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# Protecting the City's Water: Designing a Payment for Ecosystem Services Program

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Studies of water utilities across the United States show that every dollar invested in watershed protection saves tens to hundreds of dollars in water treatment costs. The threats that watersheds face are numerous: pollution, development, fire, soil erosion, drought, flooding, and others. Payment for Ecosystem Service (PES) programs mitigate the risks posed to watersheds by linking the payment for hydrological services to consumers and using the resulting funds for conservation, restoration, and land acquisition projects. This article examines several examples of municipalities in the United States that have defined and valued their ecosystem services, developed agreements to guarantee these services, and established a payment mechanism. With an exception of one case, a common characteristic among the examples is that the need for a PES program was identified only after a catastrophic event in the watershed. These examples offer insightful lessons in implementing a PES program that provides a cost-effective means of protecting ecosystem services supplied by watersheds.

Ecosystem services are the conditions and processes of a natural ecosystem that provide benefits to people and communities. Typically, these benefits are not included in conventional markets and are thus unpaid for by recipients. Over the past few decades, research has demonstrated that healthy, forested watersheds provide numerous, economically important services to society. Municipalities, water districts, and other agencies are now aligning their economic and conservation objectives in ways that explicitly link the well-being of humans and the environment. Gretchen Daily & Pamela Matson, *Ecosystem Services: From Theory to Implementation*, 105 PROC. NAT'L ACAD. OF SCI. 28 (2008). PES programs have gained importance worldwide and provide clear economic incentives for environmental stewardship by landowners and promote greater awareness among consumers of the valuable services ecosystems provide. By allowing landowners to internalize societal watershed benefits, PES systems also promote landowner communication and collaboration with downstream stakeholders. As such, PES programs are often a more efficient and cost-effective method of achieving watershed protection compared to regulations alone.

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The concept of investing in watershed protection to maintain a water supply is not new. In 1889 the Great Seattle Fire destroyed the entire downtown business district and exposed many inadequacies in the City of Seattle's water-supply system. Shortly after the fire, voters approved bonds to finance construction of the Cedar River system, which continues to be Seattle's primary water source today. At the time, city leaders also formulated a plan to eventually acquire all land surrounding the entire 100,000-acre watershed and thus control all activities on those lands. One hundred years later, in the late 1990s, the city realized this plan for the Cedar River watershed, thereby securing Seattle's drinking water supply. Similarly, by investing \$1.5 billion over ten years to protect the Catskill and Delaware watersheds, New York City has avoided spending \$6 billion in capital and \$300 million in annual costs associated with constructing and operating a new filtration plant. S. L. Postel & B. H. Thompson, Jr., *Watershed Protection: Capturing the Benefits of Nature's Water Supply Services*, 29 NAT. RESOURCES F. 98-108 (2005). Thus, as shown by the City of Seattle and New York City, investments in watershed protection have eliminated the need to construct expensive treatment facilities.

The production of surface water for municipal use is an ecosystem service that is generally neither paid for by cities nor individual water consumers. Water consumers usually pay water companies or municipalities for the services of capturing, treating, and delivering water but not for producing the water. Therefore, the goods and services provided by healthy forested watersheds are of critical importance to water consumers. Among them, flow regulation; filtration; flood control; and protection against runoff, erosion, and sedimentation are critically important, especially in areas where precipitation comes in the form of heavy rainfall or snowmelt during the spring and summer seasons as in the Mountain West and Southwestern regions of the United States.

Unfortunately, watershed-protection efforts are often only undertaken in response to watershed degradation. One hundred years of fire suppression have rendered most western forests overcrowded, vulnerable to pests, and highly prone to stand replacement fires that strip steep slopes of soil protecting vegetation. The loss of forest cover decreases a watershed's capacity to regulate flow and control soil erosion. Research of the Los Alamos reservoir in New Mexico showed a dramatic spike in the sedimentation rate due to soil erosion following the Cerro Grande fire. A. Levine et al., *A Five-Year Record of*

*Sedimentation in the Los Alamos Reservoir, New Mexico, Following the Cerro Grande Fire*, LOS ALAMOS TECHNICAL PUB. LA-UR-05-7526 (2005), available at [www.fws.gov/fire/ifcc/Esr/Library/LARsedimentaton.pdf](http://www.fws.gov/fire/ifcc/Esr/Library/LARsedimentaton.pdf). The Cerro Grande fire burned one-third of the basin's mixed conifer forest (48,000 acres) surrounding the city in May of 2000. One year after the fire, reservoir sedimentation was 140 times higher than the previous fifty-seven years and remained significantly elevated throughout the five-year study period. Reservoir sedimentation reduces the quantity and longevity of water supplies and substantially increases filtration costs. In 2002, Trust for Public Land and the American Water Works Association conducted a study of twenty-seven water suppliers across the United States and demonstrated that water treatment costs increased significantly with progressive loss of forest cover. C. ERNST, PROTECTING THE SOURCE: LAND CONSERVATION AND THE FUTURE OF AMERICA'S DRINKING WATER 21 (Trust for Public Land 2004), available at [www.tpl.org/content\\_documents/protecting\\_the\\_source\\_04.pdf](http://www.tpl.org/content_documents/protecting_the_source_04.pdf).

Forest restoration treatments, such as thinning and prescribed burning, reduce tree density, encourage the growth of large, healthy trees and understory grasses, and decrease the risk of disease and fire. Vegetation management is critical to restoring forests, reducing the risk of fire, and maintaining water quality throughout the western United States. Following massive soil erosion caused by the 1996 Buffalo Creek and 2002 Hayman fires in Colorado, Denver Water was forced to undertake a program projected to cost \$31 million to remove sediment from mountain reservoirs and unclog pipes. The Colorado utility estimates that it has already spent more money clearing sediment that flowed into reservoirs after fires than would have been required to treat the areas before the fires. *Thinking Ahead on the Effects of Fire*, DENVER POST, Apr. 13, 2008, available at [www.denverpost.com/editorials/ci\\_8883332?source=bb](http://www.denverpost.com/editorials/ci_8883332?source=bb). Concerned that another major wild-fire could erupt in stands of dry, beetle-killed trees, Denver Water has approached legislators with the idea of imposing a "watershed maintenance fee" to help clean up forests to reduce the risk of future fires. *Id.* The fees would help offset the cost to remove beetle-killed trees, create fire breaks, and thin 20–30 percent of forest identified as critical to watershed health. *Id.*

To avoid a fate similar to Denver and Los Alamos, the City of Santa Fe is taking unprecedented, proactive measures to manage their watershed. The Santa Fe Municipal Watershed Restoration Project proposes to implement a PES program that (1) provides a sustainable stream of local funding to maintain the Santa Fe watershed, (2) educates the public about watershed management and the value of services supplied by a healthy watershed, and (3) encourages water conservation by consumers. The Santa Fe watershed case is unique in that the city is not yet facing pressures to build more treatment facilities; rather PES is sought to fund the maintenance of forest restoration activities as an insurance policy against future threats to the municipal water supply.

The two reservoirs that supply 40 percent of the water to

the City of Santa Fe are surrounded by Ponderosa pine and piñon-juniper stands that cover the lower canyon's steep walls on U.S. Forest Service (USFS) land. The upper watershed, comprising of 10,000 acres in the Pecos National Wilderness, is primarily mixed conifer forest that typically experiences infrequent but catastrophic stand-replacing fires. To date, nearly 6,000 acres of Ponderosa pine in the lower watershed have undergone thinning and some controlled burning to reduce fuel loads; however, the upper watershed remains untreated. The combined cost of thinning small diameter trees and controlled burning to reintroduce natural fire regimes ranges from \$1,000 to \$2,000 per acre. Personal communications with Ron Ortega, a forester with New Mexico Forest and Watershed Institute, and Naomi Engelman, the director of New Mexico Forest Industry Association, revealed that because of limited markets and the low value of the material thinned from these forests, restoration activities can be prohibitively expensive for land management agencies and private landowners. Therefore, the greatest risk to the Santa Fe watershed is uncontrolled fire in the untreated, mixed conifer stands, as well as management practices that fail to maintain recent forest restoration treatments in the lower basin—a scenario that is common throughout the western United States. The goal of the proposed Santa Fe PES program is to provide funding to the USFS for forest restoration treatments in critical areas of the Santa Fe watershed.

### *Developing a PES Program*

Numerous publications by nonprofit groups, such as the Trust for Public Lands, Forest Trends, and the Katoomba Group, offer guidelines for developing watershed PES systems. "Best practices" or key elements of a watershed plan include (1) understanding the watershed and prioritizing protection, (2) establishing partnerships with watershed stakeholders, (3) developing a comprehensive water protection plan, and (4) developing a "funding quilt." Ernst, *supra* at 28. Furthermore, in developing a watershed PES, the ecosystem service must be well defined, valued economically, and easily measured and monitored. Finally, a payment mechanism that fits existing institutional conditions must be set up. FOREST TRENDS, KATOOMBA GROUP, UNITED NATIONS ENVIRONMENT PROGRAMME, DEVELOPING MARKETS FOR WATER SERVICES FROM FORESTS: ISSUES AND LESSONS FROM INNOVATORS (2000) available at [www.forest-trends.org/documents/publications/Developing\\_Markets\\_for\\_Water\\_Services.pdf](http://www.forest-trends.org/documents/publications/Developing_Markets_for_Water_Services.pdf). We examine examples of PES programs across the country to explain the key elements and to identify critical steps in the development of a PES program.

In her Trust for Public Land study, Caryn Ernst recommends using maps and models to prioritize watershed management, which are not only useful planning tools, but also an effective means of communicating to the public the attributes of a watershed, including threats to watershed health. Prior to undertaking restoration treatments in the Santa Fe Watershed, the Española District of the Santa Fe National Forest

prepared an Environmental Impact Statement (EIS). The EIS assessed the potential impact of the prescribed thinning and burning on ecosystem function, based upon data collected by Forest Service personnel and studies of similar ecosystems in the region. Priorities for Santa Fe watershed protection were determined in a Forest Management Plan that divides the watershed into two planning zones upstream from the city's water-supply reservoirs (the upper Pecos Wilderness and Forest Service land). Even with the information contained in the EIS, questions remain concerning the impact of forest restoration treatments on hydrological flow, water quality, aquatic wildlife, and fire prevention in the region.

Comprehensive water-quality monitoring is another key to understanding watershed health and tracking the impact of land use change on water quality. Monitoring is an essential tool for adaptive management in areas where land managers are experimenting with innovative practices. Additionally, monitoring of river flow and water quality (sediment and nutrient loads) will be necessary to demonstrate to water consumers that they are receiving the services they are paying for under a PES program. In New Mexico, results from monitoring studies are made available to the public online through a data-sharing project conducted by River Source ([www.watershedwiser.org](http://www.watershedwiser.org)), an organization that involves communities, schools, and Native American tribes in local watershed monitoring, education, and restoration activities.

The City of Salem, Oregon, has learned the importance of partnering with federal and state land management agencies to achieve long-term water protection goals. Eighty percent of land in the city's primary watershed is owned by the USFS, the Bureau of Land Management (BLM), and the Oregon Department of Forestry (ODF). After declaring a water emergency following the 1996 North Santiam River flood, the City of Salem was forced to install a \$1-million pretreatment facility to lower turbidity levels that overwhelmed its sand filtration system. Timber harvesting and related road construction contributed heavily to soil erosion during the 1996 flood. B.T. Hill, *Oregon Watershed: Many Activities Contribute to Increased Turbidity During Large Storms*, U.S. General Accounting Office RECD 98-220, at 33 (1998). Since then, the city has worked closely with the USFS, BLM, and ODF to implement improved watershed-management practices. A Memorandum of Understanding, signed by all agencies, describes the city's watershed-protection goals. The city now participates in site assessments for all timber sales. In addition, the city created an online water-quality monitoring program in partnership with the United States Geological Survey. See <http://or.water.usgs.gov/santiam/>.

Public education and grassroots efforts to mobilize voters proved crucial to the success of the San Antonio Water System (SAWS) Land Acquisition Program (LAP). In 2000, voters in San Antonio, Texas, approved a bond measure that increased the sales tax by one-eighth percent to fund greenways around the city's sensitive creeks and land acquisition to protect the Edwards Aquifer. Ernst, *supra* at 27. Of four bond issues on the 2000 ballot, including measures to increase tour-

ism and attract new businesses, only the water-quality measure was approved. The measure raised \$65 million over four years and has preserved 10,000 acres of geologically sensitive land since 2000. A portion of the Water Supply Fee funds the LAP.

Critical to the maintenance of public confidence in its water supply and water supplier is transparency. For this reason, most publications, including those referenced in this article, recommend that proposed PES fees be made explicit to the public, following an aggressive outreach campaign. This underscores the importance of demonstrating to stakeholders that the benefits of the program are (or will be) greater than or equal to the costs of implementation. To quantify these benefits, agencies often point to the avoided costs associated with protecting watersheds.

A public outreach campaign should educate water consumers about the threats to water supply and demonstrate that proactive watershed-protection measures cost significantly less than alternatives associated with watershed degradation. This comparison necessitates an economic valuation on ecosystem services supplied by restoration or conservation efforts on watershed lands. There are several valuation techniques that could be used to accomplish this, but the valuation techniques relevant to most watershed-restoration situations are hedonic pricing, choice experiments, contingent valuation, benefits transfer, and replacement and avoided costs.

Contingent valuation is a commonly used method of estimating the values of nonmarket ecosystem services. In a contingent valuation study, researchers collect information via questionnaires on the amount respondents are willing to pay to protect a given resource or the amount they would be willing to accept to allow degradation of a given resource. A main limitation to contingent valuation studies is that they report people's willingness to pay based on stated preferences to hypothetical scenarios, which may be in contrast to the actual actions taken by respondents. A contingent valuation study of respondents' willingness to pay for a management plan that would protect water quality in the Catawba River Basin in North and South Carolina demonstrated a willingness by each taxpayer to pay \$139 annually for the management plan, totaling more than \$75.4 million for all taxpayers in the area. Jonathan Eisen-Hecht & Randall Kramer, *A Cost-Benefit Analysis of Water Quality Protection in the Catawba Basin*, 28 J. AM. WATER RESOURCE ASS'N, 453-65 (2002). The study determined that the potential benefits of the plan would outweigh implementation costs by more than \$95 million.

The benefit-transfer method calculates the values of ecosystem services at a site based on the results from hedonic, contingent valuation, travel cost, choice experiments, or other studies conducted elsewhere. For example, the value of watershed enhancement in Santa Fe might be calculated based on studies conducted on watershed enhancement in Denver, Colorado. A benefit-transfer study may save time and money, but the analysis will be less applicable if significant differences exist between the study site and the subject site.

The valuation method of avoided costs or replacement

costs has been used to justify several PES programs. Avoided or replaced costs are those costs associated with replacing ecosystem services provided previously by riparian areas or avoided as a result of enhancing natural areas. A striking example of avoided costs related to natural resource enhancement is the Charles River Natural Valley Storage Project, a U.S. Army Corps of Engineers project that helps control flooding in Boston, Massachusetts, by preserving nearly 7,000 acres in seventeen existing wetlands. Jim Morrison, *How Much Is Clean Water Worth?* 43:2 NATIONAL WILDLIFE (Feb./Mar. 2005). The Corps spent \$10 million in land and preservation easement purchases to accomplish its storage goal. This is 10 percent of the \$100 million that it would have cost to build a dam with similar storage capacity. The City of Boston also saves an estimated \$17 million annually in flood damage because of the project. In addition, an estimated 1.5 percent premium has been added to the values of homes in the area due to flood-protection and amenity values provided by the wetlands. In summary, the Charles River Natural Valley Storage Project saved taxpayers \$90 million in avoided capital costs and \$17 million in avoided damage costs and increased home values by 1.5 percent.

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## Key to a successful Payment for Ecosystems Services (PES) program is simplicity in all aspects of the program: design, implementation, and monitoring.

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A watershed-protection plan should incorporate everything learned from the analysis of the watershed (maps and models), partnerships, stakeholder participation, and economic valuation studies. A comprehensive watershed-protection plan will provide an effective strategy to protect ecosystem services, manage threats to natural resources, and fund conservation projects.

Key to a successful PES program is simplicity in all aspects of the program: design, implementation, and monitoring. A 2002 survey of sixty-one watershed-based payment schemes found that watershed markets are more institutionalized than other ecosystem services and rely on cooperative relationships between demand and supply. NATASHA LANDELL-MILLS & INA PORRAS, *SILVER BULLET OR FOOLS' GOLD: A GLOBAL REVIEW OF MARKETS FOR FOREST ENVIRONMENTAL SERVICES AND THEIR IMPACT ON THE POOR* (2002). Many watershed situations across the western United States are very conducive

to a simple PES program with suppliers of water (landowners within the watershed) linked to consumers through the municipal water divisions. A well-developed forest management plan will assist landowners and municipalities in projecting the future costs to consumers to maintain watershed services. The projected watershed maintenance costs can serve as the basis for valuing the ecosystem services "sold" under a PES scheme.

Implementing the strategy set forth in a watershed-protection plan will require a steady stream of funds. The development of a "funding quilt" is another "best practice" for implementing a PES program. The Hawkwatch project in Rockaway Township, New Jersey, is an excellent example of how a "funding quilt" with multiple sources can be developed. Ernst, *supra* at 43. The funding for this project reached over \$7 million to protect local water resources. Local property taxes in Morris County and Rockaway Township contributed \$1.5 million, supplemented by \$3 million from the state's Green Acres program with a mix of grants and loans. Private foundations contributed an additional \$1 million, and the federal Forest Legacy program and the state grant portion of the federal Land and Water Conservation Fund contributed another \$2 million. The success of this project demonstrates how multiple funding sources can be achieved through leveraging from one main source. New Jersey's Department of Environmental Protection has financed the implementation of various other projects through low-interest loans by combining federal Clean Water State Revolving Funds (CWSRF) with state funding. The monies available from the CWSRF are generally used to provide loans for wastewater treatment plants, but several states, such as New Jersey, have used the money to help local governments and nonprofits purchase watershed land, restore watersheds, and reduce flooding.

There are three general financial incentive mechanisms for PES programs in practice today. FOREST TRENDS, *supra*. [hereinafter FOREST TRENDS]. These include self-organized private deals, trading schemes, and public payment schemes. The most predominant in the world today is the public payment scheme. Financing can come from a variety of sources, including general tax revenues, bond issues, or user fees. Generally, negotiations between downstream and upstream governments, businesses, and citizens groups establish the incentives and mechanisms for the PES. Due to the public goods nature of hydrological services, publicly financed payments for ecosystem services are likely to remain the most common financial mechanism used to protect water-related ecosystem services.

Key elements to consider when developing a PES contract include the terms and type of payment; when, how much, how often, and to whom payments are made; the timing of payments when ecosystem service activities are carried out by a seller; payment requirements, such as monitoring, reporting, and verification; risk management through a clause detailing how risks are shared; and contract signatories affiliated with the buyer and seller. FOREST TRENDS, KATOOMBA GROUP, UNITED NATIONS ENVIRONMENT PROGRAMME, PAYMENTS FOR

ECOSYSTEM SERVICES: GETTING STARTED, A PRIMER (2008), available at [www.katoombagroup.org/documents/publications/GettingStarted.pdf](http://www.katoombagroup.org/documents/publications/GettingStarted.pdf).

### ***Application of PES Guidelines***

There is no blueprint for setting guidelines for PES programs. The best mechanism for a specific watershed is based on what the landowners are able to do to maintain the watershed and what the water users are willing to pay to maintain the ecosystem services provided by that watershed. PES programs can be effectively designed around providing sellers with financial incentives that would improve or maintain ecosystem services to the buyer at a lower cost than the available alternatives. Once the stakeholders are aware of the sensitive areas of a watershed, we recommend the following specific action items to ensure the creation and implementation of an effective PES program: (1) Calculate the economic value of water and other ecosystem services provided by the watershed to consumers as well as the cost to landowners for future watershed maintenance; (2) Negotiate contracts for long-term enhanced management of sensitive areas; (3) Conduct a far-reaching program to educate stakeholders about both the economic benefits and costs of any proposed watershed-management plan; (4) Build an extensive watershed-monitoring program that involves citizen groups,

and make the results available to the public; (5) Evaluate monitoring results frequently and use them as part of an adaptive management strategy; (6) Establish the preferred funding mechanism(s) (tax, bond, user fee), considering the legal and political implications of each. Choose mechanisms that fit within existing institutional conditions and seek additional sources of funding; (7) Maintain public trust by making all PES transactions transparent and explicit; (8) Share experiences of the PES program early and often, especially with decision makers and stakeholders; and (9) Consult guides, such as the *PES Getting Started Primer*, for more details about drawing up contracts, valuing resources, and selecting payment schemes.

The examples cited throughout this article show that PES programs can provide significant economical and ecological value to society. The examples also reveal that the catalyst for implementing protection measures in watersheds is often a damaging and costly event. Proactive implementation of a PES program, like what is being attempted in the Santa Fe watershed, is more efficient at preserving natural resources and can be accomplished with sound economic analysis of ecosystem services. Economic analyses will provide stakeholders and the public with an explanation for the degree of funding necessary to implement protection measures, as well as vital information for making decisions regarding watershed management. 