WRI ISSUE BRIEF

Southern Forests for the Future Incentives Series *Issue Brief 9*

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Insights from the Field: Forests for Water

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SUMMARY

- This issue brief describes analyses by the World Resources Institute (WRI) in support of emerging payments for watershed services (PWS) programs in two major watersheds in Maine and North Carolina and insights gleaned from work in progress. The three pilot initiatives discussed represent different approaches to establishing PWS programs that protect forests and other green infrastructure elements.
- In the Neuse River Basin in North Carolina, WRI is working with partners to identify beneficiaries and their water-related dependencies. We learned that clear documentation of the risks that beneficiaries face from water pollution, drought, and watershed degradation will help jump-start their participation in emerging PWS programs.
- In the Sebago Lake Watershed in Maine, WRI is finalizing a methodology for "green-gray" analysis that will provide beneficiaries a way to identify cost-effective green infrastructure solutions to water infrastructure demands of the 21st century. Green infrastructure comprises all natural, seminatural and artificial networks of multifunctional ecological systems within, around, and between urban areas at all spatial scales. We learned that, to convince public investment managers to invest in green rather than gray, it is important to make the financial and business case using the same basic methodologies that are used for calculating the costs and benefits of conventional gray approaches.
- WRI is also working to develop PWS programs that help the city of Raleigh meet streetscape, conservation development, tree conservation, storm water management, and water quality goals contained in its Unified Development Ordinance in a least cost manner. We learned that market-based solutions like PWS can play a large role in land-use planning processes and that these processes may represent a large untapped demand driver for PWS programs throughout the South.

In *Southern Forests for the Future* (Hanson et al., 2010), WRI profiled how forested watersheds of the southern United States provide a number of freshwater-related benefits to the region's citizens, communities, and businesses. For instance, forests act as sponges, intercepting rainfall and absorbing water through root systems. Through these processes, forests recharge groundwater supplies, maintain base flow stream levels, and lower stream peak flows during heavy rainfall or flood events. Forests help prevent impurities—mostly from nonpoint source pollution—from entering streams, lakes, and groundwater. Forests help keep soil intact and prevent it from eroding into nearby bodies of water. Furthermore, the numerous streams and lakes found in forests provide freshwater for hydroelectric power generation, recreation, domestic and industrial water supplies, and wildlife habitat.

PWS programs are one method that can be used to maintain watershed services by protecting forests and other green infrastructure elements (Hanson et al., 2011). Through a PWS program, landowners receive financial incentives to conserve, sustainably manage, and/or restore forests specifically to yield one or more watershed-related ecosystem services. Thus, PWS is an incentive for sustaining forests for water.

The Pilots

This issue brief summarizes analyses undertaken by WRI and its partners to set the stage for pilot PWS programs in the Upper Neuse Watershed in North Carolina, the Sebago Lake Watershed in Maine, and throughout the city of Raleigh. The brief also discusses insights gleaned to date from work in progress.

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Beneficiary Analysis of the Upper Neuse River Watershed

To advance PWS in the Upper Neuse River Watershed of North Carolina, WRI conducted a beneficiary analysis that identified major public and private water users of Falls Lake Reservoir. The beneficiaries identified so far include universities, food and beverage companies, electronic and semiconductor companies, and manufacturers of health care and textile products. WRI then prepared a preliminary assessment to assist these entities in identifying water risks that they may face in the years ahead, along with opportunities for economically beneficial investments in green infrastructure such as forest conservation and restoration.

Green-Gray Analysis in the Sebago Lake Watershed, Maine

For water utilities, PWS that protect "green" infrastructure like forests and riparian buffers can be a far more cost-effective approach for meeting water quality standards than building new "gray" infrastructure, such as filtration and wastewater treatment plants. Green infrastructure can also be considered as a complement to gray, helping to reduce overall operation costs, such as those associated with filtering sediments. Although there is no single definition, in a review of the literature Tzoulas et al. (2007) suggest that green infrastructure comprises "all natural, seminatural and artificial networks of multifunctional ecological systems within, around, and between urban areas at all spatial scales." To develop a model for comparing green versus gray infrastructure costs, WRI teamed up with the conservation organization Manomet Center for Conservation Sciences (Manomet) in Brunswick, Maine, to investigate a "green-gray" investment tradeoff facing the Portland Water District (PWD). PWD stands to lose its Environmental Protection Agency (EPA)-granted filtration waiver if water quality entering Sebago Lake deteriorates as a result of upstream development. If PWD loses the waiver, it would have to build an expensive new filtration plant. Thus, stakeholders in the Sebago Lake Watershed face a choice: They can invest in green infrastructure options that help retain forest cover and improve water quality or build an expensive new treatment plant.

City of Raleigh Unified Development Ordinance (UDO)

Land-use planning processes throughout the southern United States provide an increasingly important opportunity for advancing voluntary PWS incentive programs that ensure clean water supplies while protecting southern forests. The city of Raleigh's Unified Development Ordinance (UDO) is one such opportunity. WRI completed a regulatory analysis of the UDO that identified six opportunities for protecting forests and open space within and around the city through various payments for environmental services programs, including PWS. For example, the UDO's proposed storm water requirements can be implemented more cost effectively if they include an option for developers who cannot meet storm water runoff goals to purchase credits from others who protect and restore forests for their flood mitigation services above and beyond legal requirements in other areas.

Source: Western Foothills Land Trust
Scenic waters of the Crooked River, near Bolsters Mills. The Crooked River tributary accounts for more than 40 percent of the flow into Sebago Lake, the drinking water supply for the 200,000 residents and businesses of Portland, Maine.

Results and Insights to Date

The ultimate success of PWS programs depends on three core factors: (1) robust, long-term demand for watershed services from entities seeking lower cost ways to meet regulatory standards or from beneficiaries whose bottom line is enhanced by improved water quality; (2) a steady supply of watershed services generated by entities that protect and restore forests (or other forms of green infrastructure); and (3) an exchange infrastructure that also provides a means of verification, monitoring, and enforcement. WRI's analyses thus far have focused on building demand because, without it, supply will not materialize, and transactional infrastructure becomes superfluous. The following are some key insights that were gleaned for building demand:

Identify beneficiaries. Successful PWS programs are driven by demand from public and private entities whose operations depend on clean, reliable supplies of freshwater. Identifying these benficiaries and helping them understand the risks they may face if water quality, quantity, and/or flow are jeopardized by future land-use trends or harmful management practices is thus a key first step in lining up potential investors in green infrastructure protection through PWS programs.

In the Upper Neuse River Basin, WRI extracted top water users from a 2008 survey by news organizations researching impacts of the 2008 drought and researched water dependencies for the major economic sectors that these users represented. Residential users account for approximately 60 percent of the water consumed from the reservoir, making the water utility a key component of any PWS program. However, the region is also home to a number of other large public and private water users. Major public and private water users by type include—

- ***Public:*** North Carolina State University, the state of North Carolina, Wake County, the city of Raleigh
- ***Pharmaceutical:*** Ajinomoto, Mallinckrodt, Glaxo Smith Kline
- ***Healthcare products:*** Covidien
- ***Food and beverage:*** Pepsi Bottling Ventures, Cargill
- ***Electronics/lighting & semiconductors:*** Suntronics, Cree Industries
- ***Textiles:*** Alsco

These users have specific interests in a number of factors related to the supply of water from the water utility, including the cost, reliability, and quality of water supplied. Some users employ their own water treatment processes after purchase from Raleigh and may have an interest in further reducing the nutrient and sediment levels left behind by the water utility. The diversity of businesses dependent on water points to the need to look broadly at water users in a given watershed, verify their needs and interests in considering their water supply, and design PWS programs with specific users (or beneficiairies) in mind.

WRI, in collaboration with the Conservation Trust for North Carolina and Duke University's Nicholas Institute, is beginning to engage many of these primary beneficiaries. To help these entities understand the importance of green infrastructure and benefits of participation in emerging PWS programs, the project team developed a short synopsis of findings from the literature that illustrates various green infrastructure watershed

Source: Tar River Land Conservancy
The waterways of North Carolina offer premier recreational opportunities such as canoeing. Protecting the waters of the Upper Neuse is a challenge as rapid urban development affects forests and open space in and around the greater Raleigh-Durham metropolitian area.

management options for preserving water supply and quality (Rothacker and Mulligan, 2011). The synopsis addresses wetland and forest conservation, green agricultural practices (like low till techniques), and innovative storm water management options (Figure 1). For each practice, WRI identified watershed services provided, PWS case studies and opportunities, and applicability to the Upper Neuse. The next step is to work with beneficiaries to hone in on green infrastructure options most relevant for their particular circumstances.

Make the financial business case. A general interest in green infrastructure options and PWS is not enough to stimulate actual participation by public investment managers. The financial and business case needs to be clear and convincing in terms of either cost savings or net public benefits. In the Sebago Lake Watershed, WRI conducted a preliminary analysis of how the PWD and other stakeholders in the watershedcould minimize costs by investing in forests and other green infrastructure elements, rather than gray, to meet water quality goals in the decades ahead.

WRI first worked with Manomet and other partners to identify potential green infrastructure options that would help maintain or improve water quality flowing into Sebago Lake with respect to four pollutants of concern: *Giardia lamblia*, *Cryptosporidium*, turbidity, and fecal coliform—the latter two of which are the basis for PWD's filtration waiver. Upstream land-use practices affect the presence and concentrations of these pollutants. For example, increases in agricultural land and the intensity

FIGURE 1 **Green Infrastructure Options and Benefits in the Upper Neuse River Basin**

Benefit → Practice ↓	Improved Overall Water Quality	Reduced Nutrient Loading	Reduced Sedimentation/ Turbidity	Increased Water Supply	Lower Flood and Drought Risk	Habitat and Aesthetic Co-benefits
Wetland Conservation	●	●	●	▲	●	●
Forest Conservation	●	●	●	▲	●	●
Green Agricultural Practices	●	●	●	▲	▲	▲
Green Storm Water Management	●	●	●	▲	●	▲

● = Yes ▲ = Under certain circumstances

of agriculture have been correlated with increases in all four pollutants, while impervious surface area and construction activity have a direct bearing on turbidity (Tarver, 2008; Hayes and Osmond, 2005).

The green infrastructure options considered have an overall goal of retaining or enhancing forest cover, reducing risks of road failures, and promoting more sustainable agricultural and forestry practices. After consultation with stakeholders, five options were selected as priorities, based on overall feasibility (economic, technical, landowner receptivity). The options include conservation easements, forest certification, riparian buffers, culvert replacements, and reforestation. Each of these options has well-established benefits for downstream water quality. For example, reforestation, conservation easements, and forested riparian buffers will all help retain the Sebago Lake Watershed's extensive forest cover. There is a well known relationsip between the share of forest cover and downstream filtration costs related to sedimentation and turbidity, although many other factors such as soil type, intensity of land use, and patterns of development also have influence. For example, the Trust for Public Land and the American Water Works Association in 2002 found that more forest cover in a watershed results in lower water treatment costs. According to the study, for every 10 percent increase in forest cover in the source area, treatment and chemical costs decreased approximately 20 percent, and approximately 50 to 55 percent of the variation in treatment costs can be explained by the percentage of forest cover in the source area (Ernst, 2004).

After developing a portfolio of green infrastructure options, WRI compared the cost effectiveness of investing in these options over a 20-year period relative to the alternative investment in gray infrastructure—in this case, water filtration plant upgrades. Data were collected from a variety of sources, including spatial data on current and future land use, personal communication with local stakeholders, and a thorough literature review. Data collected were preliminary in nature and used mainly to illustrate the mechanics of green-gray analysis rather than presenting definitive results. A more detailed explanation of the methods, limitations, data sources, and findings is presented in Gray et al. (2011).

The preliminary results indicate that investment in a package of these green infrastructure options could represent a cost savings of $68 million or 51 percent, relative to the gray infrastructure option in the low-cost scenario, and savings of $72 million or 76 percent in the high-cost scenario in present value terms over a 20-year period (Tables 1 and 2, Figures 2 and 3). High- and low-cost scenarios reflect estimates at the high and low end of cost ranges, respectively, for all associated costs: labor, materials, capital, lost production, etc.

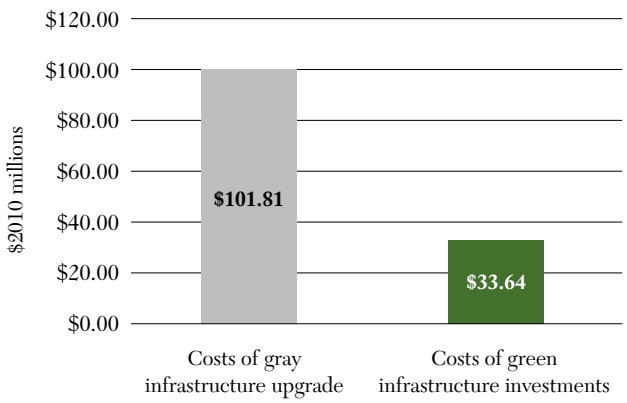
We also estimated the ancillary nonmarket benefits of two additional ecosystem services provided by forestland conservation, including carbon sequestration and landlocked salmon habitat provision. These benefits would be enjoyed broadly by all residents in the watershed who place a value on mitigating climate change and providing enhanced habitat for a regionally important species. Generating these public benefits can be seen as an important part of the mission of public entities such as PWD.

Carbon sequestration benefits were calculated by multiplying the additional carbon sequestration provided by reforested lands by a carbon benefit (based on the social cost of carbon) estimate of $25 per metric ton, a value explained in Gray et

Table 1 Green versus Gray Infrastructure Options for PWD — Low-Cost Scenario

Infrastructure Options	Quantity	Present Value Costs (millions)
Riparian buffers (acres)	367	$5.87
Culvert upgrades and replacements (units)	44	$1.77
Certification (acres)	4,699	$0.22
Afforestation/reforestation (acres)	9,395	$12.79
Conservation easements – 80% forest cover (acres)	13,215	$12.99
Green infrastructure total		$33.64
Gray infrastructure (membrane filtration) total		$101.81
Difference (green minus gray):		**-$68.17**

FIGURE 2 Low-Cost Scenario: Portland Water District Present Value 20 Year Investment Costs

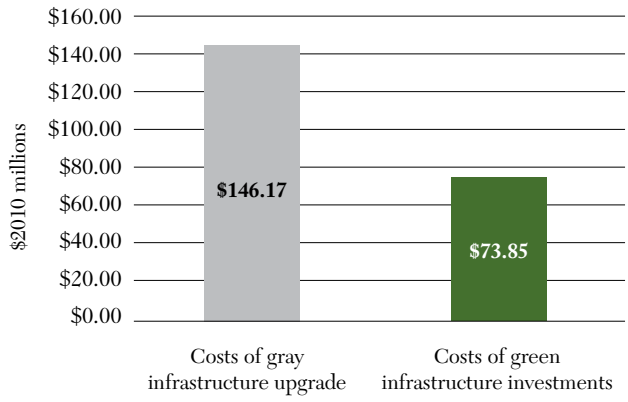


Source: Gray et al. (2011).

Table 2 Green versus Gray Infrastructure Options for PWD — High-Cost Scenario

Infrastructure Options	Quantity	Present Value Costs (millions)
Riparian buffers (acres)	1,602	$25.59
Culvert upgrades and replacements (units)	110	$4.43
Certification (acres)	5,271	$0.22
Afforestation/reforestation (acres)	24,121	$32.86
Conservation easements – 80% forest cover (acres)	10,936	$10.75
Green infrastructure total		$73.85
Gray infrastructure (membrane filtration) total		$146.17
Difference (green minus gray):		**-$72.32**

FIGURE 3 High-Cost Scenario: Portland Water District Present Value 20 Year Investment Costs



Source: Gray et al. (2011).

al. (2011). Salmon benefits were based on willingness-to-pay studies for salmon habitat restoration in Maine. These ancillary benefits have an estimated present value of $72–125 million and provide an additional justification for investing in green rather than gray infrastructure. WRI also identified data gaps that need to be filled to make the analysis more complete. A complete analysis will require making a detailed link between upstream green infrastructure options and controlled pollutants, more refined cost information, and a more robust method to address risk and uncertainty.

Overall, the preliminary analysis suggests that investing in green infrastructure could be a more cost-effective option for maintaining water quality in the Sebago Lake Watershed, relative to installation of traditional gray infrastructure. The potential cost savings warrants a deeper look at the green-gray tradeoff by PWD as it considers investment options for the future. The methodology WRI developed here can be replicated for water utilities in other watersheds and provide the basis for scaling up demand for watershed services payments from southern forestland owners.

Consider alternatives to conventional regulatory programs. PWS programs can help the city of Raleigh meet the goals and objectives of its UDO in a more cost-effective manner. Under a PWS program developed to help implement the UDO, developers who find it prohibitively expensive to meet on-site storm water pollution goals could purchase storm water pollution credits generated from installation or protection of green infrastructure elements such as riparian forest buffers, wetlands, or reforested lands in other areas. The city could require that credits purchased be generated in the same stream segments affected by the developers' projects. The PWS market would be open to all landowners with forest cover to protect or room to plant additional trees, as well as owners of businesses with significant storm water runoff who can reduce such runoff in inexpensive ways, such as tree-lined drainages. Right now, the UDO is written to grant exemptions to landowners who cannot comply. These landowners are required, in lieu of compliance, to make payments into a public fund that is used to finance conservation activities that may be implemented within the UDO or elsewhere in the county or state.

While this is one way to mitigate environmental impacts, a more effective way would be to develop a PWS program so that payments are steered toward landowners who go beyond compliance within the city and thereby advance the goals and objectives of the UDO. Replacing payments in lieu of compliance in Raleigh and elsewhere in this manner would represent a significant step forward in activating effective and long-lasting PWS programs in the Neuse Basin. WRI will continue to engage with the city of Raleigh throughout the UDO planning process to advance opportunities for PWS that can help reduce the overall cost of implementing the UDO.

Concluding Thoughts

WRI's ongoing participation in the beneficiary analysis of the Upper Neuse River basin, the Sebago Lake Watershed's green-gray analysis, and the city of Raleigh's Unified Development Ordinance (UDO) process provides insights on ways to develop effective demand drivers for PWS programs. If the benefits are clear, a diverse array of public and private entities may participate in PWS programs. Clear documentation of the risks that these entities face from water pollution, drought, and watershed degradation will provide useful information to help garner interest and participation in emerging PWS programs.

Water utilities are increasingly likely to be turning their attention to green solutions to cost effectively address the infrastructure demands of the 21st century. It is important to make the financial and business case to them using the same basic methodologies public investments managers use for calculating the costs and benefits of conventional gray approaches. This approach allows for an apples-to-apples comparison of costs and benefits.

While other benefits such as those provided by enhanced carbon sequestration and salmon habitat restoration do not have direct bearing on this apples-to-apples financial cost comparison, they may help tip the balance in favor of green infrastructure when analysts are charged with also paying attention to broader public benefits when making infrastructure investment choices.

Finally, market-based solutions like PWS can play a large role in bringing flexibility to communities' land-use planning processes. These processes may represent a large untapped demand driver for PWS programs around the country.

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Box 1

About the Southern Forests for the Future Incentives Series

This series follows and builds upon *Southern Forests for the Future*, a publication that profiles the forests of the southern United States, providing data, maps, and other information about their distribution and makeup, condition, and trends. It explores such things as the following questions: Why are southern forests important? What is their history? What factors are likely to have an impact on the quantity and quality of these forests going forward?

The publication also outlines a wide variety of measures for conserving and sustainably managing these forests so that they can continue to provide a wide variety of benefits—or "ecosystem services" such as water filtration and outdoor recreation opportunities—to people, communities, and businesses. The *Southern Forests for the Future Incentives Series* (www.seesouthernforests.org/issue-brief) delves deeper into some of these measures.

For additional information about southern U.S. forests, visit **www.SeeSouthernForests.org**. Developed by WRI, this interactive site provides a wide range of information about southern forests, including current and historic satellite images that allow users to zoom in on areas of interest, overlay maps showing selected forest features and drivers of change, historic forest photos, and case studies of innovative approaches for sustaining forests in the region.

About the World Resources Institute

The World Resources Institute (WRI) is a global environmental think tank that goes beyond research to put ideas into action. We work with governments, companies, and civil society to build solutions to urgent environmental challenges. WRI's transformative ideas protect the earth and promote development because sustainability is essential to meeting human needs and fulfilling human aspirations in the future.

WRI spurs progress by providing practical strategies for change and effective tools to implement them. We measure our success in the form of new policies, products, and practices that shift the ways governments work, companies operate, and people act.

We operate globally because today's problems know no boundaries. We are avid communicators because people everywhere are inspired by ideas, empowered by knowledge, and moved to change by greater understanding. We provide innovative paths to a sustainable planet through work that is accurate, fair, and independent.

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References

Ernst, C. 2004. *Protecting the Source: Land Conservation and the Future of America's Drinking Water*. San Francisco: The Trust for Public Land and American Water Works Association.

Gray, E., J. Talberth, L. Yonavjak, and T. Gartner. 2011. *Green vs. Gray Infrastructure Options for the Sebago Lake Watershed - Preliminary Analysis and Scoping Study*. Washington, DC: World Resources Institute. *Project report, unpublished*.

Hanson, C., L. Yonavjak, C. Clark, S. Minnemeyer, A. Leach, and L. Boisrobert. 2010. *Southern Forests for the Future*. Washington, DC: World Resources Institute.

Hanson, C., J. Talberth and L. Yonavjak. 2011. *Forests for Water: Exploring Payments for Watershed Services in the U.S. South*. Washington, DC: World Resources Institute.

Hayes, S. A, R.A. McLaughlin and D.L. Osmond. 2005. "Polyacrylamide Use for Erosion and Turbidity Control on Construction Sites." *Journal of Soil and Water Conservation* 60 (4), 193–199.

Rothacker, C., and J. Mulligan. 2011. *Cost-Effective Green Opportunities to Protect and Improve Upper Neuse Watershed Health – A Survey of the Literature for Beneficiaries*. Washington, DC: World Resources Institute. *Project report, unpublished.*

Tarver, T. 2008. "Just Add Water: Regulating and Protecting the Most Common Ingredient." *Journal of Food and Science* 73 (1): R1–R13.

Tzoulas, K., K. Korpela, S. Venn, V. Yli-Pelkonen, A. Ka´zmierczak, J. Niemela, et al. 2007. "Promoting Ecosystem and Human Hhealth in Urban Areas Using Green Infrastructure: A Literature Review." *Landscape and Urban Planning* 81, 167–178.

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