A New Approach to Water Quality Trading: Applying Lessons from the Acid Rain Program to the Lower Boise River Watershed

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Water quality trading is receiving great interest as a potential tool for achieving a watershed's water quality goals at less cost. It appeals to both regulators and watershed stakeholders as a voluntary, businesslike approach attracting a category of sources to the table that regulators have been unable to control using traditional enforcement tools—nonpoint sources. Nonpoint source pollution is a major source of the water quality problems still needing to be addressed in watersheds throughout the United States. Following the remarkable success of the Acid Rain Program's sulfur dioxide emissions trading system, however, expectations have been raised for all pollution trading systems. To date, water quality trading projects across the US have failed to deliver on those expectations because of the predominance of the "offset" trading model in their program design, which is characterized by significant costs in both time and resources to support trades. In this article, we argue that, although critical differences exist between water quality trading and the "cap and trade" model of the Acid Rain Program, water quality trading programs should consider incorporating certain key design elements that have contributed to the Acid Rain Program's success. We describe Idaho's Lower Boise River water quality trading framework as an example of how this can be done.

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Water quality trading is being used increasingly by regulators to achieve much needed water quality improvements within watersheds. The growth in popularity of water quality trading is driven by its ability to address two important issues that have proven elusive in the traditional implementation of Clean Water Act requirements. For one, water quality trading offers a means of enticing unregulated nonpoint sources (often the largest sources of water pollution) to reduce the amount of effluent entering the watershed as a result of their activities. Second, water quality trading also provides an opportunity to achieve environmentally equivalent reductions at lower cost. Many challenges remain, however, in the design of water quality trading programs that are able to demonstrate the achievement of the environmental goal at less cost without creating new obstacles and steep transaction costs for both regulators and stakeholders in the process. In addition, the success of the Acid Rain Program's sulfur dioxide emissions trading system raises expectations about the performance of pollutant trading systems. Although there are critical differences between water quality trading and the "cap and trade" model of the Acid Rain Program, water quality trading programs should consider incorporating certain key design elements that have contributed to the Acid Rain Program's success.

Although many people hope that water quality trading can achieve the same success as the Acid Rain Program, the context within which water quality trading operates introduces many challenges not faced in the Acid Rain Program. First, the 1990 Clean Air Act Amendments specifically authorized the United States Environmental Protection Agency (USEPA) to establish a sulfur dioxide emissions trading program for fossil fuel fired power plants across the continental US. In contrast, water quality trading is not explicitly mentioned in the Clean Water Act, so authority for its implementation must be found in a liberal interpretation of the statute.[1]

Second, the Acid Rain Program targets relatively large permitted sources that are easily monitored. The Clean Water Act, on the other hand, does not provide USEPA with the authority to enforce reductions from unpermitted

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nonpoint sources. Section 303(d) of the Clean Water Act establishes what is known as a Total Maximum Daily Load (TMDL) and, as is described below, assigns targeted amounts of reduction responsibility to polluting sources. Therefore, the only enforceable instrument available to USEPA to achieve reductions is the National Pollution Discharge Elimination System (NPDES) permit, which is issued to point sources. As defined by Section 502(14) of the Clean Water Act, point sources are characterized by their discharge of effluent through "any discernible, confined and discrete conveyance"; however, the definition explicitly excludes "agricultural stormwater discharges and return flows from irrigated agriculture."

Last, the Acid Rain Program is targeting emissions from a large subset of a single industry—fossil fuel fired utilities—in a geographic area extending across the continental US. Additionally, strong monitoring and enforcement tools are available to account for emissions reductions from these sources. Water quality regulators, on the other hand, face a much more difficult task in that, despite the lack of regulatory tools, the watershed's water quality goals must address pollution from all sources (not just ones within a single industry) if water quality is going to be improved within a timeframe that enables the watershed's ecosystem to recover. This task is complicated further by the current political, social, and economic constraints these regulators face. This poses a difficult challenge because, despite the considerable success of the permit program for point sources in eliminating major pollution loads, nearly half of the water bodies in the US still do not meet the minimum water quality standards to support fishing or swimming. The USEPA attributes most of the remaining pollution to runoff from nonpoint sources such as agriculture, stormwater, and urban development. While USEPA and states are currently issuing stormwater permits for small municipalities, construction sites, and industrial facilities, similar authority was not granted by the Clean Water Act for agricultural sources, which are specifically exempt from the NPDES permit program.

A comparison of water quality trading and the Acid Rain Program's sulfur dioxide emission trading system, therefore, must recognize the fundamental difference between a "cap and trade" model that only involves permitted point sources, and a trading system that requires the inclusion of non-permitted, nonpoint sources. While there have been valid arguments made by others for excluding nonpoint sources in a water quality trading system,[2] the fact that reductions from these sources are imperative for reaching water quality goals and that direct regulation of these sources remains politically unachievable ends up causing regulators to search for creative ways to include these sources. Furthermore, several studies have pointed out that nonpoint sources can offer reductions at a fraction of the cost of environmentally equivalent reductions made by point sources.[3] A trading program that includes nonpoint sources can, therefore, provide an incentive for these sources to offer cost-effective reductions in the marketplace that would not be offered otherwise. The challenge is to develop a point source/nonpoint source trading system that maintains the accountability and accuracy of the reductions being traded while minimizing the costs incurred by the regulatory agency and the trading parties involved.

The USEPA issued its *Water Quality Trading Policy* in January 2003 in order to eliminate many of the perceived regulatory barriers to trading and to identify the criteria by which trading programs would be evaluated for meeting Clean Water Act requirements.[4] No guidance, however, has yet been issued on how best to design a water quality trading program to achieve the water quality goal at the least possible cost. Instead, USEPA is allowing each state to come up with a design that best meets the needs and preferences of watershed stakeholders, while ensuring compliance with the criteria established in the *Water Quality Trading Policy.*

Most water quality trading programs to date are considered to be variations of the "offset" style of trading, in which the terms of a single trade (with either a point source or a nonpoint source) are incorporated into the point source's permit. Two notable exceptions are North Carolina's Tar Pamlico Sound nutrient trading program and Connecticut's Long Island Sound nitrogen trading program, although these two programs only involve trades between point sources. Programs featuring trades involving nonpoint sources have followed the traditional "offset" model with questionable success in achieving the intended environmental goal at less cost, due to the considerable investment in time and resources to negotiate the terms of the trade within the context of the NPDES permit.

Several authors have examined a handful of these water quality trading projects in depth, but they have concluded that the design of the projects or regulatory constraints hindered the projects' success. For instance, Hoag and Hughes-Popp attribute much of the failure of water quality trading in the example they studied to poor program design.[5] King and Kuch, on the other hand, place much of the blame on institutional obstacles that artificially constrain the demand for and supply of credits—obstacles that, they believe, could be reduced with better program design and the elimination of agricultural subsidy programs that support particular nutrient management practices.[6] What is missing from the literature, however, is a recommendation for how a water quality trading program could be designed, given the current regulatory framework, to support trades between point sources and nonpoint sources. A better design for including both types of sources is necessary to achieve water quality goals at the least possible cost to both the stakeholders and the regulators.

To improve upon the limited range of trading models currently available for water quality trading, lessons should be drawn from another, more successful trading program. While the cap and trade approach used in the Acid Rain Program is not directly applicable to water quality trading, it offers important lessons regarding how two basic principles common to the design of any successful pollutant trading system were implemented to support an efficient trading system. In this article, we show how these lessons were found to be valuable in the design of the Lower Boise River water quality trading program.

The article is organized as follows. The next section provides a closer examination of the design elements to which much of the success of the Acid Rain Program's sulfur dioxide emissions trading program can be attributed. The subsequent section uses the example of the Lower Boise River's water quality trading program to illustrate how the fundamental design principles for trading learned from the Acid Rain Program can be applied to a different trading situation. Although there are significant differences between the Acid Rain Program's cap and trade model of emissions trading and the context for water quality trading, the fundamental principles of trading should be acknowledged and their important lessons applied to water quality trading.

Fundamental Trading Principles and the Acid Rain Program

The Acid Rain Program's sulfur dioxide emissions trading system is exemplary in its successful application of the cap and trade model. "Cap and trade" is a market-based instrument that has gained widespread popularity since the concept was introduced in the early 1960s.[7] The idea behind cap and trade is to cap total emissions and, through the trading of emission allocations, allow sources of emissions the flexibility to shift the location of their emission reductions, in an attempt to lower total compliance cost. Other applications include the Regional Clean Air Incentives Market (RECLAIM) to reduce sulfur dioxide and nitrous oxides emissions in the Los Angeles basin and the USEPA lead trading program to reduce lead in gasoline. Primarily, the expected cost saving drives the popularity of this model of emissions trading over conventional command-and-control approaches. Cost savings from the lead trading program have been estimated at $250 million per year, and the sulfur dioxide allowance trading program has resulted in an estimated cost savings of approximately $1 billion annually.[8]

A number of articles have been written that offer criteria for the successful application of cap and trade.[9] Other investigators have then applied these criteria to specific emissions trading programs to determine how well they performed. Most recently, attempts have been made to apply the same criteria to the handful of water quality trading programs currently in place, and several have concluded that the programs are not able to satisfy the criteria for success.[10] Although this comparison of programs against criteria is useful for understanding which areas are responsible for a program's success or failure, it fails to capture "lessons learned" that can be used to extend the design of future programs beyond the cap and trade model.

Another approach is to identify the basic principles adhered to in the implementation of the Acid Rain Program's sulfur dioxide emissions trading system and to examine how the trading system's features support these principles. The Acid Rain Program provides a valuable example of how the implementing mechanisms influence the success of the trading program.[11] By applying these insights to the current model for water quality trading, it may be possible to improve water quality trading's chances for success in achieving important water quality goals at less cost.

From close examination of the Acid Rain Program, we have identified the following basic principles of emissions trading important for program success:

(1) Create a tradable, standardized commodity that ensures achievement of the environmental goal (as set by the pollutant cap or reduction requirement); and

(2) Achieve the environmental goal at the least cost possible by making the trading system as efficient and attractive as possible.

In the Acid Rain Program, the first fundamental principle, creating a standardized commodity, is met through four distinct mechanisms:

Measurement accuracy. This is achieved through the requirement that continuous emissions monitors (CEMS) and reporting software be installed and maintained at the source. Concentration data on sulfur dioxide (SO_2), nitrous oxides (NO_x), carbon dioxide (CO_2) gas, opacity, and volumetric flow are sampled every 15 minutes, converted into hour averages, and calculated as tons for the quarterly electronic reports to be submitted to the USEPA Emissions Tracking System. When the monitor fails to perform properly, the source must fill in any anomalies or missing data with conservative estimates calculated from equations specified in the regulations. The calculations are intended to overestimate the likely emissions during that period and therefore cause more allowances to be deducted at the end of the period than would have been needed if the monitor had read the emissions accurately. For those existing sources that are too small to justify CEMS or that burn oil or natural gas, fuel sampling and gas or oil flow monitoring equipment are used instead, calculating the estimated tons of SO_2 emitted with emission rate formulas based on the amount and type of fuel.

Automated compliance checks and penalty provisions. The sources' emissions reports must include statistical checks conducted automatically to detect data anomalies, and if any inaccurate reports are detected by the source, then it must report them on its self-certification statement in the quarterly emissions report. On the annual compliance report, the source's designated representative must also verify that the source has enough allowances to cover reported emissions. If the source concludes that there are not enough allowances on hand, then payment for the excess tons must be made according to the current penalty rate, which is automatically applied under the program's rules.[12] The USEPA also performs statistical checks when it processes the emissions report each quarter, so accuracy and swift and sure enforcement are assured before substantial violations build up without responsive action.

No local hot spots or adverse environmental impacts. Any potential adverse environmental impacts from the location of the emissions are guarded against by the requirement that the source must comply simultaneously with the existing federal and state ambient air quality standard for SO_2. This standard is set as a specific maximum of SO_2 concentration per volume of air sampled at the stack, and therefore, when enforced, prevents worsening of air quality in the local area. The availability of the data collected by the CEMS has improved the enforcement of that standard (under a different program) as well—an additional benefit of the Acid Rain Program, which focuses instead on a "total loading" or accumulation of SO_2 and other acid rain precursors in the atmosphere. The Acid Rain Program's requirements do not preempt enforcement of the ambient standard because the permit clearly states that holding enough allowances to offset emissions does not exempt the source from complying with other programs' emissions limitations.

Accurate accounting of allowances. The procedures for recording allowance transactions are designed to have the buyers and sellers of allowances bear any risk of allowances not being available for transfer, which they can manage through terms in their private contracts. Therefore, the primary responsibility of the USEPA Allowance Tracking System is to ensure that all allowances are accurately tracked and accounted for in the system so that it may be used to help determine compliance at the end of the year, when current-year account balances are reconciled against emissions reported for that year. The Allowance Tracking System ensures accuracy with such routine procedures as automatically screening submitted trades for accounts and allowance serial numbers that correspond to those used in the system, and rejecting any trades that request transfer of allowances that do not reside in the seller's account. It also conducts daily, weekly, and monthly automatic system checks to make sure that allowances are not miscounted or misplaced. This is important for two reasons. First, duplicate or missing allowances affect the amount of annual emissions authorized by the cap because every ton must be covered by an allowance, and the number of allowances must add up to the number of tons set by the cap. Second, allowances serve as the emissions compliance "currency," and therefore they are valuable to the sources that use them. Thus, the tracking system must be as reliable and accurate as a banking system in order for the public and regulated sources to continue their trust in the allowance as the compliance currency.

The Acid Rain Program addresses the second fundamental principle, to achieve the environmental goal at the least cost possible by making the trading system as efficient and attractive as possible, with three important mechanisms:

Flexible permit limit within trading parameters. The Acid Rain Program's SO_2 permit provisions contain one of

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the most important features to best support a cap and trade approach—the source's end-of-year account balance in the Allowance Tracking System serves as the authorized limit for SO_2 emissions from that source. The limit applies only to the Acid Rain Program's SO_2 emissions limit; the source is still required to comply with the state or federal ambient standard for SO_2 (whichever is more stringent), regardless of how many allowances the source has in its account. Because the trades themselves are not considered to be formal permit modifications, the source may trade allowances throughout the year without scrutiny from USEPA or the state enforcing the permit. The requirement that sources hold enough allowances to cover their reported emissions is only enforced at the end of the compliance period. Therefore, the only concern during the year is whether the source has enough allowances to cover its transfers. This is enforced by the Allowance Tracking System as part of its automated trade recording system, which rejects trades in cases when there are not enough allowances in the seller's account to cover the trade.

Simple trading processes that encourage a greater trade volume. The Allowance Tracking System is supported by simple trading procedures that minimize transaction costs to market participants and provide assurances to affected sources that trading is the easiest way to comply with the program's requirements. Trade transactions are extremely simple and have even become more automated over time, as electronic forms and signatures can now be used instead of paper and handwritten signatures. The remaining trading procedures and terms are left to the buyer and seller to address in the trade contract they negotiate between themselves—e.g., price, quantity, and penalties for failure to fulfill the contract's terms. Together, these elements encourage a much greater volume of trading than would have been achieved by procedures that would require the USEPA to conduct a trade-by-trade review. In turn, the increasing number of trades since the Acid Rain Program was launched in 1995 corresponds with the dramatic increases in estimated cost savings from lower compliance costs and with consistent achievement of the program's emissions cap.[13]

Automate trade review and compliance to increase certainty. The trade review procedures were built into the permit and the trading rules, allowing market participants to assess up front whether a trade will be determined to be valid. This avoids the need for time-consuming review of each proposed trade to ensure that the trade would not trigger any adverse impacts and that the seller has enough allowances to transfer to the buyer. The Allowance Tracking System automatically transfers to the buyer the specific allowances indicated by serial number on the transfer form; therefore, the seller is able to transfer only those allowances that reside in the seller's account at the time of the transfer. The annual reconciliation of the Allowance Tracking System with the Emissions Tracking System is also automated, deducting the number of allowances needed to cover the reported emissions at the end of the compliance period. This reconciliation is used to verify that sources have enough allowances to cover their emissions when they submit their Annual Compliance Report. The automation of allowance transfers, electronic emissions reporting, and annual reconciliation procedures required a considerable investment in staff time and resources up front to develop reliable and accurate systems; however, this effort has likely paid off in reduced program administration costs, as well as in increased reliability and accuracy for determining program compliance.

These three mechanisms working together enable the market to treat SO_2 allowances as a tradable commodity. When these are combined with the four mechanisms supporting the first principle, to establish a tradable commodity that addresses the environmental goal, the market is able to value allowances in a uniform manner—i.e., a ton of sulfur dioxide emissions will be measured in the same way across all electric utility units. Therefore, the market is not concerned with the origination or destination of allowances, allowing unfettered and nearly frictionless exchange. Furthermore, when non-utility sources are allowed to join as part of the Acid Rain Program's "opt-in" program, they are required to meet nearly identical standards and comply with the program's requirements, in much the same way as utility sources.[14] As a result, no distinction needs to be made between allowances allocated to these sources and allowances allocated to electric utilities.

Applying Lessons from the Acid Rain Program to the Lower Boise River Watershed

For water quality trading to replicate the success of the Acid Rain Program's sulfur dioxide emissions trading system, the design must incorporate the fundamental principles described in the previous section, which apply to any pollutant trading system. The trading system design, however, must also accommodate the particular challenges of including nonpoint sources in water quality trading while ensuring that the environmental goal established by the TMDL is met.[15] Unlike the cap in the Acid Rain Program, which limits a pollutant emitted by a single industry across the country, water quality trading imposes a cap on the pollutant across all types of sources that cause violations to water quality in the regarded water body. Although this implies that both permitted and non-permitted sources are subject to the cap, only the portion assigned to permitted sources can be enforced. Therefore, non-permitted, nonpoint sources are considered unregulated in the context of water quality trading. The trading system developed for the lower section of the Boise River in Idaho ("the Lower Boise") offers potential solutions to these challenges.

The TMDL is the implied cap for water quality trading. It is triggered under section 303(d) of the Clean Water Act when a water body cannot support the "beneficial uses" designated for it (e.g., swimming, fishing, and supporting trout or salmon habitat) and violates water quality criteria established to maintain those uses. A TMDL is then developed to establish the amount of pollution reduction needed to meet water quality standards, and is divided up between the contributing sources as Waste Load Allocations and Load Allocations. Waste Load Allocations are separate portions of the reduced load assigned to each permit holder that are then converted to permit limits. The size of the Waste Load Allocation is based on a variety of factors pertaining to the permittee, such as their discharge amount, location in the watershed, and available compliance strategies.

A single Load Allocation, on the other hand, is usually assigned to an entire category of nonpoint sources, such as agriculture. A separate implementation plan spells out the means by which the reductions will be achieved, usually through voluntary measures. An allocation for uncontrollable background levels and a "margin of safety" are also factored into total load calculations, to account for unallocated pollution that cannot be reduced, uncertainty of the data collected, seasonal variations, and unknown factors.

The role of the USEPA in providing oversight of implementation of the TMDL is limited; current interpretation of the Clean Water Act allows USEPA to offer only vaguely worded guidance on how the Load Allocation will be achieved. In Idaho, for example, the Idaho Department of Environmental Quality works with the Idaho Soil Conservation Commission to target voluntary cost-share programs, such as the Environmental Quality Incentives Program (EQIP), to achieve the reductions necessary to meet the Load Allocation. There is no assurance that enough farmers will choose to participate in cost-share programs to meet the reduction targets nor that their farms are the ones that will provide the greatest water quality improvements.

The Lower Boise River watershed was selected in 1997 as the site of USEPA Region 10's first water quality trading demonstration project in the region, because regulators and stakeholders believed a new incentive-based approach was needed to achieve the goals of the phosphorus TMDL. Preliminary analyses of pollution loadings to the river and their sources determined that half of the loading was coming from the dozen or so point sources (most of them publicly owned sewage treatment plants) and half from nonpoint agricultural sources. Therefore, even if point sources were required to eliminate their phosphorus discharge completely, the river would still not reach the level of phosphorus reductions needed to achieve the water quality goals required at the mouth of the Boise River. In addition, the TMDL needed to target reductions from the agricultural community in the final stretch of the river because of the agricultural community's direct impact on the total phosphorus loading at the Boise's confluence with the Snake River. The mouth of the Boise River is the target for compliance because, although the Boise River itself may not be impaired, it is the largest source of phosphorus to the lower section of the Snake River, contributing approximately 80% to the Snake's total phosphorus load. As a tributary to the Snake River, the Boise River is therefore assigned a Load Allocation under the Snake River's TMDL for phosphorus; this will require significant reductions from sources on the Boise River.

The USEPA Region 10 office in Seattle, Washington, and the Idaho Department of Environmental Quality co-led the three-year collaborative process with the watershed's key stakeholders. Water quality trading was seen by the permitted sources as a way to encourage nonpoint sources to generate cheaper reductions than they could achieve themselves, and as a means to recruit agricultural sources to the table in a non-threatening manner, to discuss how these sources could help achieve the watershed's goals. Leaders of the agricultural community in the Boise River watershed found trading attractive because it was a voluntary, businesslike approach to achieving environmental goals; it would enable farmers to sell their pollution reductions as a commodity rather than under a potential mandatory program ill-suited to their particular farm conditions that could threaten their economic livelihood.

Both sides agreed up front to two basic conditions for the trading framework: (1) that the project would not be used as a "Trojan Horse" to lure the agricultural community into new environmental regulations; and (2) that the tradable credits coming from nonpoint source reductions must be in excess of the reductions needed to achieve the Load Allocation under the TMDL.

The trading system design was completed in 2000,[16] but unexpected delays in the issuance of the Lower Boise River TMDL and subsequent NPDES permits containing phosphorus limits and authorization to trade have held up implementation of the trading system. The geographic and environmental link between the Lower Boise River TMDL and a set of TMDLs for the Snake River/Hells Canyon watershed has caused the schedule delays. The Snake River's TMDL will set the reduction target for the Boise River's TMDL; therefore, the trading system cannot be implemented until the Snake River/Hells Canyon TMDL for phosphorus is completed and approved by USEPA; this is expected by the end of 2004. This approval will enable the development of the Lower Boise TMDL in 2005. The delay in the Idaho Department of Environmental Quality's submittal and USEPA's approval of the TMDLs are for reasons unrelated to trading.[17]

Although not yet tested through implementation, the trading system's design was based on careful consideration of other water quality trading approaches, as well as the lead USEPA representative's familiarity with both the Acid Rain Program's cap and trade model and various state implementations of emissions credit trading referred to as "open market" trading (which has been less successful in providing a viable alternative model to cap and trade).[18] Examples of several water quality trading projects were also studied: North Carolina's Tar Pamlico, Colorado's Cherry Creek, and Minnesota's Rahr Malting, as well as the Michigan Department of Environmental Quality's draft state regulations for water quality trading.[19]

These water quality trading models were considered and rejected by the stakeholder group for several important reasons. The point sources in the Lower Boise watershed were not interested in being bound together as a group under a single limit, as the point sources in the Tar Pamlico watershed had done. They also preferred to trade directly with nonpoint sources instead of paying a fee to the state's agricultural agency to expand the state's nonpoint source reduction program. The Cherry Creek program required the creation of a new quasi-governmental entity to launch and administer all aspects of the trade, which would not achieve the Lower Boise stakeholders' goal to have as minimal a governmental role in trading as possible. The representatives of the agricultural community rejected the Michigan model because of that state agricultural agency's new role in enforcing a farm's conservation plan as part of the trade structure. Since the Rahr Malting permit took more than two years to issue (just to incorporate a single trade), this approach was soundly rejected because of the significant burden it would impose on an already backlogged permit staff in USEPA Region 10 and the delay in permit issuance, which the point sources said would be unacceptable. Furthermore, the stakeholders made it clear that they were only interested in trading if a new approach to incorporating trades in permits could be developed. After close examination of the cap and trade model used by the Acid Rain Program, it was decided that this new approach to water quality trading would integrate the fundamental design principles of the Acid Rain Program and adapt the approach to incorporate trades with nonpermitted sources.

The following two major sections describe the mechanisms used to implement the fundamental principles learned from the Acid Rain Program in developing a new model for water quality trading.

Creating a Tradable, Standardized Commodity that Ensures Achievement of the Environmental Goal (As Set by the Cap)

Establish a List of Acceptable Best Management Practices for Reduction Credits

Because nonpoint sources are not issued permits and are not required to monitor or verify reductions in their discharge or runoff, special provisions were developed to bring nonpoint source reductions into the Lower Boise trading system. Efforts were made to ensure that nonpoint source pollution reduction-based credits could be considered equally valid to those generated by point sources. Point sources are not required to undertake additional monitoring of their discharge beyond what would be required in the absence of trading; however, these sources are liable for any permit violations for failure to comply with their limit and any other conditions in their permit. For example, point sources using trades to meet their permit are liable for the validity of the credits, causing these sources to adopt a "buyer-beware" approach to the purchase of credits from nonpoint sources. The program

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attempts to reduce the point source's enforcement risk as much as possible by specifying up front the requirements for what constitutes a valid nonpoint source credit reduction. By defining the standard of measurement or method of estimation, the nonpoint source credit is made as uniform as possible, in order to develop a standardized, tradable commodity.

This is accomplished in part through the development of an official list of acceptable "Best Management Practices," called the BMP List.[20] These BMPs were selected for their ability to achieve significant phosphorus reductions, if designed, installed, and maintained properly. This list was developed prior to the launch of the trading system by a standing committee of Idaho's top agricultural BMP experts (known as the BMP Technical Workgroup) and can be updated with new or revised BMPs or measurement methodologies at any time, once a public comment process for each addition or modification is complete. The BMP List references the US Department of Agriculture Natural Resources Conservation Service's Field Office Technical Guide for explicit descriptions of each BMP. This guide provides a list of each BMP's design, the type of field conditions where it is best used, and how it is installed and maintained. In addition, each BMP description includes the specific measurement method or calculation used to estimate its effectiveness in reducing phosphorus. To encourage the use of direct measurement where feasible (such as using flow monitors and obtaining grab samples from a drain or stream before it flows into a constructed wetland), credit for the entire measured amount is given when direct measurement is used, whereas an uncertainty discount is applied when the estimation method is used; however, the uncertainty discount is avoided if a nutrient management plan is implemented as well. The estimation method also requires baseline numbers to be consistent with the nonpoint source Load Allocation in the TMDL. Other steps that a nonpoint source must follow to determine the amount of credit that can be offered for sale are described below in the sections on prevention of localized impacts and trade procedures.

Assign Liability for Credits to the Buyer

Once the nonpoint source has selected a BMP from the approved list and has completed its installation, it is up to the buyer to verify that the BMP follows the requirements specified on the BMP List. To transfer credits, point sources must complete and sign a "Reduction Credit Certificate" that is submitted monthly to the administrators of the system recording the establishment and transfer of credits, known as the Trade Tracking System. The submission of the form at the end of the month verifies that the reductions have already taken place during that month, and that no credits are created based on reductions anticipated in the future. Unlike the Acid Rain Program, where "banking" an unused allowance for use in future years is allowed, banking of credits is not permitted in the Lower Boise program because of the greater potential environmental impact of a pollutant in a smaller geographic area. This means that credits can only be used to offset discharges that occur in the same month that the reductions were generated, and credits generated in one month cannot be used in subsequent months. Thus, an unused credit will expire if not used for the time period in which it was created. The monthly cycle of form completion was selected to coincide with the Discharge Monitoring Report that most point sources must submit at the end of each month. Acknowledging that some measurement systems require several days or weeks to process samples, the Reduction Credit Certificates may be submitted to the Trade Tracking System up to 10 days into the second month after the reduction for the credit was generated. In addition, Discharge Monitoring Reports are not due at USEPA (the designated administrator of the NPDES permit program for Idaho) until the 20th day into the second month following the credit generation; e.g., a May Discharge Monitoring Report is not due until July 20.

Permit holders assume all liability for the validity of credits used to adjust their permit limit and are subject to any enforcement action USEPA takes based on the determination that a credit was invalid. The USEPA and the Idaho Department of Environmental Quality (accompanied by a BMP expert from the Idaho Soil Conservation Commission) may inspect a BMP on a nonpoint source's property as part of their audit of a point source, but can only take enforcement action against the point source that purchased and used the credit. Nonpoint sources that create an invalid credit are not subject to enforcement action; however, they are subject to the penalties or actions agreed to in private contracts with point sources. The contract terms are enforced through legal action undertaken by a point source or nonpoint source to uphold the conditions of the contract.

Nonpoint Source Credits are Surplus to Load Allocation Reductions

Even if a nonpoint source chooses a BMP from the BMP List, this does not guarantee the reductions will be considered valid for trading. Nonpoint source reductions are only considered valid if they are proven to be surplus or additional to the reductions specified by the nonpoint source Load Allocation. Other water quality trading programs have addressed the problem of proving additionality by requiring specific BMPs to be installed to meet the Load Allocation goal, allowing credit to be given for the installation of any additional BMP. Rather than taking this approach, the Lower Boise trading system opted to deduct a portion of the reduction created by the BMP for fulfillment of the individual nonpoint source's share of the Load Allocation, with the exact amount of the deduction to be specified by the Idaho Department of Environmental Quality as part of the TMDL's implementation plan. This allows nonpoint sources to decide which BMP is best for their specific land's conditions and to benefit from working to maximize the BMP's performance. This deduction is called the "Voluntary Water Quality Contribution" by the Lower Boise stakeholders, to acknowledge that participation in trading is voluntary; however, making the "contribution" is a requirement for the credit to be considered valid, so it is essentially a trading element that is enforced by the point sources who attest that the credit is valid when they sign the Reduction Credit Certificate. Nonpoint sources that choose not to participate in trading are still subject to the voluntary programs the state of Idaho implements to meet the reduction goals specified by the TMDL's Load Allocation. It can be speculated that the TMDL reduction goals for the Load Allocation are more likely to be met if trading is made as appealing to nonpoint sources as possible to encourage their participation in trading and, as a trade condition, a commitment to meeting their share of the Load Allocation.

In contrast, fewer requirements are placed on the creation and transfer of credits from point sources, both because the underlying reductions in the credit are more easily verified and enforced with a permit and because the point sources's Waste Load Allocation is analogous to the allocation of allowances under a cap and trade system. Therefore, point sources do not need to submit Reduction Credit Certificates to create tradable credits; rather, they need only to submit a form called the "Trade Notification Form" to the Trade Tracking System; this allows them to trade current and future reductions in a fashion similar to the Acid Rain Program's sulfur dioxide trading system. These credits are automatically applied to determine the current permit limit of a point source, although the use of credits in a month other than the one in which the reduction was generated is not allowed (i.e., no banking).

Report Trading Results on Discharge Monitoring Reports

Water quality trading has no special enforcement provisions in the Clean Water Act and therefore such a system must work within the existing penalty structure of the NPDES permit program. In the Lower Boise trading program, NPDES permit holders must comply with the terms of their permit and demonstrate through the monthly submission of a completed Discharge Monitoring Report that their measured effluent discharge does not exceed the amount authorized by their permit limit. In effect, the permit limit is adjusted by the monthly trades recorded in the Trade Tracking System. If discharge levels exceed the authorized amount after the trades are taken into account, then standard fines and penalties are imposed, with the possibility of additional enforcement actions. This is similar to the Acid Rain Program, where permit holders must self-report any violations in their Annual Reconciliation Report and include payment for the automatic penalties they calculate. In water quality trading, permit holders must also self-report any violations in their Discharge Monitoring Report if calculations show that they did not hold sufficient credits to offset the reported discharge amount. Subsequently, the amount of penalties incurred is subject to settlement terms agreed to by USEPA and the Idaho Department of Environmental Quality.

Prevent Localized Impacts

The TMDL established by the Idaho Department of Environmental Quality for the Lower Boise River sets the phosphorus reduction goal for the watershed. The introduction of trading, however, creates the possibility that phosphorus loadings in the river will increase to levels that would violate the water quality standard in a local area, creating what is referred to as a "hot spot." The TMDL's establishment of a significant reduction target and the careful distribution of the remaining loadings throughout the watershed may be enough to prevent any source from acquiring enough credits to create such conditions, as is the case in the Acid Rain Program with significant reductions set by the cap; however, a water quality trading system needs to account for the fact that local water quality and flow conditions may create the potential for hot spots.

Several options to prevent hot spots were considered for incorporation into the Lower Boise trading system, including protective limits and trading zones. The approach taken to avoid hot spots in the Lower Boise, however, is to first determine for each point source the maximum amount of phosphorus that can be assimilated by the river at its discharge location, and to then use this information to establish an upper discharge limit in the permit that cannot be exceeded no matter how many credits the point source holds to offset its discharge. This limit is likely to be based on Idaho's narrative standard for nuisance aquatic growth, rather than on a numeric standard for phosphorus, which the state does not use. Although the Lower Boise TMDL is not yet complete and permit limits are not set for the point sources, the upper discharge limit will be based on what is determined from the TMDL to be slightly less than the maximum amount of phosphorus the river can assimilate before algae blooms are triggered. This provides the source with a clear indication in advance of how much it can discharge, without having to revisit any trades it may have conducted. This, in fact, is similar to the way the Acid Rain Program relies on the state and national ambient standards for SO_2 to prevent local air quality conditions from worsening beyond those levels deemed to be protective of the public's health, and which serve as an effective upper limit in the permit for the concentration of SO_2 per unit volume that can be emitted.

The implementation of trading zones—which are used in other emissions trading programs such as the one operated by the South Coast Air Quality Management District in Los Angeles, California—is another method to ensure that pollution levels do not increase beyond an area's ability to absorb them. The Lower Boise permit will likely include provisions that limit increases in tributary creeks by restricting the direction of trading into these zones. Restrictions on the direction of trades along the river itself make less sense because large irrigation canals siphon much of the river's water in the upper stretch of the watershed. The water returns to the river laden with even more phosphorus in the lower section (closer to its junction with the Snake River), where the largest reductions are required under the TMDL. Therefore, the trades with the greatest environmental benefit are those that involve the purchase of reductions from downstream point and nonpoint sources. In fact, such downstream trades are more likely to occur because the TMDL will probably assign the largest reduction responsibility to the permitted sources, giving them an economic incentive to purchase the lowest cost reductions they can find. Those are most likely to come from the nonpoint sources located downstream, who will have the largest reductions to offer due to their favorable location-based ratio and the cost-effectiveness of the BMPs.

Trading ratios are another way to use the market to target trades in the watershed where generation of pollution reduction credits by sellers is most needed to prevent localized impacts, or where a source purchasing credits can continue to discharge without creating a localized impact. As an alternative to the typical approach of "one size fits all" trading ratios, the Lower Boise trading system has implemented a set of location-based ratios that reflect the environmental equivalence of reductions made at different locations in the watershed. The ratios are assigned to each source based on its location in the watershed and are calculated in relation to a common reference point—the town of Parma, which is near the confluence of the Boise and Snake Rivers. The term "Parma Pounds" refers to how much of a reduction in a pound of phosphorus achieved further up in the watershed will show up at the location near Parma. "Parma Pounds" are calculated by applying up to three sets of ratios to a quantity of reductions made at any point in the watershed. The first set of ratios is termed "river location ratios" and refers to the location of the source's discharge along the Boise River itself. These ratios were developed using a mass balance model that accounts for inputs, withdrawals, and groundwater flows into the river. The second set is termed "drainage delivery ratios"; these adjust the reduction amount further by applying a set of distance-based factors if the source is located along a creek or drain that flows into the Boise River. Similarly, the third set of ratios, "site location factors," adjusts the amount even further if the source is located away from the drain or creek, because its reduction impact is less effective due to an increasingly indirect hydrological connection to the Boise River. Although the concept of Parma Pounds does not necessarily prevent hot spots at a location other than Parma, it is yet another important tool for measuring the relative impact of the discharge of phosphorus throughout the watershed.

Achieving the Environmental Goal at the Least Cost Possible by Making the Trading System as Efficient and Attractive as Possible

Flexible Limits in the Permit

The Lower Boise trading system was designed to keep the trading process as simple as possible, which is accomplished primarily through the incorporation of flexible permit limits. Similar to the Acid Rain Program's permit, this flexible limit allows permit holders to adjust their initial permit limit (determined by that source's Waste Load Allocation) automatically through trading. The permit calculates the applicable limit by referring to the Trade Tracking System as the official record of credits held in the point source's account, similar to the role of the Allowance Tracking System in the Acid Rain Program. Each credit allows the point source to discharge a unit of phosphorus, which is expressed as "pounds per day," the same unit of measure used in the Waste Load Allocation. Reconciliation of the adjusted permit limit (as reflected in the point source's Trade Tracking System account) with the reported discharge amount is self-reported by the permit holder on a signed Discharge Monitoring Report that must be submitted by the 20th day of the second month. The number of credits purchased or sold is also reported, to show how the source used the credits to adjust the actual discharge amount to comply with the limit (although when the computer-based form is redesigned, it will be corrected to show the specific credit transactions that created an adjustment of the permit limit). The signature indicates that the permitted source is certifying that it is either in compliance with the permit conditions or that it is reporting a failure to comply if the adjusted discharge amount is greater than the permit limit. In the latter case, the regulatory agency would then begin an investigation of the violation.

Unlike most other water quality trading programs to date, the Lower Boise trading system does not consider each credit transaction by a point source to be a formal modification to the source's NPDES permit. Administrative and transaction costs are held to a minimum because the regulator's effort instead has been focused on defining up front the trading requirements and conditions that a point source must follow, thereby enabling the sources to screen the qualifying trades themselves. The Lower Boise trading program emulates the flexible permit approach of the Acid Rain Program by specifying conditions for trading up front in trading guidance and regulations (as well as in the permit itself), and by allowing qualified trades to automatically adjust the permit limit without a formal review process. The Lower Boise trading system also allows buyers and sellers to arrange their trades outside the permit process, only registering the results of each trade in the Trade Tracking System. In contrast to the Acid Rain Program's opt-in provisions, however, the Lower Boise trading system allows non-permitted, nonpoint sources to generate and sell reductions without having to become regulated sources under the program. This was made possible through the implementation of a trading system that is a hybrid of the cap and trade model and the emissions reduction credit approach of open market trading mentioned earlier.

As described earlier, in the Lower Boise trading system, permit holders are accountable for the validity of the reductions they purchase from nonpoint sources (which they certify when they sign and submit the Reduction Credit Certificate to the Trade Tracking System). The requirements for what constitutes a valid credit are specified in the permit. A point source can precisely calculate the amount of reductions it will be allowed to use as a credit by selecting a BMP from the BMP List and ensuring its proper installation and maintenance, and by using the specified measurement or estimation method to determine the reduction amount. After measuring or calculating the amount of reduction using the formula provided in the BMP List, the point source then subtracts the Water Quality Contribution amount and multiplies the remainder by the set of location ratios for the nonpoint source's location. The Reduction Credit Certificate "walks" the nonpoint source and point source through the necessary calculations, with certification language reminding the point source of the potential liability it faces when it signs the certificate.

Reduced Transaction Costs through Assigning Credit Liability to the Buyer

Some water quality trading programs in other states (e.g., Michigan Water Quality Trading Rules[21] and Colorado's Cherry Creek water quality trading program[22]) chose to shift liability to the regulatory agency by requiring credits, or the demonstration of the reductions themselves, to be reviewed and approved by the regulating entity before they could be traded. While it may provide more certainty in the validity of the reduction, the significant time delay and uncertainty of approval can be quite burdensome to the point source requesting the credit. Both point sources and nonpoint sources bear the sizeable transaction cost resulting from this trade approval process, and this burden often discourages trading. To reduce transaction costs as much as possible, the Lower Boise River trading framework keeps the liability for the validity of the credits with the point source, by requiring point sources to certify reductions on the Reduction Credit Certificate and by subjecting them to the standard Clean Water Act penalties if an audit finds they provided false certification. The trading framework, however, allows these sources to manage the risk associated with the purchase of reductions from nonpoint sources—such as failure to deliver valid credits—by encouraging trading parties to negotiate terms to manage that risk in the private contracts for the trades. These private contracts provide an incentive for both parties to manage the risk inherent in this transaction relationship to achieve the most economically efficient outcome.

Transfers of credits are conducted by completing a Trade Notification Form and submitting it to the Trade Tracking System. This instructs the system to remove the credits from the seller's account (which can be either a point source, a nonpoint source, or a third party) and add them to the buyer's account. No judgment by the trading system administrator or the regulatory agency is made as to whether the point source's discharge will exceed its localized impact limit or if the removal of credits will fall below its current level of discharge. The burden is placed on the point source to make sure it is in compliance at the end of each monthly reconciliation period.

Location-Based Ratios and Self-Management of Trade Risks

The Lower Boise trading system was developed by its stakeholders with a careful eye toward maximizing the certainty of the phosphorus reductions underlying the tradable credit, while minimizing transaction and administrative costs. Other water quality trading programs have addressed the uncertainty of nonpoint source reductions, as well as the different location-based environmental impacts, through a sizable trading ratio (e.g., three pounds of nonpoint source reductions must be purchased to offset a single pound of point source discharge) applied uniformly to all trades. With the realization that the market would be not able to reduce the implied risks addressed by a single ratio, the Lower Boise trading workgroup instead focused on a trading system design that broke out the types of risk inherent in transactions with nonpoint sources, allowing them to be addressed separately.

The uncertainty regarding BMP performance and effectiveness is addressed through the BMP List and measurement and estimation protocols, as well as the requirement that credits can only be created when the point source certifies that the reduction occurred. The uncertainty of whether the nonpoint source will be able to meet its obligation to install and maintain the BMP is managed through the private contract between the point source and the nonpoint source. Uncertainties regarding environmental impacts are addressed through location-based ratios and permit limits to address hot-spot concerns. This design reflects the stakeholders' intent to let the market create incentives and competitive pressure for improving the performance of phosphorus reduction technologies and BMPs. Improving the accuracy of measurement or methods for estimating reductions is also valued in the marketplace by the willingness of point sources to pay for credits reflecting such advancements. In addition, market participants have an incentive to insist that the list of approved BMPs reflects the most recent research in BMP performance and reduction quantification methods.

Under the Lower Boise River's trading framework, credits must be held in an account in the central trade database, the Trade Tracking System. This allows credits to be easily transferred to another account in the system or deducted as part of the monthly compliance process with the point source's NPDES permit limit. Trade recording and trade brokering were determined to be activities best undertaken by the private sector. This system (with periodic audits by the Idaho Department of Environmental Quality) will be run by a newly established nonprofit group, the Idaho Clean Water Cooperative, whose board members are stakeholders in the Lower Boise watershed, including municipalities, agriculture, irrigation districts, and the environmental community. (In the future, the Idaho Clean Water Cooperative may also decide to take on the trade tracking functions for other watersheds in Idaho that decide to establish a water quality trading system.) The Idaho Clean Water Cooperative has also left open the possibility of establishing trade bulletin boards and bundling small sets of credits from individual nonpoint sources to attract point source buyers. Finally, as in the Acid Rain Program, it was decided that anyone should be able to purchase a credit for whatever purposes they choose; therefore, brokers, speculators, environmentalists, and other citizens may purchase credits from nonpoint sources and point sources and either resell them or retire them from the market.

Minimize the Government's Role

What became apparent in the design of the Lower Boise's trading system was that the type of work required to determine what constitutes a valid trade at the outset of trading should be recognized as comparable to the work that would be done to determine the validity of a trade if it were submitted at the time of the trade for government approval. The information the regulator has at the time of the trade is likely no more complete or precise than it would be at the outset of the trading system, except for more current water quality conditions at the site where the credits are proposed to be used. Although the analysis would be the same, the overall level of effort would be greater, because it is customized to each proposed trade, rather than spent up front to build a system that addresses conditions throughout the watershed. The emphasis on the prevention of potential localized impacts and the tool used to set an upper bound on the point source's limit would be the same in either case, but the outcome would be different. This is because a case-by-case approval process would prohibit the last trade submitted to the regulator for approval that puts the river over its assimilative capacity. Such a situation puts the regulator in the position of controlling the market and determining which trades get recorded based on the order in which the trades are submitted and the level of analysis the regulator chooses to perform. This type of program is more likely to result in less economically efficient trades for no greater certainty in environmental outcome than a program that sets the trading conditions at the outset.

Therefore, in water quality trading, the role of the government should be to establish the environmental goal by issuing the TMDL or an equivalent regulatory driver, granting permits with the pollutant limits that define the tradable commodity, and establishing the trading conditions at the outset. Such actions should be based on available data demonstrating the nature of the pollutant and its adverse environmental impact, the very basis of the TMDL. This work is extremely important because it affects how the market will develop. Because the establishment of the TMDL is not addressed in this article and the other aspects have already been discussed, we now focus on what is involved in defining the tradable commodity. Important factors to be considered when defining the commodity to be traded in the Lower Boise system include the *form* of the pollutant, locational *impacts*, and the role of *time* and *quantity* measurements:[23]

Form: The form of the pollutant relates to whether there are significant enough differences in the type of the pollutant being discharged by the various sources to warrant differentiation, or whether a generic version of the pollutant can be used as the tradable commodity. For the Lower Boise, total phosphorus was of concern, rather than its other forms, i.e., sediment-attached (usually discharged by agricultural sources) or dissolved (usually discharged by point sources). Therefore, the two forms of phosphorus should be considered equivalent for the purposes of trading. The permit limit is therefore set for total phosphorus.

Impact: As described earlier, the location at which the discharge or reductions of the pollutant occur can have an impact on the watershed and the trading system's ability to achieve the environmental goal. A set of location-based ratios was developed to account for these differences in impact. These ratios are specified for each point source in its permit.

Time: There are two aspects to the role of *time* as it relates to water quality trading. One is that the underlying reduction upon which the credit is based must occur in the same time period as when the credit will be used. This time period is determined by the TMDL and is based on consideration of seasonal hydrological flows and related water quality impacts. It also means that water quality trading programs should rarely allow "banking" of credits, i.e., the ability to save credits for use in another time period. In the Lower Boise trading system, credits are not created until the end of the month and rely on documentation that the reduction occurred during that month. Point sources can then only use credits generated in the same month to offset their discharge of the pollutant, and report those credits on the Discharge Monitoring Report at the end of the month.

Time is also a factor in the supply and demand of credits. The effectiveness of the reduction practices used to generate credits must occur at the same time that point sources will need credits. The Boise River TMDL for phosphorus will likely require reductions during the irrigation season of May through October, but it could require reductions year-round; however, most BMPs that agricultural nonpoint sources would undertake to generate credits are limited to the irrigation season because of their interaction with managed water flows and growing seasons. Therefore, if held to year-round reduction requirements, and if their own phosphorus discharge amounts do not vary with the season as well, point sources will need to look for credits generated by non-agricultural sources or consider installing treatment technologies themselves. The permit specifies the time period in which the pollutant limit and trading are applicable.

Quantity: While measurement methods for point source discharges are well established and specified in the NPDES permit, measurement methods for quantifying nonpoint source discharge and reduction amounts are far less known. The development of a BMP List that includes the approved measurement and estimation methods as part of the BMP description is an important step in defining the tradable commodity and alleviates much of the uncertainty regarding what constitutes a valid reduction.

As is evident from the above discussion of the Lower Boise's trading framework, the inclusion of nonpoint sources introduces significant complexities to a trading system. These sources, however, offer the majority of low-cost options to reduce, which would ensure that the environmental goal is achieved in the most cost-effective manner. Given this, much effort must be devoted to the design of the procedures for approving trades up front in order to ensure achievement of the environmental goal while promoting the most economically efficient means to meet this goal. Although not yet tested through implementation, the Lower Boise's trading system offers hope that water quality trading can achieve its full cost-savings potential.

Conclusion

Water quality trading is an important tool for regulators to use in helping a watershed achieve its environmental goals at lowered cost; however, the "offset" trading model currently being used in nearly all water quality trading projects has stifled the potential of these projects to maximize cost savings, due to the cumbersome and costly process of modifying a permit to incorporate a single trade. By discouraging trades through such high transaction costs, water quality trading is failing to meet the expectations of both regulators and stakeholders as a useful means to achieve the environmental goal at less cost. This article proposes a new model for water quality trading by examining the Acid Rain Program's successful trading system for insights into how it structured its trading system to support the two basic trading principles. Although there are significant differences between the Acid Rain Program's cap and trade model and water quality trading, the Lower Boise River trading program shows how these lessons can be transferred to develop a new approach to water quality trading.

There are several important design features of the Lower Boise River trading system that support viewing the pollutant as a tradable commodity. One is a list of approved BMPs that can be used to generate nonpoint source reduction credits and assign liability to the point source using the credit, while providing the regulatory information needed to best manage that risk up front in private contracts between the trade partners. Another is the achievement of the watershed's environmental goal at less cost, which is supported by (1) using a permit with a flexible limit that is automatically adjusted with each trade recorded in a central Trade Tracking System, (2) establishing credits from nonpoint sources after the reduction has taken place, and (3) establishing location-based ratios for ensuring environmental equivalency of the trades.

Unfortunately, an evaluation of the Lower Boise's trading system is not yet possible to determine how well it will fulfill its potential, due to a delay in the development of its prerequisite TMDL. Once the TMDL is approved by the USEPA (which is expected in 2005), then the NPDES permits for the point sources will be prepared, a public comment period held, and the permits issued with language authorizing trading consistent with the system described previously. To ensure that sufficient data will be available, several years of trades should occur before any vigorous analysis is conducted on the success of the program; however, USEPA and the Idaho Department of Environmental Quality, to fulfill their regulatory obligations, will likely conduct audits of several of the permittees' trade transactions soon after they occur. The audit results will provide an early indication of the system's performance and the permittees' ability to comply with the program's requirements. The USEPA and Idaho Department of Environmental Quality economists and water quality specialists will also be interested in studying how the trading system performs once it is launched, in order to help determine future policy and design recommendations for water quality trading. The Lower Boise River project will be considered successful if it fulfills the promise of its new model for water quality trading, demonstrating a robust trading system in which many stakeholders choose to participate and achieving important environmental goals for the watershed at significantly less cost.

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Notes

1. For a specific discussion of how water quality trading aligns with the Clean Water Act, see USEPA's *Water Quality Trading Policy*'s Section III (F), http://www.epa.gov/owow/watershed/trading/tradingpolicy.html.

2. For example, see L. Shabman, K. Stephenson, and W. Shobe, 2002, "Trading Programs for Environmental Management: Reflections on the Air and Water Experiences," *Environmental Practice* 4(3):153–162; D. M. King and P. Kuch, 2003, "Will Nutrient Credit Trading Ever Work? An Assessment of Supply and Demand Problems and Institutional Obstacles," *Environmental Law and Review* 33:10352–10368.

3. For example, see P. Faeth, 2000, *Fertile Ground: Nutrient Trading's Potential to Cost-Effectively Improve Water Quality*, World Resources

Institute, Washington, DC, available at http://pubs.wri.org/pubs_description.cfm?PubID=2690.

4. United States Environmental Protection Agency, 2003, *Final Water Quality Trading Policy*, http://www.epa.gov/owow/watershed/trading/finalpolicy2003.html.

5. D. L. Hoag and J. S. Hughes-Popp, 1997, "Theory and Practice of Pollution Credit Trading in Water Quality Management," *Review of Agricultural Economics* 19(Fall/Winter):252–262.

6. King and Kuch, 2003, "Will Nutrient Credit Trading Ever Work?"

7. J. H. Dales, 1968, *Pollution, Property, and Prices*, University of Toronto Press.

8. R. N. Stavins, 2000, "Market-Based Environmental Policies," in *Public Policies for Environmental Protection*, M. A. Toman, ed., Resources for the Future, Washington, DC.

9. For example, see S. Benkovic and J. Kruger, 2001, "To Trade or Not to Trade? Criteria for Applying Cap and Trade," in *Optimizing Nitrogen Management in Food and Energy Production and Environmental Protection: Proceedings of the 2nd International Nitrogen Conference on Science and Policy, The Scientific World* 1; R. N. Stavins, 1998, "What Can We Learn from the Grand Policy Experiment? Lessons from SO_2 Allowance Trading," *Journal of Economic Perspectives* 12(3):69–88.

10. For example, see Hoag and Hughes-Popp, 1997, "Theory and Practice of Pollution Credit Trading in Water Quality Management"; King and Kuch, 2003, "Will Nutrient Credit Trading Ever Work?"; Shabman, Stephenson, and Shobe, 2002, "Trading Programs for Environmental Management."

11. For more information about the Acid Rain Program, see USEPA's Clean Markets Division Web site, http://www.epa.gov/airmarkets/arp/index.html.

12. For an explanation of the penalty amounts, see http://www.epa.gov/airmarkets/arp/reconcil/index.html#out. The penalty amount was $2,000 per ton and indexed to the Consumer Price Index when the rules were issued in 1990; as of 2001 the penalty had increased to $2,774.

13. A. D. Ellerman, 2003, *Lessons from Phase 2 Compliance with the US Acid Rain Program*, Working Paper #WP-2003–009, MIT Center for Energy and Environmental Policy Research, Cambridge, MA.

14. For more information about the opt-in program, see the Acid Rain Program Web site, http://www.epa.gov/airmarkets/arp/optin/index.html.

15. For more explanation, see the USEPA TMDL Web site, http://www.epa.gov/owow/tmdl/intro.html.

16. For a full description of the trading system and the collaborative process used, see the Idaho Department of Environmental Quality's Web site, http://www.deq.state.id.us/water/tmdls/lowerboise_effluent/lowerboiseriver_effluent.htm.

17. For the most current report on the status of the Snake River/Hells Canyon TMDL for phosphorus and the Lower Boise River TMDL for phosphorus, check the Idaho Department of Environmental Quality's Web site, http://www.deq.state.id.us/water/surface_water/TMDLs_Main.htm.

18. For examples of state programs, see New Jersey's Open Market Emissions Trading Program Web site at http://www.state.nj.us/dep/aqm/omet and Michigan's Air Emissions Trading Program Web site at http://www.michigan.gov/deq/0,1607,7–135–3310_4103_4194–10617–,00.html.

19. For links to information about these programs, see USEPA's water quality trading Web site, http://www.epa.gov/owow/watershed/trading/tradelinks.html.

20. The draft Lower Boise River Water Quality Trading BMP List was available for public comment through February 2004; check the Idaho Department of Environmental Quality's Web site at http://www.deq.state.id.us/water/wastewater/pollutant_trading.main/htm for its most current version.

21. See http://www.michigan.gov/deq/0,1607,7–135–3313_3682_3719—,00.html.

22. See http://www.cherrycreekbasin.org.

23. These factors are also discussed in the USEPA document *Water Quality Trading Assessment Handbook: Region 10's Guide to Analyzing Your Watershed*, available on the USEPA Region 10 Web site, http://www.epa.gov/rhr 10earth.

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