

Lessons about Effluent Trading from a Single Trade

by

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Abstract: Despite many years of existence, programs that allow transferable discharge permits to control water pollution have had quite limited success. This paper discusses a single trade that recently took place in the Lake Dillon drainage basin between point and nonpoint pollution sources. This trade demonstrates many of the challenges that are faced in effluent trading but also highlights the potential efficiency gains that can be achieved through such programs.

Key words: Nutrient contamination, Transferable permits, Water pollution

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I. Introduction

Market-based programs for the control of pollution are rapidly on the rise in the U.S. Not only are SO₂ permits bought and sold on the Chicago Board of Trade, but volatile organic compounds, nitrogen oxides and other air pollutants are traded in local markets throughout the country. Markets that involve the trading of water pollution rights are also growing in number and scope. In 1996, the U.S. Environmental Protection Agency (EPA) released a draft framework for water pollution trading that implicitly sanctioned the development of such programs. A recent report to the EPA lists sixteen market-based programs for the control of water pollution that are in various stages of implementation and nine more programs that are under development (Environomics 1999).

Despite this burgeoning interest in effluent trading, the experience with trading is quite limited. According to the Environomics report (1999), less than ten trades have actually taken place in the nation's entire history of effluent trading.¹ Only one or two trades have taken place in each of the trading programs that have been in existence for more than a decade. The experience suggests that there are characteristics of water pollution problem that pose serious barriers to trading.

In this paper we tell the story of a single trade in one of the nation's oldest water pollution trading programs, the program established to control phosphorous loading into Lake Dillon Reservoir in Colorado. The story is interesting because it highlights many of the institutional challenges that water pollution trading programs face and helps us understand why water pollution trades have been quite limited to date. However, this trade also demonstrates the potential benefits of pollution trading. From this single trade, therefore, numerous insights can be gained on the future of water pollution trading.

II. The challenge of effluent trading

The notion that markets might be used to allocate the pollution load between multiple sources is attributed to Crocker (1966), Dales (1968) and Montgomery (1972). Since that time, the principle that markets can reduce the cost of achieving environmental goals has become a centerpiece of environmental economics (e.g., Baumol and Oates

1988; Tietenberg 2000). These theoretical ideas began to make inroads into policy in the 1970s. In 1975 the EPA began to authorize limited emissions trading in air contaminants; offsets were incorporated into the Clean Air Act (CAA) in 1977; a variety of programs were created during the 1980s; and in the 1990 amendments to the CAA a variety of trading systems were created, including a nationwide market for sulfur dioxide credits.

While air pollution markets gained momentum, markets in water pollutants have largely stagnated. The earliest application of water pollution trading was the Fox River program in Wisconsin, which was authorized in 1981 following on predictions of substantial cost savings (David et al. 1980). Despite the high hopes invested in that program, however, it was not until 1995 that a successful trade was completed (Jarvie and Solomon 1998). The inactivity in the Fox River market is mirrored in virtually every other effluent trading program in the country (Environomics 1999). Where effluent trading has been authorized, very few transactions have actually been carried out. With few trades, it seems likely that the cost reductions generated through trading are minimal.

The relative ineffectiveness of effluent trading programs can be traced to both physical and institutional characteristics of the water pollution problem. Unlike many air pollutants, it would be an egregious error to treat water pollution as uniformly dispersed over a wide area. Water pollutants flow downhill within a single watershed and concentrations change over time. This creates two problems for effluent trading. Unlike air pollutants that often drift over a rather large region, water pollution problems are confined to a watershed. Hence, the number of potential participants in an effluent trading market is usually quite restricted. As a result, polluters have limited ability to find suitable trades and the resulting markets can be “thin”, in which prices can be manipulated by a few traders.

Secondly, the environmental impacts of water pollution can be highly variable depending upon the point of discharge. This creates real concerns that trading could lead to localized pollution problems or “hot spots,” which would be a direct violation of the Clean Water Act (CWA). Because of these concerns, toxins from point sources, which have long been subject to stringent regulations, are typically not appropriate for trading. Water pollution trading is most appropriate for pollutants where damages are associated

with accumulated loads, particularly nutrients. However, this introduces a complication because nutrient contamination is generated to a large extent by nonpoint sources from which pollution cannot be easily monitored. Effluent trading, therefore, is most appropriate from a physical perspective where it is most difficult from a regulatory perspective.

When a trading program includes nonpoint sources, substantial difficulties arise. Because nonpoint source pollution cannot be measured (at reasonable cost), effluent trading programs that involve nonpoint sources uniformly quantify load reductions based on the implementation of best management practices (BMPs). Ribaudo, Horan and Smith (1999) list three main problems with this approach: monitoring and enforcement costs are quite high; predictions of loads are likely to either be expensive or imprecise; and legal conflicts may arise between the estimated pollution reductions achieved through the trading program and the actual reductions required by the CWA. Despite these limitations, there appear to be few if any alternatives to calculating credits for nonpoint source reductions based on predicted loads. As a result, point-nonpoint trading programs have been encumbered by reporting and monitoring requirements that lead to high transaction costs, and high trading ratios that discount the value of pollution reduction credits.

Transferable discharge markets for water pollutants, therefore, face significant challenges. Water quality markets are typically small in size, the damages associated with different sources often vary substantially, and the markets often involve nonpoint-source pollution. As a result of these difficulties, programs to date have not generated a convincing record. Given the investment of agency time that is required to set-up and monitor water quality trading programs, there is certainly reason to wonder if this regulatory approach is worth the effort.

III. The Lake Dillon effluent trading program

The pollution trading program in Colorado's Lake Dillon watershed is the second oldest effluent trading program in the nation. Nestled in the towering Rocky Mountains, the Lake Dillon area attracts thousands of tourists each year from all over the world to the nearby ski areas and other recreational attractions. It is an area where pristine natural

beauty is on display and maintaining that beauty is critical to the region's economic vitality.

In the early 1980s there was growing concern about the water quality in Lake Dillon. A maximum load analysis was conducted in 1982, and a cap was placed on the total phosphorous loads from point sources that could enter the lake. Through modifications in the point sources' National Pollutant Discharge Elimination System (NPDES) permits, the obligation to meet the cap was distributed between the point sources in the region, primarily to four municipal wastewater treatment plants.² Two years later the State Water Quality Control Commission sanctioned an innovative program in which point sources could increase their annual allowable phosphorous discharges in exchange for activities that reduced phosphorous from nonpoint sources elsewhere in the lake's drainage basin. The purposes of the trading program were twofold: to allow growth without jeopardizing environmental quality, and to begin controlling the growing nonpoint source pollution problem in the valley.

The design of the Dillon program has a number of features that have consequences for its environmental and economic performance. These features are summarized in Table 1. The program prohibits point sources from trading surplus pollution allowances and has no provisions that allow the banking of nonpoint source credits for future sale. Together these features diminish the incentives for point sources to abate phosphorous, either through upgrades in their own plants or by early reductions in advance of trades. Additionally, a 2:1 trading ratio is imposed requiring two pounds of phosphorous reduction for each credit to be used by a point source effectively raises the price of trades and diminishing the demand. On the other hand, one feature of the Dillon program greatly facilitates trading. Nonpoint pollution in the region is generated primarily by privately owned septic or Individual Sewage Disposal Systems (ISDSs). Although the exact load reduction that might be generated by switching a home from a to a waste water treatment facility cannot be known, studies in the early 1990s estimated that ISDSs generate an annual average of 200-250 grams per person, or approximately one pound per home (Ray 1999). The one pound per home standard became a basis on which trading could easily proceed, greatly reducing transaction costs when a trading opportunity became available.

Despite being allowed since 1984, until 1999 no trades took place under the Lake Dillon trading program. The absence of trades can be attributed to two factors. First, trades did not take place because of an absence of demand. Following the 1982 study plants throughout the valley upgraded their water treatment facilities in the early 1980s, reducing loads far below the cap; phosphorous loads from point sources dropped by 86% between 1981 and 1991 (U.S. Environmental Protection Agency). As a result, while in 1980 it appeared that demand for credits might be strong, within two years the plants were all well below their caps, effectively eliminating demand in the market.

The lack of immediate scarcity would not necessarily have eliminated interest in nonpoint source reduction if firms could have generated credits in the short run, anticipating that they might be able to sell those credits in the future. However, as noted in Table 1, the Dillon trading program does not allow such trades. While a point source can increase its own NPDES permit by reducing nonpoint pollution, once such credits are recognized, they are incorporated into that point source's discharge permit and can no longer be transferred to other sources (State of Colorado Water Quality Control Commission). Hence, except for two nonpoint pollution reductions that were carried out by Breckenridge, the trading provisions of the program have gone entirely unused.

It appears that the restrictions on trading between point sources reflect the cautious support that regulators have given to trading. While there is an appreciation that trading might reduce costs and provide incentives for nonpoint source pollution, regulators also seem to be uncomfortable with the use of market mechanisms to move pollution rights between sources. The "commoditization" of pollution rights is avoided. Rather, regulators in the program believe that the right to a pollution-free environment is held by the community, and limited rights to pollute are then granted to the polluters (personal communication, Robert Ray, Northwest Colorado Council of Governments, 12/22/99). That is, the right to pollute is not a commodity that can be freely traded between polluters. If a source seeks to expand its pollution, it must compensate the public (in this case through nonpoint source reductions) rather than compensating other sources.

There is reason to believe that some of the restrictions that the regulators have imposed on the program have been counterproductive. Although point source discharges

have fallen sharply, nonpoint sources loads have risen as a result of development in the community and expansions at the nearby ski areas. Total phosphorous loads into Lake Dillon in 1998 loads were estimated to be at 85 to 90 percent of the cap (personal communication, Robert Ray, Northwest Colorado Council of Governments, 12/22/99). ISDSs are the leading anthropogenic source of phosphorous. Loads from these systems are predicted to increase by more than threefold when the region is fully developed (Summit Water Quality Committee 1995). Since investment in credits for future sales is not possible, as long as the point sources are below their caps, demand for credits generated by nonpoint source reductions will be limited.

A. The Copper Mountain-Frisco trade

Until 1999 no trades had occurred under the Dillon program.³ Wastewater treatment plants had no need to increase their permitted loads and speculation in nonpoint source credits was not allowed. Even Copper Mountain, which was closest to its NPDES permitted level, was emitting only 35% of its permitted level in 1993 (Summit Water Quality Committee 1995).

Demand for credits finally arose in 1997 when Intrawest, a Canadian based developer and operator of village-centered ski resorts, purchased Copper Mountain ski resort. According to company documents, Intrawest's business plan focuses on creating a "direct relationship between leisure activities on and around the mountain and the village at its base - a village with entertaining shops, great restaurants, first-class lodging and no cars" (Lamphier 1999). Development of the base area, including lodging, restaurants and other services is, therefore, central to Intrawest's plans for Copper Mountain.⁴ The firm's plans include an additional 1,000 residential units and 80,000 square feet of commercial space (Mountain Zone 1996).

This expansion in the district's housing is expected to lead to much greater volumes of wastewater and, without some action, would likely result in phosphorous discharges in violation of Copper Mountain's NPDES permit. The phosphorous limit, therefore, was positioned to create serious problems for Intrawest's growth plan. The district developed a plan that included upgrades at the wastewater treatment plant but loads were still anticipated to be forty pounds above the NPDES permit. Intrawest's

expansion plan, therefore, created the demand for phosphorous credits that had not existed during the pollution trading programs' first sixteen years.

Since all the other plants in the Lake Dillon valley were generating phosphorous far below their permitted levels, one might expect that it would have been relatively easy to negotiate a transfer from another plant. However, because the rules did not allow trading between point sources, the only option available was to identify nonpoint source reductions that would qualify for trading. Further, because the program imposes a trading ratio of 2:1 on all trades, a total of eighty pounds of phosphorous needed to be abated.

Copper Mountain began to look for opportunities to purchase the credits elsewhere in the valley. The first project considered would have compensated the Breckenridge Sanitation District for the placement of sewage lines to a long-proposed housing development. The cost of this project, approximately \$2 million, was to be passed onto Intrawest through increases in the connection fees associated with the new housing units (Personal communication, Elizabeth Black, 4/6/00). While substantial, this anticipated cost was relatively small compared to the investment of over \$300 million that Intrawest expects to make during the first decade of its involvement with the area (Mountain Zone) and Copper Mountain began planning to carry out the Breckenridge proposal.

Several months after planning for the Breckenridge project was underway, Butch Green, Manager of the Frisco Sanitation District, offered an alternative and more economical plan. Green offered to provide incentives to homeowners to change from their existing ISDS to treatment at Frisco's water treatment facility. The proposal was for Copper Mountain to pay the homeowners' \$6,000 system investment fee, substantially reducing the cost of connection that typically runs \$11,000 to \$16,000 not including the cost of the line from the service line to the home. Based on the one pound per home standard, and taking into account the 2:1 trading ratio, the necessary forty credits could be generated by hooking up 80 homes to Frisco's treatment system. This project would reduce Copper Mountain's cost to under \$500,000, saving Intrawest \$1.5 million.

Not surprisingly, the proposal was quite attractive to Copper Mountain and was quickly approved. Potential homes were contacted by mail. And after two mailings,

exactly eighty commitments were obtained. The project was completed in 1999 and the expansion in Copper Mountain's phosphorous permit was granted, thereby completing the first trade in the nearly twenty year-old Lake Dillon program.

B. Impacts of the trade

The Copper Mountain-Frisco is a clear example of the benefits that can come from pollution trading. The benefits to Intrawest are clearly financial. The profits that Intrawest hopes to earn from the Copper Mountain development depended upon the ability to purchase credits. Once the firm had invested in the resort, it was willing to pay \$2 million for the needed phosphorous credits. The \$500,000 bill for the Frisco credits was a bargain. Although the Frisco Sanitation District is not a profit-maximizing agency, it also benefited economically from the trade. The additional homes expanded their operating base of support and increased the funds that can be drawn on for future expansions in their facilities. Finally, for the homeowners that participated in the program, the trade significantly reduced the cost of converting from a septic system to the convenience of the town's water treatment plant.

The trade also appears to have led to environmental gains. Because of the 2:1 trading ratio, if the scientific analysis is correct the trade should lead to a net reduction of forty pounds per year into the lake. Furthermore, according to Green some of the homes that participated in the program had sub-standard ISDSs (personal communication, 12/22/99). Since it is likely that the phosphorous run-off from these systems was above average, the trade probably generated phosphorous reductions in excess of the predicted eighty pounds per year. On the other hand, not all the homes that were connected to the town's sewer system would have continued to use their septic systems indefinitely. In fact, some of the homes had already negotiated to be connected to Frisco's system when the Copper Mountain trade was initiated. Green estimates that about 20% of the homes would have voluntarily connected to the system in the next five years. As a result, some of the phosphorous reductions that were recognized and credited would have been generated even in the absence of the trade.

As an interesting aside, it is worth noting that there are a host of environmental and social problems that are associated with economic growth; water pollution is only

one of these. The market for water pollution rights has created a means by which economic growth can be achieved without sacrificing water quality. However, it does not address any of the other negative impacts such as increased air pollution and congestion that the region may suffer as a result of Copper Mountain's expansion. Hence, in a classic example of second-best principles at work (Laffont 1988), although efficiency in one dimension might have been achieved, we cannot say unequivocally that this has resulted in a socially superior outcome.

IV. Lessons learned

The Lake Dillon case study provides a good example of the prospects and limitations for water pollution trading. We find in this case five lessons for effluent trading markets: 1) resistance to the idea of making pollution a transferable right is persistent and continues to hinder the performance of pollution markets, even in programs that have existed for many years; 2) the objectives of polluters are often not limited to simple cost minimization and, as a result, the policy implications that follow from the cost minimizing model may not always hold; 3) point source NPDES restrictions remain the primary vehicle through which demand for pollution credits is created; 4) when rules are well established and widely understood, and market participants are well acquainted with each other, transaction costs can be slight relative to the gains and 5) water pollution markets may be far from ideal, generating few and infrequent trades, but the option of trading has the potential to offer substantial benefits: improving the environment, allowing for economic growth and benefiting many in the community.

The first lesson that we find in the Lake Dillon program is that there remains among those who regulate the region's environmental problems a reluctance to treat pollution reduction as a transferable right. Environmentalists have long had ethical concerns with the use of transferable discharge permits. First, there is resistance to the granting of private rights to pollute the environment, which is viewed as a community asset. This perspective is embodied in the 1990 Clean Air Act that defines a pollution allowance as a "limited authorization to emit ... [that] does not constitute a property right" (104 Stat. 2591). Despite this limitation, the Clean Air Act does explicitly

authorize and provide rules for trading of air pollutants. Such authorization is lacking in the CWA. Each new effluent trading program must address local environmental concerns by groups that are relatively unfamiliar with the concept of trading. The result can be highly restrictive rules on trading. Second, some environmentalists argue that market-based approaches to pollution reduction are ethically flawed. Goodin (1994), for example, has likened market-based approaches to pollution control to the medieval practice of selling indulgences as an alternative means of achieving God's forgiveness. According to this view, pollution is a sin and payment, whether to the government or another source, is an inappropriate way of atoning for that sin.

Either of these ethical perspectives can lead regulators to place restrictions on the transferability of credits. This is what we find in the Dillon case. The program prohibits banking of credits and as recently as 1996 a proposal to allow point source trading was rejected (State of Colorado Water Quality Control Commission). Robert Ray of the Northwest Colorado Council of Governments, a major force behind the Lake Dillon program, explained that point-source trading has been prohibited because regulators saw environmental quality as a community right that is granted to different entities, not as a private right that can be exchanged like a commodity (personal communication, 12/22/99). Of course, there are complications associated with water pollution so that effluent trading programs face important design challenges; caution is justified. The Dillon program's restrictions on point sources, however, appear to be aimed at limiting the flexibility of those sources that are already largely controlled by regulations. These restrictions suggest a reluctance on the part of regulators to let market forces allocate pollution reduction responsibilities.

Since we find such resistance in Dillon's program, where the value of trading has been long recognized, it seems likely that resistance to trading will be at least as strong elsewhere in the nation. On the other hand, there is growing acceptance of pollution trading, even within the environmental community (e.g., National Wildlife Federation). Trades at the Lake Dillon Program elsewhere may convince the environmental community that a regulated market can be cost effective without jeopardizing environmental quality.

A second lesson of the Dillon program relates to the incentives that encourage polluters to reduce their loads. The models that have been used to study pollution trading typically present the source as a cost-minimizing firm for whom the pollution externality is of no concern. This model may be inappropriate in describing water pollution problems. Municipally owned wastewater treatment plants clearly have civic interests that are distinct from profit maximizing firms and may, therefore, willingly adopt pollution abatement. This might be part of the reason why point sources in the Dillon region dramatically reduced their pollution in the early 1980s, far below the levels required by the plants' NPDES permits.⁵ Such overcompliance is consistent with the hypothesis that the plants are not following the standard cost-minimizing model. It follows, therefore, that the policy recommendations that arise from cost-minimizing models may not be wholly accurate. For example, Hahn and Noll (1990) have argued that the ability to bank pollution abatement credits can provide an important incentive for pollution abatement activities even before trades are negotiated. But if no financial incentives for early abatement are needed, as was the case in the Dillon program, then crediting such reductions would have eliminated the need for the Frisco trade the nonpoint source reductions that were achieved.⁶ Had the opportunity for banking existed, a lower level of environmental quality might have resulted. The case study provides anecdotal evidence that the basic assumptions that provide the normative foundation for transferable discharge credits may be false in some important settings and, therefore, the outcomes of such programs may differ in important ways from the outcomes predicted theoretically.

The third lesson that we can draw from the Dillon case is the continued relevance of NPDES standards. While point-nonpoint trading represents a new vehicle by which to achieve nonpoint-source pollution reduction, the permits on point sources remain the primary enforcement mechanism through which pollution control objectives are pursued. Nonpoint source loads in the Dillon area have grown sharply over the last decade and are expected to increase further in coming years. Because of surplus point-source permits, there has been little incentive to reduce nonpoint source loadings. Copper Mountain is near its cap and future growth may require it to carry out additional trading. However, it is not clear that growth in the other districts will be sufficient to generate demand for

credits in the near future. In the absence of demand from point sources, the trading program does nothing to mitigate growth in nonpoint source loads. Without restrictions on nonpoint sources, only substantial downward revisions in the point sources' NPDES permits would create demand for nonpoint source abatement. Hence, if the lake's quality reaches a level that is deemed environmentally unacceptable, major policy changes will be required: either point source NPDES permits will need to be revised, or nonpoint sources will be regulated. Neither of these outcomes is politically palatable, but permit revisions would be more straightforward.

The fourth lesson learned from the Copper Mountain-Frisco trade is that the transaction costs associated with a pollution trading program may fall sharply over time. Transaction costs have often been identified as a major problem for effluent trading programs (Jarvie and Solomon). For example, recent trades negotiated in Minnesota have required years of negotiations, new scientific studies and significant government intervention (Senjem). In contrast, despite the absence of trades in the Dillon program, its long history created a fluid environment for trading when the opportunity arose. Prior research had provided estimates of the credits that could be achieved by converting ISDSs, participants were well aware of the possibility of trading and there was confidence that trades could be easily moved through the regulatory channels. Finally, the trading partners were accustomed to working with each other to address water management issues in the region. Together, these factors dramatically reduced the search and information costs so that agreeing to the terms of the trade involved little more than a few meetings and telephone conversations. As new programs begin to gather experience, they too should see a drop in transaction costs. Limited activity in the short run does not mean that a program will be unsuccessful in the long run.

The final lesson we draw from the Copper Mountain-Frisco trade is that water pollution trading can work in the "real world," but it will not necessarily look like the textbook ideal. The history of effluent trading has been one of disappointment; programs have generated few and infrequent trades and benefits have been slight. However, even when trading is not fluid or frequent, the option of trading can provide substantial benefits when demand arises. The Copper Mountain-Frisco trade demonstrates many of the theoretically predicted benefits of pollution trading. By allowing trading, the Lake

Dillon community has found a way to sustain economic growth without sacrificing the lake's water quality. Intrawest was able to carry out its expansion of Copper Mountain village. The Frisco sanitation district added additional customers to its system providing it with financial resources for future expansions and maintenance of its facilities. Eighty homeowners received a valuable service at reduced cost.

Despite the restrictions that are present in the Lake Dillon trading program and despite its long period of inactivity, a major trade has finally taken place that led to environmental gains while making the participants better off. While it seems unlikely that future trades will be numerous and frequent, the trade has shown that when the need arises, the trading option adds valuable flexibility for the control of water quality in the Lake Dillon area. Hence, this single trade helps give us a realistic impression of both the benefits and limitations of effluent trading and this is perhaps the most important lesson of all.

References

- Baumol, W.J., and W.E. Oates. *The theory of environmental policy*, 2nd. ed. New York: Cambridge University Press, 1988.
- Crocker, T. "The Structuring of Air Pollution Control Systems." *The Economics of Air Pollution*. H. Wolozin, ed., New York: W.W. Norton, 1966.
- Dales, J.H. *Pollution, Property and Prices*. Toronto: University of Toronto Press, 1968.
- David, M., W. Eheart, E. Joeres, and E. David. "Marketable Permits for the Control of Phosphorus Effluent into Lake Michigan." *Water Resources Research* 16(April 1980):263-270.
- Environomics. A Summary of U.S. Effluent Trading and Offset Projects. Report to Dr. Mahesh Podar, U.S. Environmental Protection Agency. Bethesda, MD. November, 1999.
- Goodin, R.E. "Selling Environmental Indulgences." *Kyklos* 47(1994):573-96.

- Hahn, R.W., and R.G. Noll. "Environmental Markets in the Year 2000." *Journal of Risk and Uncertainty*. 3(December 1990):351-67.
- Jarvie, M., and B. Solomon. "Point-Nonpoint Effluent Trading in Watersheds: A Review and Critique." *Environ. Impact Assessment Rev.* 18(March 1998):135-57.
- Laffont, J.-J., *Fundamentals of Public Economics*. Translated by John P. Bonin and H el ene Bonin. Cambridge, Mass.: MIT Press, 1988.
- Lamphier, G. "Interview with Joe Houssian, Chairman, President and Chief Executive Officer of Intrawest." *Resort Life* (Intrawest 1999 Annual Report, pages 9-11. Available online at www.intrawest.com/corporate/finreports/pdfs/e_itwar.pdf. Accessed on 10 April 2000.
- Montgomery, W. D. "Markets in Licenses and Efficient Pollution Control Programs." *J. of Econ. Theory* 5(December 1972):395-418.
- Mountain Zone. "Intrawest Acquires Whistler and Copper Mt. Resorts." December 18, 1996. Available online at mountainzone.com/ski/intraw.html. Accessed on 19 April 2000.
- National Wildlife Federation. *A New Tool for Water Quality: Making Watershed-Based Trading Work for You*. Montpelier, VT: National Wildlife Federation, Northeast Natural Resource Center, 1999.
- Ray, R. "Summit Water Quality Committee 1998 Annual Report." Unpublished report of the Northwest Colorado Council of Governments, Silver Creek, Colorado, July 1999.
- Ribaudo, M.O., R.D. Horan, and M.E. Smith. *Economics of Water Quality Protection from Nonpoint Sources*. Agricultural Economic Report number 782, Economic

- Research Service, United States Department of Agriculture: Washington, D.C., 1999.
- Senjem, N. "Point-nonpoint Source Pollutant Trading in Minnesota: Past, Present and Future." Unpublished Report. Minnesota Pollution Control Agency, Rochester Minnesota (no date).
- State of Colorado Water Quality Control Commission. "Dillon Reservoir Control Regulation 4.10 5 CCR 1002-17," amended May 13, 1996.
- Summit Water Quality Committee. "Lake Dillon Phosphorus Accounting System." Unpublished Report. Northwest Colorado Council of Governments, Silverthorne, Co., April 15, 1995.
- Tietenberg, T. *Environmental and Natural Resource Economics*. New York: Addison Wesley Longman, 2000.
- U.S. Environmental Protection Agency. "Draft Trading Update--December 96: Lake Dillon, Colorado" Available online at www.epa.gov/OWOW/watershed/trading/lakedil.htm. Accessed on April 10, 2000.

Table 1
Environmental and Economic Impacts of Rules
Governing Trading in the Lake Dillon Effluent Trading Program

Policy	Environmental impact	Economic impacts
Prohibitions on point-point trades	Increases demand for nonpoint credits but decreases interest in point-source abatement.	Raises abatement costs by prohibiting trading of surplus point-source rights.
Prohibitions on credit banking	Nonpoint reductions only valuable if a trade can be consummated immediately. Demand for nonpoint credits is reduced. Delays the development of nonpoint source abatement.	Eliminates incentive to invest in nonpoint credits.
2:1 Trading ratio	Each trade can lead to a net pollution reduction	Creates a wedge between buyers and sellers decreasing the market efficiency
Standardized credit rates for septic systems	Variability in actual pollution reductions is ignored. Can lead to either over- or under-compliance	Transaction costs are substantially reduced

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¹ The EPA report distinguishes offsets from trades where offsets involve a single participant while trades involve multiple participants. More than ten transactions have probably occurred if trades between point sources in the Tar Pamlico Basin are included (Malcolm Green, personal communication, August 6, 1999).

² As of 1996, the total cap was 718 kg/year and 96% of this was allocated to four major sanitation districts: Breckenridge, Copper Mountain, Frisco and Summit County's Snake River Sewer Plant (State of Colorado Water Quality Control Commission 1996).

³ Environomics (1999) reports two prior trades in the program. According to Lane Wyatt of the Northwest Colorado Council of Governments and the Summit Water Quality Committee (personal communication 4/19/00), both of these trades involved cases where Breckenridge Sanitation District (BSD) was granted additional credits to compensate for sewerage septic system. These transactions increased BSD's permitted load. However, since BSD's 1993 loads were less than 15% of its permitted level (Summit Water Quality Committee 1995), the value of these credits to them appears to be quite low. Hence, these earlier transactions were of a quite different nature than the recent Copper Mountain-Frisco trade discussed below.

⁴ Although the ski resort has been renamed Copper by Intrawest, the metropolitan district is still Copper Mountain.

⁵ Of course, the fact that point source pollution abatement is typically lumpy, i.e., purchased in large blocks, is also part of the reason for the reductions that the plants achieved.

⁶ Here we refer only to the banking of point source reductions. Had sources been able to bank nonpoint reductions this would have increased the incentive to control nonpoint pollution and may have delivered environmental benefits.