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Bottom line economics and a quest for better environmental performance are impelling a closer look at urban greening and the benefits natural systems can provide. But such efforts are running into regulatory barriers

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In September 2009, Philadelphia issued its plan for stanching the overflows of its sanitary sewer and stormwater systems. Its dream is not one of pipes and tunnels and concrete cityscapes. Instead, its vision, "Green City, Clean Waters," is one of trees, open spaces, and permeable landscapes — a "green legacy for future generations," according to local officials.

In its long-term plan to comply with the Environmental Protection Agency's combined sewage overflow regulations, the city proposes to realign its infrastructure, converting 34 percent of the land to permeable surfaces. Using full lifecycle costs, planners concluded that every dollar spent on "gray" infrastructure such as CSO tunnels generates a dollar and ten cents in environmental and other costs. Its greening approach, in contrast, would meet CSO requirements while also producing cleaner air, cleaner water, and greenhouse gas reductions — the proverbial win-win situation.

Philadelphia, like many of the nation's cities, is rediscovering the many benefits of nature. Natural landscapes — wetlands and sea marshes, watersheds of free-flowing rivers and streams, forests, grasslands, even urban parks and greenways — purify water; absorb pollutants from the air; help protect coastal communities from catastrophic storms; and prevent erosion.

As Philadelphia and countless other metropolitan areas are discovering, greening efforts are yielding environmental results while reducing costs to provide essential infrastructure. New York City invested over $1.5 billion to protect and restore the Catskill Mountain watershed to sustain the city's water quality, rather than spending up to $9 billion on filtration plants. Using similar ecosystem services concepts, Seattle reduced the volume of runoff by 98 percent in one neighborhood with extensive use of green infrastructure that cost 25 percent less than traditional alternatives.

Though they can result in cost-effective environmental solutions, urban greening efforts sometimes face regulatory barriers. At times, these obstacles result from the absence of clearly developed measures of their benefits. In some cases, these efforts face institutional hurdles linked to agency turf, fragmented government jurisdictions, and coordination difficulties within cities and between cities and their neighboring countryside.

Despite implementation challenges, urban greening is nudging its way onto city agendas across the nation. Greening options have moved beyond

occasional investments in environmental imagery to find their place as serious infrastructure choices among urban planners and engineers. What is driving this shift? Are the environmental benefits real?

In part, cultural changes and aesthetic aspirations within communities are pushing the quest to bring nature back into cities. But bottom line economics and a quest for better environmental performance are also impelling a closer look at urban greening and the benefits natural systems can provide. Four drivers lie behind cities' quests to go green.

First, many metropolitan areas rely on aging infrastructure for which replacement and system expansion costs are often exorbitant. In its 2009 "Report Card for America's Infrastructure," the American Society of Civil Engineers rated drinking water and wastewater infrastructure as poor, an assessment reflected in EPA's estimate that the nation requires at least $390 billion over the next two decades to update or replace wastewater systems alone, using current technologies.

Washington, D.C., for example, is building three tunnels to handle sewer overflows at a cost of $2.2 billion. In Philadelphia, revising its system of combined sewage and stormwater pipes into separate systems would entail restructuring over 1,600 miles of pipes. Cities are looking for alternatives to traditional infrastructure that carry a lower price tag while meeting city needs.

Second, gray infrastructure is not performing uniformly well. In New Orleans, the failure of its flood control infrastructure during Hurricane Katrina made world headlines. But the New Orleans tragedy was not an isolated one. Levee failure in California during heavy rainfall in 2006 triggered emergency state spending to shore up infrastructure. In the Midwest, devastating floods continue to imperil communities, most recently when rivers overflowed near Nashville this past spring. Costs of these disasters have climbed from less than $1 billion in 1900 nationwide to over $200 billion in 2005. Eying these expenditures, communities are re-examining natural systems such as floodplains and wetlands, evaluating their potential to meet economic, environmental, and safety needs.

Or consider impermeable surfacing, which contributes significantly to stormwater runoff. The 2008 "State of the Nation's Ecosystems Report" of The Heinz Center concludes that "nearly 60 percent of urban and suburban landscapes in the nation had more than 30 percent impervious surface cover, a level at which adverse impacts on stream ecosystems have been observed."

With paving of city surfaces has also come a loss of tree cover. East of the Mississippi, tree cover has declined 30 percent over the past 20 years, while the urban footprint has increased 20 percent. An estimated 634 million trees are "missing" from urban areas across the United States as a result of urban and suburban development. These losses and associated growth in permeable surface areas have cost cities an estimated $100 billion in increased stormwater management needs.

Third, climate change; challenges of managing water supplies, water quality, and water flows in extreme storm events; and escalating energy costs and associated impacts all strain current urban infrastructure and resource management.

Finally, cities struggle to generate revenues sufficient to cover their costs. Detroit's budget gap in 2009, as a percentage of its general fund, hit 20 percent. Atlanta, Philadelphia, New York, Chicago, Phoenix, and Los Angeles all had deficits greater than 10 percent of their general funds. Within this context, infrastructure greening options that could provide the same or better services at lower costs are drawing attention.

The Stormwater Center at the University of New Hampshire concluded that ecosystem services achieved through bioretention can reduce polluting constituents in stormwater runoff by almost 100 percent. Re-establishing tree cover and permeable surfaces and restoring natural flood plains in adjacent watersheds can cost-effectively alter stormwater flows.

Less obvious are the effects of the natural land-

scape on energy use, associated air pollution, and greenhouse gas emissions. U.S. Forest Service studies of urban forests show linkages between tree canopy and urban temperatures. In a study of trees in Minneapolis, Forest Service researchers found annual savings of $6.8 million in energy costs resulting from existing tree canopy. U.S. Forest Service analyst Greg McPherson has documented energy conservation benefits from urban tree canopy. Planted as windbreaks, trees can reduce heat loss for avoided winter heating costs of 10 to 12 percent. If trees are strategically located, they can also shade buildings in the summer and lower surrounding temperatures. In Atlanta, appropriately placed shade trees reduced cooling costs in some locations by 34 percent. A single tree shading a house, according to another Forest Service study, can save 100 kilowatt-hours in electricity use annually.

Trees can also provide air quality benefits, though assessing their net benefits is complex since trees also emit volatile organic compounds that can contribute to ozone formation. Key to achieving net benefits is the strategic selection of species types and their location within the urban setting.

While tree canopy can provide air quality benefits, loss of tree canopy can adversely affect air quality. A study in Houston showed that its loss of 16 percent of its tree canopy over the last three decades translates into a loss of annual air pollution "removal services" pegged at $38 million and an even greater annual loss of stormwater management services valued at $237 million.

Barriers to Natural Solutions

These examples highlight the significant services that natural systems and their components provide to human communities, their health, safety, and prosperity.

Though city greening efforts are encyclopedic in breadth, many untapped opportunities remain. Several factors contribute to difficulties in investing in integrated greening efforts across cityscapes and with adjacent communities.

Agency silos inhibit coordination across air, water, wastewater, stormwater, climate, energy, open space, and other infrastructure and services. In Albany, New York, for example, the city owns the wastewater plants but does not own the pipes leading to them. This structure limits opportunities to rethink wastewater infrastructure and use wastewater fee revenue to revise pipe infrastructure. At the state level, similarly fractured responsibilities are common. In Virginia, for example, the Department of Environmental Quality permits wastewater while the Department of Conservation and Recreation permits stormwater.

Indeed, federal and state permitting structures can inhibit urban greening. A green infrastructure approach involves an evolution of urban landscapes over time as part of ongoing infrastructure maintenance and renewal processes as streets, energy and electricity infrastructure redevelopment, and new development occur. Through these processes, old gray infrastructure is replaced with green infrastructure. Over a 30-year timeframe, replacement and renewal goals are met. Costs are incremental, incurred during natural replacement or new development cycles.

The challenge for cities — and for EPA and other federal and state agencies — is that current compliance tools and procedures are not well configured to give credit for this gradual urban greening, even when incremental pollution reduction begins right away with the first investments, while results from new tunnels loom 15 years or more into the future when they are finally connected.

Jurisdictional structures challenge agencies that would like to work across governing boundaries and at scales commensurate with and natural landscape dynamics. City government budgets are divided among specific services that include stormwater management, wastewater treatment, parks and recreation programs, drinking water, public building management, and so on. In many areas, municipal residents are served primarily by private power companies. The benefits of green infrastructure are, thus, dispersed across these different services, making them difficult to perceive. In addition, the beneficiaries of these ecosystem services have little or no authority, incentives, or responsibility to pay for them.

One study of Washington, D.C., found that trees provided benefits of some $5.55 million per year by reducing energy costs in buildings, removing air pollution, and other ecosystem services. Yet budget structures present trees largely as a cost, with no corresponding way to charge the beneficiaries of energy conservation or pollution reduction for these benefits.

Still, some opportunities exist for cities to better align incentives for greening investments and generate revenue streams to fund greening investments. Fees that reinforce incentives to establish, protect, or enhance natural ecosystems and green infrastructure can motivate green investments, strengthen ecosystem services markets, and enhance ecosystem restoration.

A 2007 stormwater utility survey conducted by Black & Veatch showed 9 percent of respondents using a combination of impervious and gross area to set stormwater fees. This fee structure meets the required test that city service fees must be linked to service costs. At the same time, it creates incentives for landowners to reduce use of runoff-creating surfaces.

The City of Bellevue, Washington, links its stormwater fees to the amount of impermeable surface and total surface area and includes credits for stormwater management measures and wetlands. These fees help Bellevue pay for stormwater infrastructure and operating costs. But they are also a catalyst for conservation that reduces the quantity of runoff and brings water quality benefits by encouraging use of permeable surfaces.

Governance Challenges

Beyond public utility structures, urban greening efforts face other governance challenges. Cities and countryside could benefit from ecosystem conservation and restoration that transcends jurisdictional boundaries and links what cities are doing with what the nation and rural communities are doing to restore ecosystems.

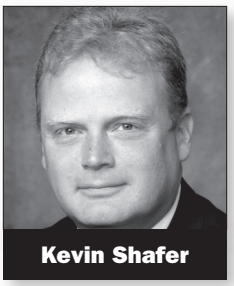
Recognizing that stormwater is a major source of pollution in southwestern Wisconsin, the area's Regional Planning Commission began modeling six watersheds for population growth, development patterns, and other variables as a precursor to exploring how to better integrate municipal and non-urban watershed management. That initial effort resulted in creation of a partnership involving the six watersheds and two rivers.

The voluntary partnership provides a regional approach while also developing actions that drill down to the neighborhood level. While stormwater management is

Leaping Regulatory Hurdles

In Milwaukee, we have succeeded in meeting regulatory requirements with construction of an extensive system of pipes and water reclamation facilities to collect and treat sewage and stormwater. This system has reduced annual combined sewer overflows by 86 percent. But it's not enough.

As the region plans for the future, it is working to weave green infrastructure into the fabric of the urban setting. Green infrastructure is effective in dealing with stormwater runoff and is, in many cases, proven to be more cost effective than sewerage. Implementing green infrastructure, however, requires motivated partnerships and approaching water management issues in a new manner.


Kevin Shafer

As our region has learned, you must show people that this dual approach creates synergistic benefits. The Milwaukee Metropolitan Sewerage District started piloting and implementing green infrastructure projects because it knew that it was the right approach, not because it was required by regulation. Regulation was actually, at times, an obstacle.

During the course of implementation, MMSD discovered multiple benefits of green infrastructure, including reduced stormwater runoff, improved water quality, long-term reduction in energy costs and greenhouse gases, and, most importantly, economic benefits. Through complementary implementation and education programs, MMSD continues to foster new relationships with many different partners and is starting to see real results.

As with anything worth doing, Milwaukee still has many challenges to surmount. Silo thinking continues to prevent watershed-wide implementation. Green infrastructure is still an afterthought when striving to address water management issues.

To change this dynamic, an integrated watershed plan must be developed and tied to an integrated regulatory approach that reaches beyond political jurisdictions. To pave the way, work to change the water resource culture must be accomplished by providing good information to decisionmakers.

To implement green infrastructure approaches, communities should think of the hydrologic cycle and apply that thought process to the entire watershed. Then, they must use that same concept to develop regulations that bridge the silos among urban stormwater runoff, climate change, energy consumption, and sewer overflow management. Once these bridges are built, state and federal regulators must recognize green infrastructure as a viable approach and integrate it into the toolbox of water management options outlined in permits. This will provide regulatory incentives for communities to justify the investment in green approaches.

As the benefits of natural infrastructure are recognized by regulators, there will need to be a targeted funding approach that does not simply carve green funding out as a set aside from other funding efforts, but rather integrates infrastructure funding under a sustainable umbrella of grey and green approaches.

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the province of each municipality or stormwater district, a single flood management authority creates the glue upon which to join action among municipalities. The agency responsible for flood management regulations is using its flood management requirements to coordinate actions among 28 different municipalities.

Yet Wisconsin's laudable effort at regional watershed management underscores the difficulties associated with such efforts and explains their infrequent emergence. Urban areas still largely lack tools for integrating urban greening with non-urban restoration and management at a watershed scale. For example, EPA is, for the first time, just now selecting pilots for its new watershed-level permits. And a key player, agriculture, still has not joined the Southeastern Wisconsin Watersheds Trust.

Farm runoff remains a significant contributor to impaired water quality. Federal Clean Water Act regulations do not currently regulate nonpoint sources of pollution from runoff. As a result, the agricultural community does not have a strong incentive in most states to alter land practices to reduce pollution or take part in watershed management greening programs.

Clustering or grouping permits for wastewater, stormwater, and other related facilities by cities or special districts can facilitate integrated greening investments. Though such permitting innovations are rare, the idea of clustered permits is gaining some traction. In the Tualatin Basin, the local surface water utility watershed includes a number of towns, four wastewater systems, and stormwater runoff from multiple locations. Permits at four wastewater treatment plants expired in 2000. Rather than renew each permit and, separately, seek a required stormwater permit, the local water agency bundled into a single permitting action the renewals of all four wastewater treatment permits and the stormwater permit.

Though some federal and state regulations impede greening investments, other tools support greening but are not often used. EPA guidance regarding "emerging measures" under the Clean Air Act allows tree planting to qualify for ozone-reduction credit yet most cities have not taken advantage of such provisions. The emerging measures may account for not more than 6 percent of total incremental additional emission reductions necessary for attainment of air quality standards. This CAA guidance can help cities seeking to expand their tree canopy to work with nontraditional partners, such as electric utilities, air quality districts, and others to incorporate tree planting into their air quality strategies and to support investment in urban forests.

The Sacramento Metropolitan Air Quality Management District has teamed with the U.S. Forest Service Center for Urban Forest Research and the Sacramento Tree Foundation to examine the feasibility of using trees to clean the air. Preliminary estimates for Sacramento, which is among the 10 areas in the nation with the highest ozone pollution, show potential for urban forest strategies to help achieve "as much as 8 percent of the required reductions in VOCs [volatile organic compounds] and 1.1 percent of the required reductions in NOx [nitrogen oxides], depending on the scenario."

The CWA's 2003 Phase II Stormwater Regulations also support green infrastructure options to meet requirements. The EPA model stormwater permit guidance recognizes trees and tree-planting for purposes of improving runoff control, especially in post-construction contexts. As with the air quality guidance on emerging measures, using these tools requires good metrics to demonstrate performance. For water quality, establishing credits for greening practices involves location-specific, sometimes complex calculations.

EPA also manages grant and loan programs under the CWA and the Safe Drinking Water Act that can support infrastructure greening and land acquisition to protect water supplies, though they have only infrequently been used for these purposes. These include the Clean Water State Revolving Fund, which offers loans for water quality improvements that have generally funded wastewater treatment infrastructure. However, these funds (over $1 billion, combined with another $4.7 billion in state monies) can be used to implement nonpoint source management plans and develop and implement estuary plans. Just 5 percent of projects target nonpoint source pollution mitigation.

Under the SDWA, State Revolving Fund loans help fund public water system infrastructure. A third of these funds can be used for investment in water source protection that includes land acquisition. Of this amount, 15 percent can support voluntary and incentive-based measures. One review of these grants and loans concludes that "since the act's inception, only $2.7 million in assistance has been used by systems to protect less than 2,000 acres of land under the set asides."

Though these loans could be used for greening and land acquisition, their infrequent use for these purposes is, in part, attributable to the enormous backlog of infrastructure needs such that cities

tend to steer money toward repairs and replacement of critical infrastructure. One remedy to this problem would be to provide incentives to use a portion of these funds for source water protection, particularly where such investments can demonstrate cost-effectiveness in achieving water supply, water quality, and water management goals.

The Ohio Water Restoration Sponsorship Program provides significant loan rate reductions for wastewater treatment projects if the recipient uses a portion of the savings for watershed protection and restoration directly or contributes to a land trust, park district or other watershed protection. In New Jersey, through its Green Acres Program, the state adjusted its criteria to allocate funds under the Clean Water State Revolving Fund to give three times the weight to projects with water supply protection benefits through land protections.

Other cities are using local and private funds to support urban greening. In a joint initiative with The Conservation Fund, the Milwaukee Metropolitan Sewerage District Greenseams Program used land acquisition and easements to protect an initial 925 acres (now over 1,800 acres) in the Milwaukee metropolitan area's growth corridors to combat flooding and safeguard water quality. Funding came from the district, the Wisconsin Department of Natural Resources, the U.S. Fish and Wildlife Service, the Wisconsin Coastal Management Program, and others. The investment helps reduce longer-term needs for other traditional water management infrastructure.

This nation, its cities, and its countryside are rethinking the role of natural systems and processes in providing clean water, clean air, flood protection, and other benefits. The environmental dynamics of climate change, the increasingly landscape dimensions of resource management challenges, and persistent ecosystem degradation require new mental maps for managing cities and their surrounding environments. Changing circumstances are outstripping the capacities of both urban infrastructure and governing structures. Moreover, the cumulative negative impacts of this infrastructure and its transformation of ecosystems point to the need to rethink the nexus of city and countryside; people and places; ecosystems and economies. Urban greening is an essential part of this emerging shift. •