called for more than half of the progress to be in place by the plan's midpoint in 2017.

We are now at that midpoint of the restoration plan, and it is clear that the states collectively have not met their interim 2017 goal, and indeed look to be nowhere close to reaching the final 2025 goal. Progress has lagged in large part because restoring the Chesapeake Bay requires substantial energy, commitment, and, of course, resources. But with most of the "low-hanging" pollution reductions already banked, regulators and government officials across the watershed are desperately scrambling for additional reductions. Sometimes, these efforts result in truly innovative approaches, but sometimes they rely on corner-cutting.

The current push for a trading market for nutrient pollution is seen by some as an innovative market-based solution to jump-start the flagging restoration effort at a low cost. A trading market would allow people, companies, and governments required by law to reduce the amount of pollution they discharge to purchase "credits" for pollution reduction efforts undertaken by someone else. In theory, water pollution trading ensures overall discharges are capped over time and encourages reductions to happen where they can be achieved at the lowest cost. If done right, a trading program may provide an incentive for some to reduce pollution beyond what is required of them by law.

But water pollution trading is untested on a large scale in the real world, and success or failure in the context of the Bay depends entirely on how the market is structured. The main problem with trading generally is the risk that program designers will prioritize rules that promote trading activity over

ones that would demonstrably help to meet pollution-reduction goals. In their efforts to develop a functioning market, they can lose sight of the true purpose: cleaning up the Bay.

The first principle of trading should be to do no harm. Trading programs are only a means to an end. The end is clean water, not establishing a high-volume trading market. The Chesapeake Bay will not be restored by shuffling pollution credits around or by concocting questionable accounting rules. If the rules governing a trading market are drawn poorly, then the market could actually facilitate an increase in pollution with each pollution credit traded.

The following report is based on a close evaluation and analysis of more than two years' effort by the Maryland Department of the Environment to create a water pollution trading program. Over the past two years, the department has worked with a stakeholder advisory group to develop a new, comprehensive nutrient trading program. The department released a draft trading manual and a number of early discussion drafts before submitting its finished product to the General Assembly in October 2017. After immediate criticism, the department pulled the regulations back to make some changes and on December 8, 2017, published a final proposal of the regulations for public comment. Unless the department again pulls the regulations back, the new trading program will be up and running in early 2018.

From day one, environmentalists and others have raised concerns about program design choices that threaten to undermine the broad goal of reducing pollution in an equitable, measureable, and transparent way. True to those expectations, the final proposed trading regulations suffer from three major problems:

- **Uncertain Reductions**: The regulations fail to account for uncertainty about the degree to which certain pollution-reduction activities are actually reducing pollution;

- **Pollution Hot Spots**. The regulations will allow trading in a way that leads to pollution hot spots and other concerns for local communities and water quality; and

- **Paper Credits**. The regulations will allow trading of credits that exist only on paper and are not backed by real pollution reductions — "paper credits."

If Maryland's trading program is to succeed in creating a market that reduces pollution with every trade, we should expect to see dozens or hundreds of new water pollution control projects created throughout the state over the next few years. Instead, what the newly proposed regulations are likely to generate is what the nonpartisan federal analysts at the Government Accountability Office (GAO) recently found in their review of about two dozen smaller water pollution trading programs around the United States: that "trading is not responsible for reducing nutrient pollution, according to EPA, state, and other stakeholders" but instead "was useful because it allowed point sources to manage risk" and "reduce the cost of compliance." If Maryland expects a different result here, one that actually reduces nutrient pollution, it will need to significantly revise the proposed trading regulations.

Maryland has traditionally been seen as a leader in Bay restoration efforts, but the new nutrient trading policy proposed by the state's Department of the Environment has several major flaws. If adopted, the policy would threaten not only Maryland's leadership role, but also the potential for meeting the state's pollution reduction goals under the Bay cleanup.

An Introduction to Pollution Trading

Pollution trading is a market-based regulatory tool that has primarily been used in the United States over the last several decades to facilitate the reduction of air pollution or mitigate human impact on our climate. Familiar examples include the national acid-rain reduction effort based on trading credits for reducing nitrogen oxide and sulfur dioxide emissions from stationary sources of air pollution. The common theme is that trading can be used to allocate pollution reduction responsibilities across a large geographic area, where pollutants are widely dispersed and the total pollution load from all sources may be capped and reduced.

The premise behind pollution trading is that some entities can reduce their pollution loads more easily than others. If the required reductions are converted to 'credits,' which can be bought and sold, then those who cannot easily reduce their pollution can instead offset their excess by purchasing credits from others who are able to go beyond their individual limits at a lower cost. In the abstract, trading can incentivize pollution reductions from the easiest, most affordable sources, leading to a lower total cost of meeting a pollution cap.

A nutrient trading program, if implemented correctly, will include carefully considered rules and safeguards. A trading program implemented without such safeguards, can easily lead to an overall increase in pollution.

In theory, then, pollution trading might be a reasonable regulatory mechanism for the Chesapeake Bay Total Maximum Daily Load (Bay TMDL) because Bay pollutants originate at a variety of geographically dispersed sources and because decades of careful scientific study have established a strong understanding of the pollution levels that the receiving waters can accommodate.

Real-world nutrient trading programs are complex. A nutrient trading program, if implemented correctly, will include carefully considered rules and safeguards. These safeguards include things like rigorous reporting requirements, transparency, mechanisms for enforcement and evaluation of program effectiveness, and quantitative adjustments to account for uncertainty.

If a trading program is implemented without such safeguards, it can easily lead to an overall increase in pollution. In other words, efforts to promote a nutrient trading program by making it easier or cheaper for participants can be counterproductive. If policymakers lose sight of the ultimate goal — clean water — and instead become fixated on maximizing trading market activity, they may omit important safeguards. This will inevitably lead to a policy failure – marketplace activity will go up, but so will pollution.

Another risk inherent in trading relates to geography – if a nutrient trading program is designed around a cap covering a large area (*e.g.*, the Bay watershed, or a state in its entirety), it can create local "hot spots" where pollution can remain at previous levels or even increase. Such a failure to eliminate hot spots might not prevent the region from meeting the overall cap but could create unhealthy conditions for specific waterways and communities. A successful nutrient trading program will, therefore, include safeguards to protect local water quality.

The U.S. Environmental Protection Agency (EPA) expects all state-level nutrient trading programs to contain multiple, specific safeguards. The agency's expectations are laid out in a series of "Technical Memoranda" on topics such as "establishing offset and trading baselines" and "accounting for uncertainty."[1] The Technical Memoranda reflect EPA expectations about what is necessary to ensure the attainment of water quality standards in the Chesapeake Bay watershed. EPA is supposed to object to Clean Water Act permits, and reject pollution load reduction credits claimed by states that are part of the Bay TMDL, if they are based on an inadequate trading program.

To briefly summarize, a few of the essential elements of a successful trading program include:

- Nutrient credits that account for uncertainty and the risk of a net increase in pollution loads;
- Nutrient credits that meet the principle of "additionality," meaning that each credit must be backed by a real and additional reduction beyond what the credit generator is already obligated to produce; and
- Protections for local water quality.

These issues are not the only fundamental components of a legitimate and well-designed trading policy, but they stand out because they have the greatest potential to derail progress in restoring the Chesapeake Bay. If the final trading program regulations address these three issues properly, the program may ultimately be successful at providing minor additional nutrient and sediment pollution reduction benefits while mitigating the side effects of pollution trading. But if the current trading regulations become law, Maryland's program will almost surely deliver a clear and unambiguous setback for the Bay and may significantly worsen local water quality and environmental conditions for many communities.

Pollution Hot Spots Are Inevitable and Must Be Mitigated

Pollution trading programs can create local "hot spots," where a large number of pollution credits are bought in a small geographic area. By definition, each credit represents pollution reduced somewhere other than where credits are purchased. A well-designed pollution trading program, however, can mitigate local impacts. Unfortunately, Maryland's recently proposed trading regulations do not resolve these concerns, raising the possibility that they cross the line in the Clean Water Act that prohibits anything that "causes or contributes" to local water quality impairments.

Hot spots present two primary concerns: first, that discharges of the target pollutant remain unacceptably high in local areas; and second, that discharges of co-pollutants are ignored.

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In a properly designed trading program, pollution is reduced in the locations where credits are generated and never surpasses pre-trading levels where the credits are purchased. In essence, credit purchasers in a trading program with a pollution cap are importing the right to continue to discharge pollution in their area. This will necessarily cause disparate outcomes for communities and ecosystems surrounding the credit purchasers, compared with the area surrounding the credit sellers.

All trading programs focus on only one or a few specific pollutants. The pollutant of concern for climate trading programs is generally carbon dioxide; with air programs, it might be nitrogen oxides or sulfur dioxide; and with water pollution trading programs, the pollutants of concern are often nutrients. Invariably, any type of trading program ignores many other pollutants that are discharged alongside the pollutant of concern. This is a challenge for nearly every trading program. Thus, program designers and policymakers should ask important questions before proceeding, such as:

- How many other pollutants are present in the discharges that we are seeking to address?
- Are these other co-pollutants more or less harmful to public health or the environment?
- Would existing pollution reduction efforts better protect communities than a trading program?
- Would a trading program lead to significant disinvestment in environmentally and economically beneficial pollution reduction programs?

Maryland's proposed trading regulations have fundamental flaws that fail to protect local waters from both stubbornly high levels of nutrients and unacceptable discharges of co-pollutants.

Maryland's Proposed Trading Regions Are Not Based on the Real World

One of the first questions confronting pollution trading program designers – and one of the first opportunities to establish policies that protect against hot spots – is how to draw trading region boundaries. Put simply, large boundaries maximize the number of potential trades, while smaller boundaries limit the possibility for adverse consequences on local communities. Since the main purpose of a nutrient trading program is clean water, not maximizing trading volumes, Maryland's nutrient trading program needs geographic restrictions based on reasonably small and actual watershed boundaries, reflecting local water quality conditions and guarding against downstream trades that fail to benefit local areas.

Figure 1. Comparison of the Proposed Trading Regions and Four-Digit Watersheds

Note: The map on the left shows the five different four-digit watersheds in Maryland's portion of the Chesapeake Bay watershed, including the merger of three different four-digit watersheds (Western Shore, Eastern Shore, and Susquehanna) into one new trading region, as proposed in the trading regulations. The map on the right shows the 153 eight-digit watersheds in Maryland, including the 142 watersheds in the Chesapeake Bay watershed.

The commonly used classification system for watersheds is the U.S. Geological Survey's Hydrologic Unit Code.[2] This code spans from very large "two-digit" regions (like the entire Mid-Atlantic, coded HUC 02) all the way down to a small "twelve-digit" subwatershed (like Lower Rock Creek or Upper Bull Run, both of which have HUC identifiers that are 12 numbers long). From the outset, Maryland's trading rules have centered on only three excessively large trading regions: the Potomac River Basin, the Patuxent River Basin, and everything else in Maryland's portion of the Chesapeake Bay watershed (which creates a single trading region out of three different four-digit watersheds).

Despite consistent opposition and feedback from concerned stakeholders, Maryland's recently proposed regulations maintain these three trading regions, which are both overly expansive and not based on real watershed boundaries. Figure 1 above illustrates the difference between large four digit watersheds in Maryland and smaller eight-digit watersheds.

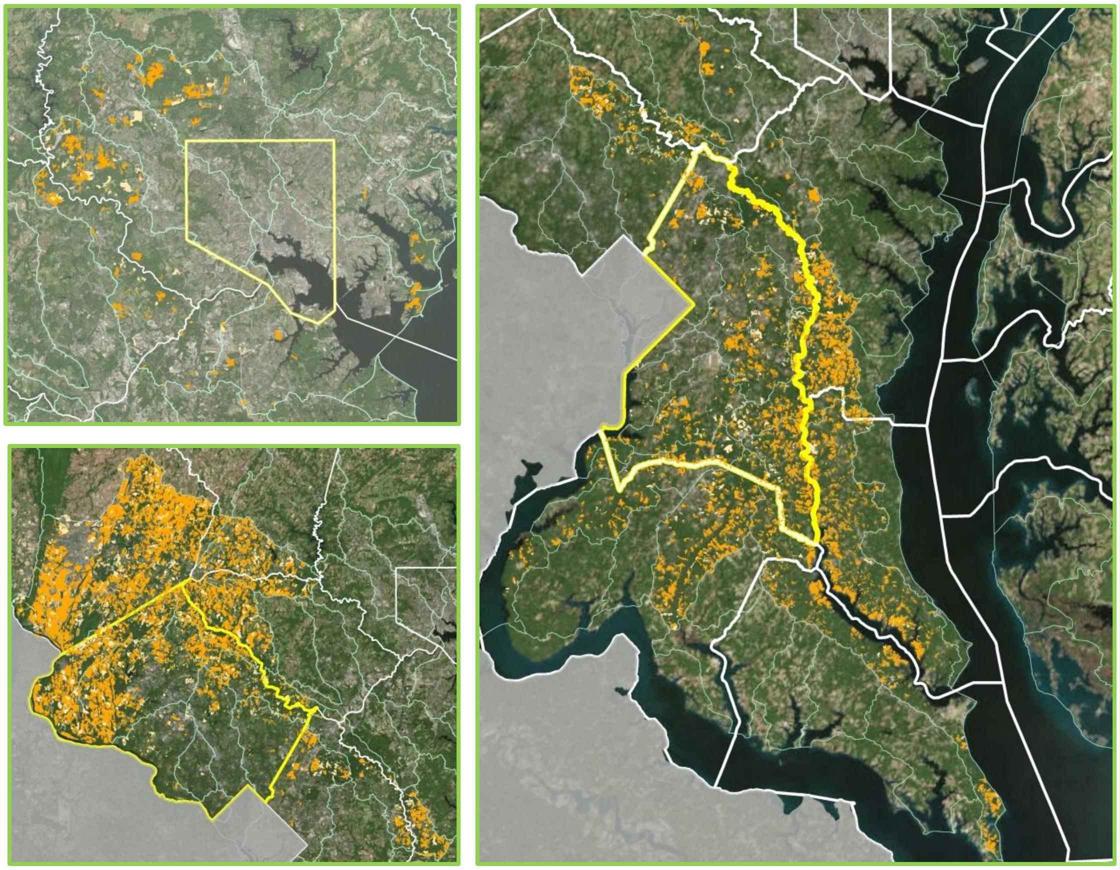
Drawing only three excessively large "four-digit" trading regions means that urban Prince George's County, east of Washington, D.C., could buy pollution reduction credits from someone in Garrett County in the far western part of the state, or that Baltimore City could buy credits from somewhere in Worcester County near the Atlantic Ocean. The justification for such expansive trading geographies is that it is all the same as far as pollution to the main stem of the Chesapeake Bay is concerned. But what about local water quality?

Recognizing that the largest demand for nutrient credits will likely be cities and counties needing to comply with their relatively expensive stormwater permits, Maryland's early draft trading manual laid out specific rules governing where those credits could come from. For example, one of the drafts of the trading manual proposed a sensible trading scale in which a county stormwater permit holder could purchase credits from any eight-digit watershed that overlapped with the county boundary, giving most counties somewhere between five and ten watersheds from which to purchase credits and creating a trading region twice the size of the county.

Using moderately sized eight-digit watersheds as the trading boundaries would have been a reasonable compromise among stakeholders. Unfortunately, the recently proposed final version of the regulations submitted in December 2017 uses the excessively large four-digit regions. Without suitably small trading boundaries, the regulations will fail to protect local water quality and will distort the market by limiting the demand for local credits. Figure 2 below shows that a trading system based on eight-digit watersheds would provide plenty of capacity to purchase credits generated on crop or pasture land in and around each urban county. With so much agricultural and other land available for the generation of credits in local watershed boundaries, there is no justification for maintaining just three oversized trading regions.

The early draft trading manual declared as a "guiding principle" that the program must "protect local water quality." But without more stringent rules, this guiding principle will be a hollow promise, inconsistent with EPA's recent guidance[3] providing explicit directions to Chesapeake Bay states regarding how to create a proper trading program that protects local water quality. Protecting local water quality is neither optional nor subordinate to efforts to protect the Chesapeake Bay. The Clean Water Act prohibits anything that causes or contributes to local water quality impairments. If the trading regulations are designed in a way that leads to an increase in pollution of local waters, it will be hard to defend the regulations as lawful.

Figure 2: Crop and Pasture Lands in Urban Watersheds



Note: The maps above show crop and pasture lands in watersheds that are within or intersect the boundaries of Montgomery and Prince George's counties and Baltimore City. This demonstrates the potential for the purchase of credits generated from the agriculture sector even in the most urban counties and where trading regions are restricted to only eight-digit watersheds.

Sending Money Downstream

Another basic principle that Maryland has recognized in early drafts of the trading rules but failed to fully achieve in its recently proposed regulations is the need to ensure that pollution credit buyers are downstream of the sellers or generators of those credits. To understand why this principle is essential to creating a trading program that protects local water quality, consider the following example.

If the Town of Springfield wanted to purchase pollution reduction credits from a farmer who can reduce water pollution at a much lower cost than the town can, should it turn to Farmer Joe two miles upstream or Farmer Bob two miles downstream? The town would be foolish if it sent taxpayer dollars down to Farmer Bob, whose pollution reductions would only benefit downstream communities and never reach the town. In addition, the entire stretch of land and water between the upstream town and farmer Bob would suffer. The town would obviously want to contract with Farmer Joe, upstream, to benefit water quality for the town (and the stretch between Farmer Joe and the town).

But what if Farmer Joe is charging twice as much, or cannot and will not reduce pollution at all? Then Springfield might have an incentive to work with Farmer Bob downstream anyway, even though the trade threatens local water quality.

Maryland's new regulations include some restrictions on these sorts of trades involving downstream purchases that are improved somewhat from earlier drafts of the regulations, but not enough to prevent local water quality from being sacrificed with inappropriate downstream purchases of credits.

Last-Minute Changes Are Still Not Enough to Protect Local Waters

Maryland first announced the release of its trading regulations in October 2017, but after stakeholders expressed serious concerns about the lack of rules protecting impaired local waters, among other things, the department pulled the regulations back to make changes. Unfortunately, those changes still do not address a few important issues.

For example, the department changed the regulations by requiring that a credit from a local impaired waterway be generated within the same watershed "*or* upstream" [emphasis added]. It is unclear whether this is a drafting error or intentional, but instead of requiring the credit to be bought in the same local watershed *and* upstream, the regulations still allow for downstream purchases. Moreover, the regulations do not provide a definition of "upstream." This is no small or inconsequential oversight. Because the trading regulations contain only three excessively large trading regions, it is possible that a credit buyer in a locally impaired watershed could still be allowed to buy a credit from dozens, or even hundreds, of miles "upstream" in that same trading region.

Precise and carefully crafted geographic trading rules are essential for creating a trading market that is protective of the local environment. But smart geographic rules are also economically beneficial. MDE declared that a nutrient trading system supports "an emerging environmental restoration economy." But if a town sends its taxpayer dollars downstream, or to far-flung areas of the state, not only will less money go to improve local water quality, it could stymie the actual restoration economies that have already been emerging around the state thanks to major investments in clean water projects funded by county stormwater remediation fees and other sources.

Precise and carefully crafted geographic trading rules are essential for creating a trading market that is protective of the local environment. But smart geographic rules are also economically beneficial.

Each year, state and local governments invest hundreds of millions of dollars in stormwater remediation, stream restoration, and other projects to reduce the impact of polluted runoff and improve local streams. These restoration projects improve water quality and the health of local communities and ecosystems. A growing body of economic research shows that they also provide a substantial return on the investment of local taxpayer dollars.[4] These projects are both labor- and capital-intensive, providing local jobs that cannot be exported and boosting demand for local contractors and engineering firms. Such investments benefit the local economy, the local environment, and local quality of life – a triple bottom line.

But if trading regions are drawn broadly and municipalities are allowed to purchase cheap credits from faraway places, the state's trading program will create a strong disincentive to make these investments, trading away all of the benefits and undercutting the local restoration economy.

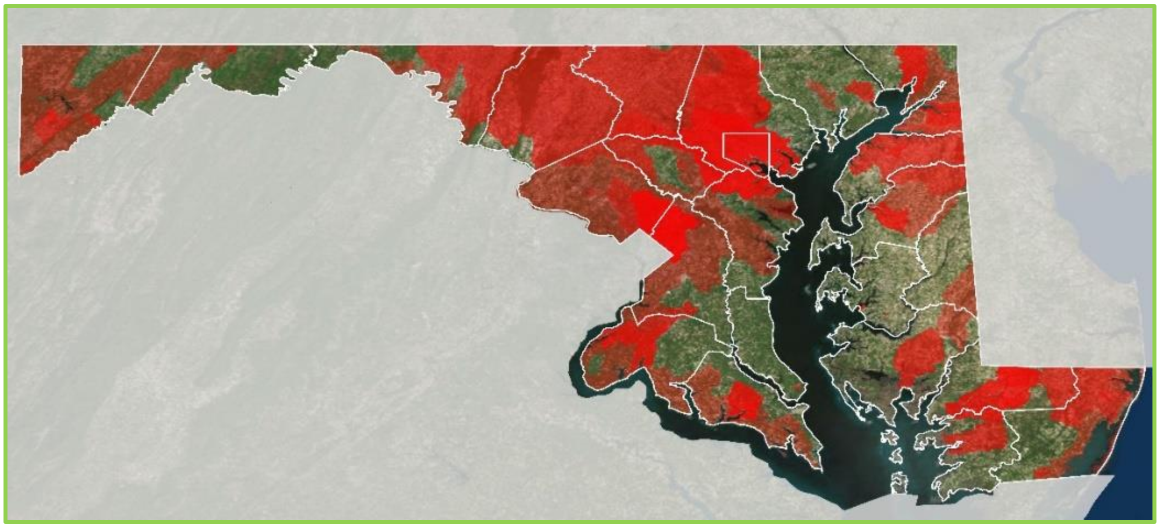
Making Sure Hot Spots Do Not Become Dangerously Polluted Clusters

Creating reasonably small trading regions and prohibiting the purchase of downstream credits are two relatively straightforward recommendations for mitigating hot spots and addressing local water quality concerns. But a much thornier issue is how to make sure a *nutrient* trading program does not delay or destroy efforts to reduce *other* forms of pollution, including some that are far more toxic and hazardous to local communities.

The main focus of Maryland's nutrient trading program is reducing nitrogen pollution in the Chesapeake Bay. The program's developers are certainly cognizant of the problems that arise when local water quality conditions are ignored. In fact, the very first paragraph of the trading regulations refer to the need to "enhance Maryland's effort to protect and restore not only the water resources of the Chesapeake Bay and its tributaries, *but also local waters*" [emphasis added], and allow trades "as long as the trade does not cause or contribute to a violation of State water quality standards." However, the new regulations are designed in such a way that they will almost certainly result in disinvestment from pollution control projects, particularly in urban areas that are most afflicted by pollution.

Most local waterways in Maryland are recognized as impaired by at least one pollutant, and as a result, many watersheds are subject to one or more TMDLs (see Figure 3 below). If the state's trading program were to fully respect local water quality concerns, virtually all trades would be subject to restrictive geographic trading rules that force trades to be upstream *and* within the local (eight-digit or smaller) watershed. Unfortunately, even if such protective rules that respect the territorial boundaries of TMDLs or impaired watersheds were developed, they would not, by themselves, be sufficient to protect local water quality. To illustrate why, consider the most common type of trade initially envisioned by trading program advocates and developers.

Figure 3. Watersheds Subject to a Local TMDL



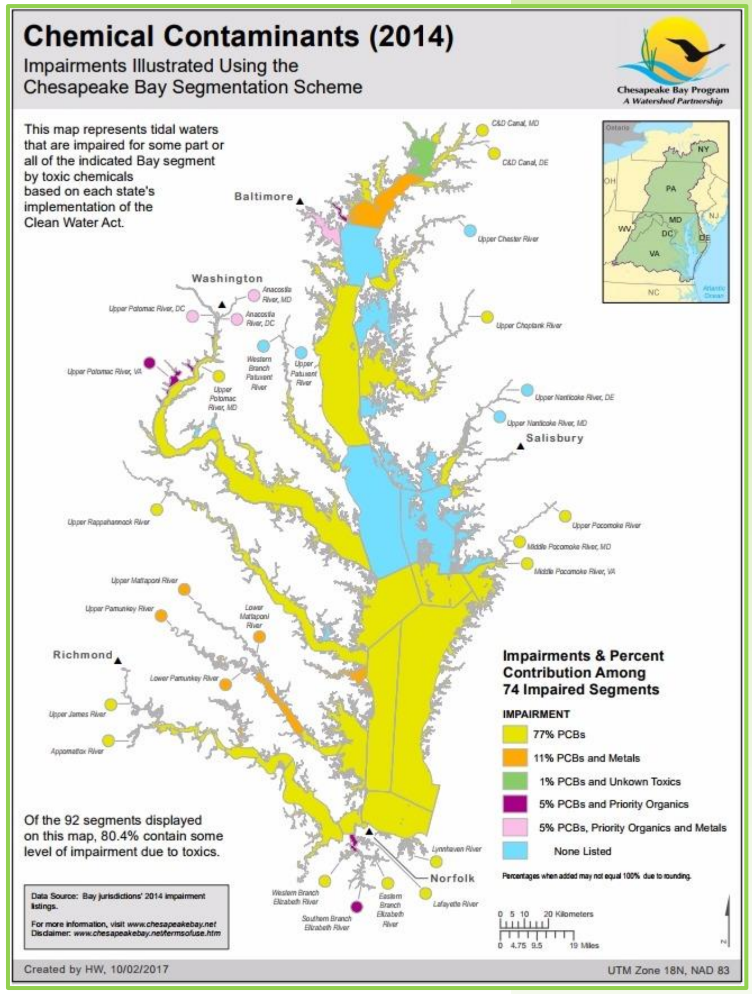
Note: Areas in red reflect watersheds subject to a local TMDL. Darker shades of red reflect areas subject to multiple TMDLs. The map does not show areas subject to the Chesapeake Bay TMDL, which covers nearly all of the state, or areas that are known to be impaired but do not yet have a TMDL.

Most trading volume in a future trading market in Maryland will likely occur between a municipality holding a stormwater permit and a farmer, because this is where the greatest opportunity for arbitrage, or difference in the ability to reduce pollution, exists. Reducing a pound of nitrogen pollution by removing pavement or installing polluted runoff control projects is expensive on a dollar-per-pound basis. It is much cheaper to reduce a pound of nitrogen on a farm field by planting or installing agricultural best management practices and projects. Given this price differential, most nitrogen credits should theoretically be purchased by a stormwater permit holder and sold by a farmer.

In this theoretical world, the trading program would involve millions of *nitrogen* credits flowing from agricultural sellers to eager urban buyers, and total *nitrogen* pollution would theoretically decline (further assuming the trading program rules were designed appropriately). But if a municipality decides to forgo the installation of stormwater management projects, it is not only missing the opportunity to reduce *nitrogen* pollution, but also to address the problem of hundreds of chemicals and other pollutants coating the pavement and washing untreated through the local communities and directly into the nearest waterways.

In this way, where the pollution profiles of buyers and sellers are vastly different, a one-for-one trade of nitrogen will not necessarily improve the environment or protect community health. In fact, such a trade could make matters much worse for communities if the buyer is purchasing only a reduction of nitrogen in exchange for the permission not to control dozens, if not hundreds, of other toxic pollutants that would otherwise be captured. (And, as noted, the community gets no benefit at all if the credit is not purchased from upstream in the same watershed.)

This sort of disinvestment in local environmental restoration projects limits local investments in green jobs and fails to deliver needed improvements to public health in local communities. It may reduce short-term costs for the local government, but it shifts costs onto members of the local community and prevents the economic, health, and environmental benefits that come from such investments.



The Chesapeake Bay suffers from nitrogen, phosphorus, and sediment pollution, but it also receives all sorts of other toxic contaminants, such as lead, mercury, and thousands of chemical compounds. This is why the 2014 Chesapeake Bay Watershed Agreement speaks of the need for achieving the Bay TMDL reductions of nutrient and sediment pollution, as well as "reducing the impact of toxic contaminants" including "mercury, PCBs, and other contaminants of emerging and widespread concern." [5] The Chesapeake Bay Program has established an entire work group focused on how to address these many dangerous pollutants.[6]

A trading program that does not recognize the hazardous potential from the many toxic substances polluting urban waterways can end up ignoring our most vulnerable communities by allowing local jurisdictions to merely pursue the cheapest possible manner to reduce nutrients or comply with their environmental permit obligations. As shown in a map produced by the Toxic Contaminant Workgroup,[7] at right, most tidal segments of the Chesapeake Bay watershed are impaired by at least one class of toxic chemicals, and urban waters near Baltimore City and Washington, D.C., are impaired by several classes of toxic contaminants.

To address this problem, trading regulations should include provisions that require credit purchasers to disclose publicly all pollutants they discharge and require the department to prohibit any purchase without a demonstration that the credit buyer is adequately controlling each pollutant. Where a proposed purchaser of nutrient or sediment credits discharges a different type of pollution into a waterway that has been deemed impaired for that same pollutant, the trade should be prohibited without a clear demonstration that the purchase will not interfere with efforts to control that pollutant.

Real Pollution Reductions Can Only Be Achieved if Maryland Accounts for Uncertainty

If a farmer plants a forested buffer between her crop fields and a river, she will reduce the amount of nitrogen and phosphorus migrating from the crop fields to the river. The farmer will reduce her pollution load. If the farmer lives in a state with a nutrient trading program, she may be able to sell credits for that reduction. The number of credits that the farmer can sell will be calculated using a model based on studies that estimate the extent to which buffers are generally able to reduce nutrient loads.

But will this particular farmer's forest buffer perform as well as the model assumes? Probably not. The scientific literature on this topic suggests that forest buffers and other agricultural Best Management Practices (BMPs) do not perform as well in the real world as they do in experimental studies. There is a lot of uncertainty in BMP performance. If we do not account for that uncertainty, we run the risk of giving credit for load reductions that have not actually occurred.

Substantial Trading Ratios Are a Fundamental Component of Good Trading Programs

Simple pound-for-pound water pollution trading schemes are rare. Most trading programs apply one or more *trading ratios* or *retirement provisions* to alter the balance of credits on either side of a sale. A 2:1 trading ratio, for example, requires a credit buyer to purchase two pounds worth of credits for every pound of pollution the buyer plans to discharge. Whatever the precise numbers, trading ratios or retirement provisions are critical to good trading programs because they enable the programs to achieve a range of policy goals including water quality improvement, creation of an insurance or reserve pool of credits that are used to mitigate failed credit generation, and adjustment for pollution attenuation between an upstream location and a downstream location.[8]

One of the most important policy goals served by trading ratios is accounting for the uncertainty inherent in a trade. A credit theoretically represents a pound of pollution reduction, but the actual amount of pollution reduced by a BMP is rarely, if ever, known. The net load after a trade should be zero – with the credit generator offsetting the load of the credit purchaser – but in practice it will almost always be something other than zero. This uncertainty is typically addressed with an explicit "uncertainty ratio." Uncertainty ratios provide a margin of safety against overestimates of load reduction, and they help to account for variability in the performance of credited practices. An uncertainty ratio is especially important for trades or offsets involving so-called "nonpoint" sources, such as farm fields, because the pollution loads from nonpoint sources cannot be measured in the same way that discrete point source discharges (e.g., at the end of a pipe) can be measured.

In the context of the Bay TMDL, uncertainty ratios help environmental agencies provide the required "reasonable assurance" that water quality standards will be attained:

> When the [EPA] establishes or approves a [TMDL] that allocates pollutant loads to both point and nonpoint sources, it determines whether there is reasonable assurance that load allocations will be achieved and water quality standards will be attained. EPA does that to ensure that the wasteload allocations and load allocations established in the TMDL are not based on overly generous assumptions regarding the amount of nonpoint source pollutant reductions that will occur. This is necessary because the wasteload allocations for point sources are determined, in part, on the basis of the expected contributions to be made by nonpoint sources to the total pollutant reductions necessary to achieve water quality standards. If the reductions embodied in load allocations are not fully achieved because of a failure to fully implement needed point source pollution controls, or the reduction potential of the proposed BMPs was overestimated, the collective reductions from all sources will not result in attainment of water quality standards. As a result, EPA evaluates whether a TMDL provides reasonable assurance that nonpoint source controls will achieve expected load reductions.[9]

Research indicates that regulators routinely overestimate best management practices efficiencies; because of the present degree of uncertainty, an uncertainty ratio of at least 2:1 should be established.

Uncertainty ratios also help agencies provide a margin of safety, another requirement of the Clean Water Act.[10]

As explained below, research indicates that regulators routinely overestimate BMP efficiencies; because of the present degree of uncertainty, an uncertainty ratio of at least 2:1 should be established. This is in line with the uncertainty ratios applied in other nonpoint-point nutrient trading programs, which are almost universally 2:1 or higher.

Regulators Routinely Overestimate BMP Effectiveness

Unlike discharges through monitored point source outfalls, the nutrient load reductions from agricultural BMPs are difficult to measure. Instead, pollution reduction assumptions, sometimes called "BMP efficiencies," are generated from carefully controlled research studies.

For a number of reasons, BMP efficiencies derived from research experiments tend to overestimate real-world pollution reductions. A study of BMP implementation at a small farm in Michigan presents one example.[11] Researchers first estimated and then measured the phosphorus removal efficiencies of various BMPs, including the exclusion of livestock from a stream area, the planting of grass filter strips, and manure management. The projected BMP efficiency (87 percent phosphorus removal) overestimated the actual efficiency (23.4 percent) by a factor greater than 3.

That was not an isolated case. The National Research Council (NRC) observed that

> BMP efficiencies are often derived from limited research or small-scale, intensive, field-monitoring studies in which they may perform better than they would in aggregate in larger applications . . . Thus, estimates of load reduction efficiencies are subject to a high degree of uncertainty.[12]

The NRC suggests that the uncertainty is largely in one direction – BMP efficiencies are likely to overestimate actual nutrient removals. Indeed, the report goes on to say that "[p]ast experience . . . has shown that credited BMP efficiencies have more commonly been decreased rather than increased in the light of new field information."[13]

The EPA echoes the NRC conclusion, stating that "few, if any, data suggest actual watershed-wide implementation efficiencies as high as those in the research literature."[14] This is in part because real-world validation of nonpoint pollution load estimates is so difficult that it is rarely attempted. However, to the extent that we can compare BMP pollution reduction assumptions to actual pollution reductions, the BMP efficiencies appear to be overly optimistic.[15]

Such findings are persuasive, and they make clear that the gaps between projected and actual pollution savings from BMP are not simply a matter of uncertainty or unpredictability, but rather of systematic bias in the projections. In some cases, the Chesapeake Bay Model BMP efficiencies reflect adjustments made to account for this bias. Research estimates for cover crop effectiveness, for example, were reduced by 25 percent in an attempt to approximate realistic estimates for average conditions.[16] It is important to note that these adjustments, when they were made, only accounted for a perceived bias. Even after such adjustments are made, the effectiveness of a BMP continues to be uncertain due to factors such as how well a BMP is maintained or how long a living BMP (e.g., a forest buffer) takes to reach maturity.

Research to date suggests that an uncertainty ratio of at least 2:1 is needed to account for the high degree of uncertainty associated with agricultural and other nonpoint BMPs.

BMP Efficiencies Are Not 'Conservative'

Some people familiar with the development and implementation of nutrient trading programs have mischaracterized BMP efficiencies as "conservative," meaning that they are intentionally lower than actual effectiveness.[17] This is a critical error. As discussed above, it is more likely that the opposite is true, and that BMP efficiencies are overly optimistic. In the case of the Bay Model's treatment of agricultural BMPs, for example, even after adjustments were made to adjust for known biases, the results were not conservative. According to EPA, "The process used to develop the CBP partnership BMP effectiveness values is designed to arrive at unbiased and realistic values.... [Adjustments to remove bias] generate BMP effectiveness values that are *unbiased and realistic but not necessarily conservative* [emphasis added]."[18] In the best case, BMP efficiencies are realistic. In other cases, they suffer from such a bias, and they are too high. They are, in fact, the opposite of conservative.

Trading Ratios Less Than 2:1 Are Outside the Norm

Research to date suggests that an uncertainty ratio of at least 2:1 is needed to account for the high degree of uncertainty associated with agricultural and other nonpoint BMPs. In general, reviews of pollutant trading programs have confirmed that uncertainty ratios are usually 2:1. A 2005 EPA review, for example, stated that:

> Trading ratios often are used as a mechanism to manage uncertainty associated with the effectiveness of non-point source controls. All programs use trading ratios, but these ratios vary considerably from program to program. . . [T]he most common trading ratio for programs that are trading nutrients between point and non-point sources is 2 to 1.[19]

Trading programs have been reviewed many times, and this conclusion about uncertainty ratios is consistent.[20]

Several reviews of trading ratios have blurred the distinction between ratios used to address uncertainty and ratios used for other purposes (*e.g.*, net reduction in load), and have also considered various ratios used in point-to-point, nonpoint-to-point, or cross-pollutant trading. We have read several reviews and looked into individual trading programs in order to make a rough inventory of uncertainty ratios used specifically in nonpoint-to-point trading of nutrients. As shown in Table 1, uncertainty ratios are almost uniformly 2:1.

Uncertainty Ratios Account for Uncertainty in Credit Generation

The EPA has identified several overlapping sources of uncertainty in nutrient trading, including the BMP efficiency estimate, variability in weather conditions, the time it takes for a BMP to become fully functional, and others. All of these sources of uncertainty relate to characteristics of the credit generator.[21] The uncertainty ratio is a tool to mitigate against underperformance of credit-generating BMPs. Some have suggested that trades between nonpoint credit generators and nonpoint credit purchasers – nonpoint-nonpoint trades – should not require uncertainty ratios, with a vague justification that the uncertainties on either side of the trade will mysteriously "cancel each other out." This argument is both glib and unsupported by experience.

The uncertainty ratio exists to account for uncertainty in *credit generation*; the characteristics of the credit purchaser are irrelevant. Mathematically, there is no reason to expect that the uncertainties on either side of the trade will cancel each other out. In fact, in some scenarios they will amplify each other, leading to an even greater net increase in loads. Appendix A breaks this down graphically and shows that the net result of a trade is the same regardless of whether the credit purchaser is a point source or a nonpoint source. With both types of trade, there is a significant risk that there will be a net increase in pollution unless an uncertainty ratio is used.

EPA Expects All Trades Involving Nonpoint Credit Generators to Use 2:1 Uncertainty Ratios

The EPA set out its expectations for addressing uncertainty in nutrient trading programs in a 2014 technical memorandum.[22] Again, this memorandum's expectations are not merely aspirational or in any way optional. The memo provides instructions to the states regarding the policies that the EPA will require before approving permits and accepting nutrient reduction data for use in the Bay Model.

The technical memorandum on uncertainty states that, with a couple of narrow exceptions, "EPA expects the Bay jurisdictions to apply an uncertainty ratio of at least 2:1 to transactions involving credits generated by nonpoint sources."[23] This statement is clearly focused on credit generators, says nothing about credit purchasers, and does not create an exception for nonpoint credit purchasers (nonpoint-nonpoint trades). States must apply the 2:1 ratio to all trades involving nonpoint credit generators, even if the purchaser is also a nonpoint source. Failure to do so would violate the TMDL and increase the risk of an overall increase in pollution loads.

Maryland's Proposed Nutrient Trading Regulation Fails to Adequately Implement the 2:1 Uncertainty Ratio

The Maryland Department of the Environment's (MDE) recently proposed nutrient trading regulation includes a 2:1 uncertainty ratio but does not apply it broadly enough. Specifically, it requires a 2:1 ratio for trades "involving credits generated by nonpoint sources and acquired by wastewater point sources."[24] However, the next sentence of the proposed rule creates a giant loophole, allowing MDE to use a lower ratio (or no ratio) if "the generator, seller or buyer of the credit is able to demonstrate to the Department that a lower ratio is justified and protective of water quality standards." MDE therefore has virtually unlimited discretion to ignore EPA's 2:1 ratio requirement.

Just as troubling, the regulation explicitly exempts certain nonpoint-to-point trades from the 2:1 requirement. For trades "involving credits generated by nonpoint sources and acquired by stormwater point sources," the uncertainty ratio is 1:1, which is to say no uncertainty ratio at all.[25] This plainly fails to meet EPA expectations.

In addition, the regulation creates yet another carve-out for trades between nonpoint credit generators and "other non-regulated sources," which are generally going to be other nonpoint sources. As described above, there is no rational policy reason to exempt trades between two nonpoint sources, and again MDE has failed to meet EPA expectations.

The result of all of these loopholes is that many trades, perhaps even most trades, will be exempted from the 2:1 uncertainty ratio requirement. If the BMPs used to generate these credits fail to perform as expected, overall pollution loads will increase. As discussed earlier, there is a high likelihood of this happening. MDE's nutrient trading regulation is therefore likely to seriously undermine Maryland's ability to meet its TMDL targets.

Table 1: Uncertainty ratios used in point-nonpoint nutrient trading programs.

Trading Program	Pollutant	Trading Ratio	Basis for Ratio	Reference
Colorado; Bear Creek Total Phosphorus Trade Program	Phosphorus	2:1	Unknown	Bear Creek Watershed Association[26]
Colorado; Chatfield Reservoir	Phosphorus	2:1[27]	Uncertainty (implied by basis for possible exemption[27])	Chatfield Water Authority[28]
Colorado; Cherry Creek Basin Trading Program	Phosphorus	2:1 to 3:1	Uncertainty	U.S. EPA [29]
Colorado; Lake Dillon	Phosphorus	2:1	Unknown	U.S. EPA[30]
Delaware; Pinnacle (Vlassic Foods)	Nutrients	2:1	Margin of safety and location	UVA[31]
Delaware; Inland Bays	Nutrients	2:1	Unknown	UVA[32]
Florida; Lower St. Johns River	Nutrients	2:1 and 3:1, depending on source of credits	Uncertainty	Florida DEP[33]
Massachusetts; Wayland Business Center Treatment Plant Permit	Phosphorus	3:1	Unknown	Environomics[34]
Michigan; Kalamazoo River Water Quality Trading Demonstration Project	Phosphorus	2:1 or 4:1, depending on the nature of baseline practices	Uncertainty	Environomics[35]; U.S. EPA [36]
Michigan; Water Quality Trading	Nutrients and other pollutants	2:1[37]	Uncertainty and environmental benefit	Michigan Administrative Code[37 above]
Minnesota; Southern Minnesota Beet Sugar Cooperative Trading Program	Phosphorus	1.6:1[38]	Uncertainty	Environomics and EcoAgriculture Partners[38]
Minnesota; Draft Statewide Water Quality Trading Rules	Phosphorus	2.5:1	Uncertainty, risk, and location	UVA[39]

Trading Program	Pollutant	Trading Ratio	Basis for Ratio	Reference
New York; New York City Watershed Phosphorus Offset Pilot Program	Phosphorus	3:1	Unknown	Environomics; U.S. EPA [40]
New York; Croton Watershed	Phosphorus	2:1 to 3:1	Unknown	UVA[41]
North Carolina; Neuse River Nutrient Sensitive Water Management Strategy	Nutrients	2:1 (implied by payment price)[42]	Unknown	Environomics[42]; U.S. EPA [43]
North Carolina; Tar-Pamlico Nutrient Reduction Trading Program	Nutrients	2:1 or 3:1, depending on source of credits	Uncertainty	UVA[44]
Ohio; sugar Creek Watershed—Alpine Cheese Co.	Phosphorus	3:1	Uncertainty and Margin of Safety	UVA[45]
Ontario South Nation River Total Phosphorus Management Program	Phosphorus	4:1	Uncertainty	OECD[46]
Virginia trading policy	Nutrients	2:1	Uncertainty	U.S. EPA[47]
Wisconsin Red Cedar River Pilot Trading Program	Phosphorus	2:1	Unknown	Environomics[48]

Paper Credits and the Principle of Additionality

In 2004, Maryland's General Assembly made a bold decision that would significantly reduce water pollution flowing into the Chesapeake but would also alter the nature of any future nutrient trading program in Maryland. The Bay Restoration Fund law created a small user fee to pay for upgrades at the state's 67 major sewage treatment plants, among other pollution control projects. Once fully completed, these 67 large projects will reduce annual nitrogen pollution discharged into the Bay by more than 9 million pounds.

Years later, when Maryland officials began discussing the creation of a comprehensive nutrient trading program, the simplest path forward would have been to simply ignore sewage treatment plants as a potential source of pollution reduction credits, or at least ignore any facilities that had received Bay Restoration Fund money. After all, the state long ago made the decision to subsidize the installation of pollution reduction equipment representing the limits of technology, taking off the table 9 million potential pollution credits – a significant majority of credit generating potential from the municipal wastewater pollution source sector.

Instead, Maryland's trading program will allow already upgraded sewage treatment plants to generate pollution reduction credits. The problem with that approach, of course, is that if pollution reductions have already occurred, then there cannot be any *additional* pollution reductions behind each pollution reduction credit traded. Moreover, if facilities upgraded with public funds are allowed to generate credits without affirmatively acting or investing in a way that further reduces pollution, then the public has effectively subsidized the pollution of waters near both the credit buyer and seller.

It is in fact technologically possible for any of Maryland's upgraded sewage plants to further reduce pollution. But the danger in allowing these plants to become a source of new credits is that, if the trading program does not include just the right mix of carefully crafted rules, the entire program could be jeopardized and the market overwhelmed by "paper credits" backed by no new and actual pollution reductions. This situation would represent a major setback for water quality in Maryland, a dubious use of taxpayer dollars, an unfair advantage for these facilities in the nutrient trading market, and a substantial distortion in the market that the state is working to foster.

This section describes the fundamentally important trading principle of "additionality," analyzes Maryland's development of trading rules for upgraded sewage treatment plants, and offers a few straightforward recommendations to prevent the market from becoming overwhelmed with paper credits that can seriously impair water quality.

Additionality Means Not Getting Something for Nothing

The principle of "additionality" is as simple as it is essential in a pollution trading program. Basically, it means that behind each pollution reduction credit is an *additional* reduction in pollution. By contrast, we use the term "paper credit" here to refer to a credit that exists only on paper and is not backed by any new reduction in pollution. For example, a discharger might try to sell credits for reductions that were made in the past, or for reductions that are to occur in the future. If there are a large number of paper credits in a trading marketplace, the ultimate amount of pollution will fail to meet reduction targets, and may even increase, as buyers attempt to offset real pollution with fictional reductions.

In some pollution trading markets, selling a paper credit might be considered fraud or grounds for serious sanction. And in any trading market, a significant number of paper credits not only harms the environment but can cripple the market by establishing artificially low prices that prevent the participation of legitimate credit producers. After all, it does cost money, time, and resources to reduce pollution. If there is no market signal setting a price, no incentive will exist to invest in the work needed to create pollution-reducing projects to generate new credits. Without significant changes, Maryland's regulations will fail to establish a legitimate market to promote new pollution control projects.

Over the last several years, each of the drafts of the Maryland's nutrient trading manual or regulations has contained provisions that would allow the market to be flooded with innumerable paper credits from sewage treatment plants.

Over the last several years, each of the drafts of the Maryland's nutrient trading manual or regulations has contained provisions that would allow the market to be flooded with innumerable paper credits from sewage treatment plants. This happens when an upgraded facility that had previously used state Bay Restoration Fund subsidies to upgrade to "enhanced nutrient removal" (ENR) technology is allowed to count these past reductions from already upgraded plants as creditable projects.

Specifically, a few provisions in these drafts allowed for the creation of paper credits. First, the rules attempted to redefine ENR pollution levels as 4 milligrams per liter (mg/L) of nitrogen pollution, rather than the lower and more protective 3 mg/L standard already set out in state statute. The Bay Restoration Fund law and all written materials generated by both the General Assembly and MDE during and after the enactment of the statute set 3 mg/L for nitrogen as a key threshold level for the program. To establish a baseline of 4 mg/L would set an inappropriately weak standard for becoming eligible to trade and would, as noted above, subsidize additional pollution.

Second, the draft rules failed to specify that credits must be based on a level of pollution lower than the one at which sewage plants were already operating. In other words, even if a sewage plant was operating at clean levels below the appropriate baseline of 3 mg/L, they could still sell credits for doing nothing more than operating at the levels they were supposed to after receiving state funds to upgrade their technology. Third, these early draft rules did not specify that credits must be generated by *new* projects or activities, such as ones established after a certain date or specified in a credit application. Here again, it appears that the drafters of the rule lost sight of the purpose of the credit-trading market: to reduce pollution.

Despite Improvements, the Regulations Fail To Ensure Real Reductions

After receiving significant feedback about the need to ensure conformance with the principle of additionality, MDE made some changes before releasing the first version of its proposed regulations in October 2017. These new rules appeared to address some of the additionality problems but still contained a number of inconsistent provisions that would create uncertainty and potential loopholes.

These pre-release revisions included three improvements on earlier proposals related to the principle of additionality. One allowed upgraded sewage plants to only "generate credits for performance below 3 mg/L of nitrogen." The second properly defined a "pollution reduction" behind each credit as "a practice, or combination of practices that is determined by the Chesapeake Bay Program to be an effective and practicable method of preventing or reducing pollutants." The third is a prohibition on the generation of credits prior to the effective date of the regulations.

After strong and immediate opposition from stakeholders, MDE pulled the October 2017 regulations back for revisions and released an improved set of regulations in December 2017.

Each of these changes made before the regulations were first proposed in October 2017 took steps toward resolving the additionality problem, but each was seemingly negated by conflicting or ambiguous language elsewhere in the regulations. For instance, while the October 2017 regulations appropriately stated that credits generated by sewage plants must be below 3 mg/L of nitrogen, they nevertheless redefined ENR to be 4 mg/L of nitrogen, which is inconsistent with statute. The regulations also repeated this higher 4 mg/L threshold in the rule governing how to calculate credits. It is unclear what the purpose of these provisions would have been if plants are truly not allowed to generate credits without at least meeting the 3 mg/L limit currently defined by state law.

After strong and immediate opposition from stakeholders, MDE pulled the October 2017 regulations back for revisions and released an improved set of regulations in December 2017. The December regulations take additional steps toward resolving the problem by requiring wastewater treatment plants to discharge at rates consistent with statute (the definition of ENR was not corrected and still includes a reference to nitrogen levels of 4 mg/L, but the operative rules were fixed). But, once again, the December regulations simply do not go far enough to close the loopholes and ensure suitably protective trades.

Although the final regulations submitted in December contain a more restrictive standard (at 3 mg/L) and also a rule requiring that credit generating practices be new as of the effective date of the regulations, this language rings hollow if sewage plants that have already been upgraded over the last decade are still allowed to generate credits without doing anything additional.

Paper credits from sewage treatment facilities are still virtually certain to be sold on the market. Under the final December regulations, a municipal wastewater treatment plant that was upgraded years ago and is operating under ENR levels of 3 mg/L can generate credits. The regulations do not require a facility to apply for credits prospectively and describe what new actions they will take or investments they will make to reduce pollution. Instead, the credit calculation provisions merely state that "at the end of each calendar year," credits will be awarded based simply on a subtraction between ENR levels and actual levels. Not only does it not matter if the facility did nothing new at all to earn those credits, nothing in the rules even prevent the facility from earning credits if pollution increased over the prior year. Such credits exist entirely on paper and do nothing to curb pollution. To the contrary, they support increased pollution.

Another failing of the December draft is that while the regulations sensibly claim to prohibit the use of public funds for the generation of credits, the rule is rendered meaningless because sewage plants previously upgraded using state funds are expressly permitted to generate credits for doing nothing. The vast majority of the taxpayer-funded cost associated with restoring the Chesapeake Bay over the last decade occurred at the time that each of the ENR upgrade projects was installed. These pollution reductions were already purchased by taxpayers and should not be allowed for purchase now.

MDE officials understand the need for these simple and common-sense rules. In fact, better provisions have already been drafted by the department and are included in another regulatory proposal to implement the new Clean Water Commerce Act, a state law designed to spur innovative new pollution reduction projects using the state Bay Restoration Fund. If sensible protections against paper credits are appropriate for those regulations, surely they are similarly appropriate for the state's larger and more comprehensive pollution trading regulations.

If the final nutrient trading regulations are revised to include a few corrective provisions, water quality advocates can be assured that each credit generated by an ENR facility is new and represents actual reductions, and other credit generators can participate in the market knowing they compete on a level playing field as part of a fair market for buying and selling credits.

Conclusions and Recommendations

Maryland's new nutrient trading regulations suffer from three main shortcomings. If they are not addressed, Maryland's efforts to restore the Chesapeake Bay and protect local water quality will suffer, and the state's attempt to establish a nutrient trading program that can serve as a model for other states will likely fail.

The following is a set of recommendations designed to remedy the problems with the trading rules.

- **Maryland's trading regions must be suitably small and firmly drawn.** An eight-digit boundary could represent a reasonable compromise for all trades, and the rules should incentivize the creation of local pollution reduction practices by clearly prohibiting trades outside of the bounds of these trading regions.

- **Maryland's trading rules should clearly prohibit the purchase of credits from downstream sellers.** Even if trading regions are maintained within the boundaries of eight-digit watersheds or smaller, local water quality problems will arise if buyers purchase credits from sellers located downstream.

- **Maryland's trading program must recognize pollutants beyond nutrients or other pollutants of concern.** The program must require the prospective buyer of credits to demonstrate that trades will not jeopardize other existing efforts to invest in local projects that control polluted and toxic runoff and mitigate public and community health hazards.

- **All trades involving nonpoint credits must use a 2:1 uncertainty ratio.** Nonpoint pollution credits are inherently uncertain. In many cases, the default assumption about how well a nonpoint pollution control works will be overly optimistic. Since the uncertainty derives from the credit generator, the characteristics of the credit purchaser are irrelevant, and there is no rational basis for exempting "nonpoint-nonpoint" trades from this requirement.

- **The regulations should take a firm and unambiguous stance that no credits may be generated without an additional and verifiable pollution reduction.** These provisions should require a facility to submit an application to the department describing what new and additional capital investments or operational improvements it will make to reduce pollution. Any resulting pollution reduction credits awarded should be based only on the difference in actual pollution loads between the subsequent year and the prior year. And in no circumstance should credits be allowed for a plant that is not meeting the statutorily defined ENR threshold of 3 mg/L.

Appendix A: Net Change in Pollution Load with Point or Nonpoint Source Credit Purchasers

The following tables demonstrate that the characteristics of the credit purchaser are irrelevant to the need for an uncertainty ratio. These tables assume that pollution loads from credit generators or purchasers are greater than or less than expectations by a fixed amount – in other words, that errors in opposite directions will "cancel each other out." The tables also assume that there are no trading ratios used. Table A1 presents scenarios in which the credit generator is a nonpoint source, with uncertain loads, and the credit purchaser is a point source, with certain loads. Table A2 presents scenarios in which both sources are nonpoint sources with uncertain loads.

These tables show that whether the credit purchaser is a point source or a nonpoint source, the likelihood of a net increase in pollution loads is the same. If the credit purchaser is a nonpoint source, there is the additional risk of a large net increase in pollution.

Table A1: Nonpoint source credit generator and point source credit purchaser.

Credit generator: Is load reduction greater than, less than, or equal to expectation?	Credit purchaser: Is load to be offset greater than, less than, or equal to expectation?	Net result
Reductions > expectation	Load = expectation	Net decrease in pollution
Reductions = expectation	Load = expectation	No net change
Reductions < expectation	Load = expectation	Net increase in pollution
Net increase in pollution:		**1 out of 3 scenarios**

Table A2: Nonpoint source credit generator and nonpoint source credit purchaser.

Credit generator: Is load reduction greater than, less than, or equal to expectation?	Credit purchaser: Is load to be offset greater than, less than, or equal to expectation?	Net result
Reductions > expectation	Load > expectation	No net change
Reductions > expectation	Load = expectation	Net decrease in pollution
Reductions > expectation	Load < expectation	Large net decrease in pollution
Reductions = expectation	Load > expectation	Net increase in pollution
Reductions = expectation	Load = expectation	No net change
Reductions = expectation	Load < expectation	Net decrease in pollution
Reductions < expectation	Load > expectation	Large net increase in pollution
Reductions < expectation	Load = expectation	Net increase in pollution
Reductions < expectation	Load < expectation	No net change
Net increase in pollution:		**1 out of 3 scenarios**

About the Center for Progressive Reform

Founded in 2002, the nonprofit Center for Progressive Reform is a 501(c)(3) nonprofit research and educational organization comprising a network of scholars across the nation dedicated to protecting health, safety, and the environment through analysis and commentary. CPR believes sensible safeguards in these areas serve important shared values, including doing the best we can to prevent harm to people and the environment, distributing environmental harms and benefits fairly, and protecting the earth for future generations. CPR rejects the view that the economic efficiency of private markets should be the only value used to guide government action. Rather, CPR supports thoughtful government action and reform to advance the well-being of human life and the environment. Additionally, CPR believes people play a crucial role in ensuring both private and public sector decisions that result in improved protection of consumers, public health and safety, and the environment. Accordingly, CPR supports ready public access to the courts, enhanced public participation, and improved public access to information.

About the Environmental Integrity Project

The Environmental Integrity Project is a nonpartisan, nonprofit watchdog organization that advocates for effective enforcement of environmental laws. Comprised of former EPA enforcement attorneys, public interest lawyers, analysts, investigators, and community organizers, EIP has three goals:

1. To illustrate through objective facts and figures how the failure to enforce or implement environmental laws increases pollution and harms public health;
2. To hold federal and state agencies, as well as individual corporations, accountable for failing to enforce or comply with environmental laws; and
3. To help local communities obtain the protections of environmental laws.

We act as a watchdog because we have to. State and federal agencies charged with protecting the environment often are squeezed by limited resources and political interference from well-funded lobbyists hired by the industries they are required to regulate. We help level the playing field by giving communities the legal and technical resources they need to claim their rights under environmental laws.

Political influence should play no role when the government decides whether to enforce laws which keep cancer-causing benzene out of the lungs of children, for example, or deadly coal soot particles out of the bloodstreams of the elderly.

We do this by advocating for fair enforcement of environmental laws and regulations; writing and distributing reports and data; taking legal actions against big polluters and government agencies, when necessary; and by teaching communities how to participate in the public process regarding important state and federal environmental decisions.

Endnotes

[1] U.S. EPA, Trading and Offset Technical Memoranda for the Chesapeake Bay Watershed, available at: https://www.epa.gov/chesapeake-bay-tmdl/trading-and-offset-technical-memoranda-chesapeake-bay-watershed.
[2] For more information, see U.S. Geological Survey, Hydrologic Unit Maps, available at: https://water.usgs.gov/GIS/huc.html.
[3] U.S. EPA, Local Water Quality Protection When Using Credits for NPDES Permit Issuance and Compliance, available at: https://www.epa.gov/sites/production/files/2015-07/documents/localwaterqualitytm20140306pg.pdf.
[4] *See e.g.*, Water Environment Federation and WateReuse, The Economic, Job Creation, and Federal Tax Revenue Benefits of Increased Funding for the State Revolving Fund Programs (April 2016), available at https://watereuse.org/wp-content/uploads/2015/01/WEF-WRA-SRF-Economic-Impact-Study-Report-April-29-2016.pdf.
[5] Chesapeake Bay Program, 2014 Chesapeake Bay Watershed Agreement, available at: https://www.chesapeakebay.net/documents/ChesapeakeBayWatershedAgreemenetFINAL.pdf.
[6] See the Chesapeake Bay Program Toxic Contaminant Workgroup, available at:
[7] The map is available at: https://www.chesapeakebay.net/channel_files/25557/toxics_indicator_2014.pdf.
[8] *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).
[9] U.S. EPA, Chesapeake Bay Total Maximum Daily Load for Nitrogen, Phosphorus and Sediment, page 7-1 (Dec. 29, 2010) (emphasis added, and certain acronyms converted to full text for clarity).
[10] 33 U.S.C. § 1313(d)(1)(C).
[11] Kieser & Associates, Post-BMP Implementation Monitoring Results for the Cooper Township Agricultural Site #2 Area A, Project 97-IRM-5C (Dec. 31, 2001).
[12] National Research Council (NRC), Achieving Nutrient and Sediment Reduction Goals in the Chesapeake Bay 73 (2011).
[13] *Id.* at 76.
[14] U.S. EPA, Chesapeake Bay Phase 5.3 Community Watershed Model, page 6-9 (Dec. 2010), available at: http://www.chesapeakebay.net/about/programs/modeling/53.
[15] For more on comparisons between BMP efficiencies and real-world data, see Environmental Integrity Project, Murky Waters: More Accountability Needed for Farm Pollution in the Chesapeake Bay, pp. 29-39 (July 14, 2014), available at: http://www.environmentalintegrity.org/reports/murky-waters/.
[16] T. Simpson and S. Weammert, Developing Best Management Practice Definitions and Effectiveness Estimates for Nitrogen, Phosphorus and

Sediment in the Chesapeake Bay Watershed, 114 (University of Maryland Mid-Atlantic Water Program, Dec. 2009).
[17] See, e.g., World Resources Institute, Addressing Risk and Uncertainty in Water Quality Trading Markets, 3, 13 (Feb. 2014).
[18] U.S. EPA, Accounting for Uncertainty in Offset and Trading Programs – EPA Technical Memorandum, 8 (Feb. 12, 2014); see also U.S. EPA Chesapeake Bay Model, supra note 5, at 6-3 ("[t]he objective was to develop BMP definitions and effectiveness estimates that represent the average operational condition of the entire watershed").
[19] Morgan and Wolverton, *supra* note 1, at 15; *see also* Organization for Economic Co-operation and Development, Water Quality Trading in Agriculture 36 (2012) (citing Morgan and Wolverton as evidence that "ratios of 2:1 or higher are common in U.S. programs.").
[20] *See, e.g.*, WRI, *supra* note 1, at 10 ("Uncertainty ratios are often set at 2:1"); M.O. Ribaudo and J. Gottlieb, Point-Nonpoint Trading—Can it Work?, 47 J Am. Water Resources Assn. 5, 9 (Feb. 2011) ("Uncertainty ratios in water quality trading programs generally range from 2:1 to 5:1.").
[21] See EPA, 2014 Technical Memorandum, supra note 11, at 6 ("A number of factors may cause a BMP to produce lower than expected pollutant load reductions").
[22] Id.
[23] *Id.* at 10. The exceptions are for instances where routine monitoring is used to increase the certainty of load reduction estimates, or where BMPs are made permanent through a conservation easement or other deed restriction.
[24] Section .08(C)(1)(c).
[25] Section .08(C)(1)(a).
[26] Bear Creek Watershed Association, Total Phosphorus Trade Program and Nonpoint Source Trading Guidelines (Feb. 8, 2006).
[27] "[T]he Trade Ratio will be 2:1 for all Trade Projects unless the applicant requests an exemption of the 2:1 trade ratio based on adequate water quality data collected on a project-specific basis." Chatfield Water Authority, Water Quality Trading Guidelines, 10 (Apr. 25, 2007).
[28] *Id.*
[29] Morgan and Wolverton, *supra* note 1, at 17.
[30] *Id.*
[31] Jennifer Vogel, A Survey of Trading Ratios Used for Generation of Credits in Water Quality Trading Programs, 6 (UVA Environmental Law Clinic, July 20, 2012).
[32] *Id.* at 6.
[33] Florida DEP, The Pilot Water Quality Credit Trading Program for the Lower St. Johns River: A Report to the Governor and Legislature, at 12–13 (Oct. 2010), available at http://www.dep.state.fl.us/water/wqssp/docs/WaterQualityCreditReport-101410.pdf.
[34] Environomics, A Summary of U.S. Effluent Trading and Offsets Projects, prepared for Dr. Mahesh Podar, U.S. EPA, at 17 (Nov. 1999).
[35] *Id.* at 19.
[36] Morgan and Wolverton, *supra* note 1, at 17.

[37] Michigan regulations require retirement of 50% of nonpoint source credits "to address uncertainty and to provide a net water quality benefit." This would be, in ratio terms, a 2:1 ratio. Mich. Admin. Code r. 323.3016.

[38] The trading ratio is divided into three components: 1.0 to provide an offset, 1.0 to provide an environmental benefit, and 0.6 to account for uncertainty. Environomics, *supra* note 21, at 23; *see also* EcoAgriculture Partners, The Watson Partners and the Southern Minnesota Sugar Beet Cooperative, 18 (May, 2011) (confirming that "the required number of phosphorus reduction trading credits remains 2.6 times the annual phosphorus mass discharge limit for the WWTF.").

[39] Vogel, *supra* note 18, at 10.

[40] Environomics, *supra* note 21 at 29; Morgan and Wolverton, *supra* note 1, at 17.

[41] Vogel, *supra* note 18, at 18.

[42] *See* Environomics, *supra* note 21, at 25.

[43] Morgan and Wolverton, *supra* note 1, at 17.

[44] Vogel, *supra* note 18, at 12.

[45] *Id.* at 14.

[46] Organization for Economic Co-operation and Development, Water Quality Trading in Agriculture 23 (2012)

[47] U.S. EPA, Virginia's Trading and Offset Programs Review Observations, Final Report (Feb. 17, 2012).

[48] Environomics, *supra* note 21, at 36.