

Urban Water: Strategies That Work

The Urban Institute

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Final Report

December 9, 2013



EXECUTIVE SUMMARY

In the summer of 2013, the Greater New Orleans Foundation (GNOF) held a series of five Workshops, *Urban Water: Strategies That Work*. Co-sponsored by more than 30 partners, the Workshops were organized by the Urban Institute under GNOF's leadership. The Workshops had two goals; the first, met by Workshops 1–4, was to inform a wide variety of New Orleans stakeholders about innovative *green* approaches to stormwater management that have been successfully adopted by vanguard American cities. The second goal, met by Workshop 5, was to provide a venue for New Orleans stakeholders to come to consensus on moving forward on specific green infrastructure goals and approaches.

Green stormwater techniques offer significant cost, environmental, health, and economic advantages over traditional, or gray, approaches that construct ever bigger facilities to manage growing stormwater runoff created by urbanization and climate change. In contrast, green infrastructure includes a variety of techniques that retain and partially treat most stormwater on-site, as it would have been before urbanization disrupted the natural water cycle.

The first of the five Workshops covered local stormwater conditions and national trends. In the next three Workshops, professionals from five vanguard cities – the District of Columbia, Houston, Milwaukee, Philadelphia, and Portland (OR) – described their experiences creating green neighborhoods, structuring large-scale metropolitan projects linking off-site stormwater retention to open space and recreational needs, developing innovative pricing and financing techniques, and implementing demonstration and pilot projects, comprehensive neighborhood scale programs, public education campaigns, and K-12 outreach.

The experiences of the five vanguard cities, and additional information about other cities, offered New Orleans a variety of important green stormwater infrastructure options to consider. At the fifth Workshop, a wide variety of New Orleans stakeholders talked about the next steps for the region; they discussed the green stormwater approaches that they had learned about and recognized problems in moving forward. There was clear consensus on the need to develop some kind of a green infrastructure approach to the problems in New Orleans and recognition that not all the appropriate and important stakeholders were at the table. There was no clear consensus on specific programs and policies to adopt, but participants actively discussed the following strategies, which are listed in the order of the time spent discussing them:

- Educate the public about the extent of the problem and the role and value of green stormwater techniques;
- Improve and coordinate the local governance of stormwater problems;
- Adopt innovative financing options and incentive programs to encourage adoption of green stormwater approaches;
- Combine off-site stormwater retention with recreational and open space activities;
- Get more and different stakeholders to the table and involved;
- Develop pilot and demonstration projects to test the local applicability of approaches tried elsewhere;
- Link green infrastructure strategies to vacant land; and
- Make the public aware of the relationship between Federal Emergency Management Agency (FEMA) flood maps and the insurance premiums they pay.

The Workshops constitute Phase I of the Greater New Orleans Foundation's efforts to encourage neighborhood organizations, governmental agencies, advocacy groups, faith-based entities, the development community, and business leaders to actively consider the wide array of green infrastructure techniques that could be effectively implemented in New Orleans to address terrible flooding and sanitation problems. Phase II, which will begin in the spring of 2014, will build on this new understanding to draw more stakeholders into the conversation and bring strong green stormwater elements into projects throughout the greater New Orleans region.

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Introduction

Most American communities face major stormwater challenges, largely due to increasing urbanization: surfaces that used to absorb and filter water are now covered with buildings, streets, and parking lots. Water that once infiltrated the earth, recharging ground and surface water supplies, or that was released by plants and trees through evaporation, or re-used for gardens and orchards, now runs off impervious surfaces. This stormwater runoff creates substantial local flooding and water pollution in nearby water bodies. Ironically, even communities struggling with a dwindling supply of potable water face the challenge of getting rid of stormwater.

New Orleans, however, faces unique stormwater problems: large areas of the city are below sea level and served by an aging and deteriorating stormwater system. As a result, New Orleans streets and neighborhoods flood in every storm, causing serious property damage, disrupting businesses and families, and creating health problems. In heavy rains, stormwater infiltrates New Orleans' equally aging sanitary sewer system, resulting in the discharge of untreated stormwater and sewage into Lake Pontchartrain and other nearby water bodies. To make matters worse, New Orleans is experiencing major subsidence exacerbated by its approach to stormwater management; the more the city pumps out stormwater, the worst subsidence becomes, causing massive leaks in the existing system and increasing flooding from every storm.

New Orleans' traditional approach to stormwater management has been to plan for ever bigger pipes, transfer stations, tunnels, and treatment facilities. As a recent article in the *Times Picayune* (Rainey, 2013) noted,

New Orleans has...[f]ifteen miles of thick, imposing concrete floodwalls [that] cut canals and waterways off from neighborhoods and hide them from residents. Major projects, some financed with federal dollars, are expanding the drainage system's capacity to funnel even greater volumes at faster rates out of populated areas. This is an antiquated approach to water management.... It lowers the water table, dries out the soil and causes the city to sink further into the swamp. Such subsidence cracks roads; upsets foundations. And it teaches residents to have a not-in-my-backyard attitude toward water.

In fact, most US communities have traditionally addressed their stormwater challenges in this way. They continue to plan for or build massive infrastructure to retain, move, and dilute the growing volume of stormwater.

But a second approach is rapidly gaining prominence: green stormwater management. Rather than expanding facilities to meet the ever increasing volume of stormwater runoff, some communities are adopting green approaches that *manage* stormwater runoff, generally on-site or in more natural ways. Green stormwater approaches reduce the demand for new capital investments by slowing, lowering, or even eliminating the volume of stormwater runoff. They often do so in ways that mimic the natural water cycle: evaporation, absorption, and re-use. And, almost all green approaches make property owners more responsible for their contribution to the problem. The number of communities implementing green infrastructure approaches to managing stormwater has proliferated rapidly in just the last few years.

The Greater New Orleans Foundation (GNOF), in conjunction with the Urban Institute and 30 other partners, organized a series of five Workshops in the summer of 2013 to bring to New Orleans major decision-makers from a small number of vanguard cities to share their experiences and insights. The focus was a peer-to-peer exchange to invite water practitioners and public officials who had successfully implemented green infrastructure approaches elsewhere to share their experiences. Many implemented such approaches, sometimes against great stakeholder and political opposition.



Workshop 5 of Urban Water Series
Source: Greater New Orleans Foundation

The Urban Water Series Workshops had two major goals: the first was to give the stakeholders of New Orleans a closer and more detailed understanding of the experiences of five vanguard cities: the District of Columbia, Houston, Milwaukee, Philadelphia, and Portland (OR). The first four Workshops in the series addressed this goal.

The five vanguard cities differ from New Orleans in important ways, yet each faced deteriorating stormwater systems and serious financial exigencies. And, in spite of these challenges – or perhaps because of them – each developed a number of successful green infrastructure programs and policies. As a group they improved institutional governance, created effective new revenue sources, provided incentives and penalties to encourage property owners to retain stormwater on-site, structured major public green infrastructure pilot and demonstration projects to provide proof of concept, and organized meaningful public and K-12 green stormwater education and outreach programs.

The second major goal of the Workshop series, addressed at the fifth and last Workshop, was to provide a forum for New Orleans stakeholders to come to some consensus on the next steps the region could undertake to address local stormwater problems with appropriate green approaches. In a facilitated conversation with a wide variety of local stakeholders and elected officials, participants agreed that there was a pressing need to move forward but that all stakeholders were not at the table. Widely discussed next steps included educating the public about green stormwater approaches, improving the local governance of stormwater water, adopting innovative financing options and incentive programs, combining off-site stormwater retention with open space and active recreational activities, getting more stakeholders involved, developing pilot and demonstration projects to illustrate the validity of different techniques successful elsewhere, using green approaches to address vacant land, and showing the public that even if they don't experience stormwater flooding they are paying far more for homeowners insurance because they live near people who do experience flooding.

This report has five major sections. The first section briefly describes the problems caused by stormwater runoff and the ways in which US cities address them. The next major section describes the emergence of green infrastructure approaches to managing urban stormwater. The following major section describes the content of the five Workshops and synthesizes the topics and issues that emerged from the formal talks, audience questions, and comments.

The fourth section focuses on the issues that engaged the audience and panelists at the fifth and last Workshop, and the final section briefly summarizes the material presented in the report.

This report also has two significant appendices with an update of materials offered to Workshop participants and posted on the GNOF website. Appendix I provides a fuller description of different types of green stormwater infrastructure techniques and management approaches, briefly identifying which American cities have successfully implemented these approaches. Appendix II gives detailed case studies of each of the five vanguard cities.

Green stormwater management is sweeping the country for many reasons; cities today on the cutting edge may be old news tomorrow. But it is instructive to see the wide range of green stormwater strategies being adopted around the country and understand how the vanguard cities in fact became that way.

Managing Stormwater

Most cities across the nation are grappling with the need to reduce the devastating economic, social, and environmental impacts of stormwater runoff. The National Research Council concluded that stormwater runoff from the built environment is one of the greatest water challenges facing the nation because it is one of the most important sources of the pollution in our streams, rivers, and lakes. Increasing stormwater runoff is largely the result of increasing urbanization: buildings, streets, and parking lots have been constructed on land that used to be able to retain, absorb, or use stormwater. The more impervious cover in a city – that is, land that will not hold or absorb stormwater – the more stormwater runs off the property where it fell, picking up pollutants, debris, waste, and bacteria as it moves over the urban landscape.

Older cities, and the older sections of newer cities, generally have sewer systems that combine stormwater with sewage. In a heavy rain, the rapid volume of stormwater runoff overwhelms the capacity of the system to treat waste. The result is the frequent discharge of untreated sewage into nearby waterways. Most US cities with combined sewer systems are in violation of federal and state environmental regulations and have been mandated to substantially reduce the number of such discharges.

Newer cities, and the newer sections of older cities, generally have separate sanitary and stormwater sewer systems. However, many of these separate systems, like that in New Orleans, cannot handle the volume of stormwater in many storms; this leads to serious localized flooding. Moreover, the sheer volume and speed of stormwater being discharged into nearby waterways destroys river and creek banks, making water murky with un-dissolved solids while the urban pollutants that water has picked up endanger human health and aquatic wildlife. Increasingly, state and Federal regulatory bodies are setting standards for the amount of such solids and pollutants that can be discharged into waterways.

To make matters worse, even in cities with separate sanitary and stormwater sewer systems, the sanitary system may be in such poor condition that stormwater infiltrates the sanitary system in heavy rains. This again leads to the discharge of raw, untreated sewage into nearby water bodies.

New Orleans, while maintaining separate sanitary and stormwater sewer systems, continues to experience serious problems with flooding, raw sewage in the street,

and massive untreated sewage discharges into local waterways even as it continues to sink. In 2012(a), a report by local expert Jeff Thomas noted that,

“The city’s diminished stormwater capacity is a function of mass pipe breakages along over 1,500 miles of drainage pipes. These breakages are largely caused by soil subsidence and “shrink-swell” that are worsening because rainwater does not sufficiently absorb into the ground as it is pumped to Lake Pontchartrain via barricaded culverts and canals. Neighborhood flooding is exacerbated when pipe breakages pair with catch basins clogged by excessive runoff from impervious properties, curbs, and streets. As the city subsides, pipes break, and runoff accelerates, pumping stormwater become more expensive, requiring ever more power and maintenance to take on gravity.” (p. 3)

Gray infrastructure investments can address all these problems; within the last decade, many cities have replaced underground pipes, expanded pumping stations, built new treatment facilities, and planned and/or built large tunnels for both their sanitary and stormwater sewer systems. These tunnels hold overflow, waiting for the pressure to decrease as each storm passes, so that sewage can be treated by existing plants while separated stormwater can be released slowly enough that it does not violate standards for solids and urban pollutants.



Flooding in New Orleans
Source: Steve Picou

These kinds of investments have or will cost many US cities each well in excess of \$1 billion. But most communities lack that level of funding. More importantly, there is growing consciousness of the need to stop expanding infrastructure to meet ever growing stormwater runoff. Green infrastructure approaches, in contrast to gray, largely prevent stormwater from entering and burdening the gray infrastructure, in the short or long term. Many do so in ways that mimic or parallel the natural water cycle while also changing the loci of responsibility for stormwater management by actively involving all property owners in reducing stormwater runoff and paying their fair share of green and gray infrastructure costs.

Emerging Green Stormwater Management

Introduction

There are many green techniques in stormwater management; table 1 lays out a number of individual approaches, identifying cities which have successfully implemented them. Green infrastructure approaches are generally cheaper and more resource-conscious than gray infrastructure; they also have the ability to more fairly distribute the costs of stormwater management while re-establishing major components of the natural hydrological cycle.

Widely discussed green stormwater management approaches tend to fall into four major categories:

- Creating green neighborhoods: small-scale approaches throughout a community that can have significant impact in individual neighborhoods and build to major city-wide or regional impact;
- Structuring large-scale metropolitan land use strategies: packaging recreational and open space opportunities with off-site green stormwater retention and natural treatment;
- Developing innovative pricing and financing techniques: raising revenue and providing incentives for property owners to retain stormwater on-site; and
- Organizing significant and effective public outreach: using pilot projects, public education campaigns, and K-12 outreach to engage wide segments of the public.

Each is briefly described here. Appendix I contains more detailed information about each approach and a brief discussion of some of the cities associated with them. Appendix II contains detailed case studies of the five vanguard cities whose officials made presentations to New Orleans stakeholders during the Urban Water Series Workshops.

Table 1

Cities Experienced in Green Infrastructure for Stormwater Management

	Austin (TX)	Camden (NJ)	Chicago	Cincinnati	Cleveland	DC	Denver	Houston	Jacksonville (FL)
Green Neighborhoods									
Green Roofs			•			•			
Green Streets		•	•		•			•	
Green Public Spaces	•	•	•	•		•	•	•	•
Green Homes	•	•	•		•	•	•	•	•
Greening Vacant Land		•			•		•		
Metropolitan Strategies									
Green Space Conservation								•	
Unified Water Management			•						
Innovative Financing									
Impervious Cover Charges	•				•	•	•	•	•
Rebates & Fee Reductions	•		•		•	•	•	•	•
Development Regs & Charges	•		•			•	•	•	•

Table 1 (continued)

Cities Experienced in Green Infrastructure for Stormwater Management

	Kansas City (MO)	Los Angeles	Milwaukee	New York City	Philadelphia	Pittsburgh	Portland (OR)	Seattle	Syracuse (NY)
Green Neighborhoods									
Green Roofs			•	•	•		•		
Green Streets		•	•	•	•		•		•
Green Public Spaces	•	•	•	•	•	•	•	•	•
Green Homes	•	•	•	•	•	•	•	•	•
Greening Vacant Land					•	•			•
Metropolitan Strategies									
Green Space Conservation			•						
Unified Water Management	•			•	•	•	•	•	
Innovative Financing									
Impervious Cover Charges	•		•	•	•		•	•	
Rebates & Fee Reductions	•	•		•	•		•	•	•
Development Regs & Charges	•	•		•	•	•	•	•	•

Green Neighborhoods

Some green techniques work at or near the site of rainfall. These approaches often rely on trees, shrubs, and other vegetation, planted in certain ways along roads and property lines and in parking lots, to retain and address pollution after a storm. Common techniques include rain barrels, disconnecting downspouts from the stormwater or sanitary sewer system, roof gardens, bioswales, rain gardens, and replacing impervious materials with permeable ones. These approaches manage stormwater by: 1) holding and “treating” it, slowing releasing it over time; 2) holding water and allowing it to slowly evaporate; 3) absorbing water and allowing it to percolate into the water table or directly to nearby waterways; and 4) re-using stormwater for existing vegetation and gardens. In all these approaches, stormwater is “treated” to a major extent because urban pollutants and particulates are absorbed and retained by the vegetation and/or by the ground through which the stormwater passes.

Metropolitan Land Use Partnerships

A second type of green infrastructure approach occurs off-site, in the way stormwater runoff is handled. A number of cities or metropolitan areas have developed flood control systems in cooperation with open-space and active recreation opportunities. These natural water facilities can be attractive complements to hike and bike trails; the recreational areas that parallel natural ponds, wetlands, and open canals can provide safe locations for stormwater overflow a few times a year.

The first and second approaches, each in its own way, create inviting greened areas and open space, important amenities in themselves. They can also provide new recreational opportunities and make communities more attractive places for residents, businesses, and industry. For example, there is some evidence that homes in neighborhoods with greened streets have a higher resale value. And many advocates believe that a large-scale focus on green infrastructure will pay off in economic growth and new jobs.

Innovative Financing and Pricing

Some green infrastructure approaches use pricing and regulatory controls to ensure that all property owners pay their fair share of the cost of stormwater management while reducing or even eliminating the demands they put on the gray infrastructure. For example, many cities have initiated new or have modified their existing

stormwater utility fees to reflect the real cost of stormwater management. These cities have moved to charging industrial and commercial property owners (and occasionally homeowners) a stormwater fee based on proxies for differences in use or demand, generally the percentage of impervious cover on the property, the size of the property, or both.

Imposing such fees give a wide variety of property owners the incentive to investigate effective and efficient green stormwater techniques. To increase positive reinforcement, many cities will automatically reduce stormwater fees if property owners undertake specific green activities, such as replacing the impervious cover in their parking lots with permeable materials or putting in roof gardens, etc.

In addition, an increasing number of cities are making new developments pay for connecting to the stormwater system or requiring that they effectively retain and treat most stormwater on-site. Development permission for even small-scale projects in some cities is conditioned on reducing or eliminating the amount of stormwater allowed to run off the property. In turn, developers use a variety of green and sometimes gray methods to meet those performance standards. If, for geological or other reasons, developers cannot meet these standards, they may be allowed to pay an in-lieu fee put into a fund for green infrastructure elsewhere. Moreover, many cities are requiring a higher standard of proof that developments actually achieve required on-site stormwater retention.

Public Outreach and Education

Managing stormwater runoff has often been the least conspicuous of all public utility services; many cities traditionally did not charge directly for the service even as they imposed monthly fees on property owners for providing clean water and treating sewage. Some cities levied a stormwater fee as a percentage of clean water fees; that meant that the owners of large expanses of impervious cover such as parking lots might never have paid stormwater fees at all because they did not use much or any potable water. (It also meant that institutions with substantial green space, such as college campuses, paid a far greater share of the cost of stormwater management than they should have.) Not surprisingly, this meant that many citizens were unaware of the dangerous and costly nature of stormwater runoff – and, more importantly, of the crucial role that individual property owners play in creating it.

In addition, cities with separate stormwater systems do not generally strain or chemically treat stormwater that is not directly mixed with sewage. Most stormwater collected by separate stormwater systems is eventually dumped into nearby bodies

of water along with all the pollution, waste, heavy metals, and bacteria it is carrying. Again, not surprisingly, the public is often unaware of this fact. As a result, they dump leaves, garbage, motor oil, and animal waste in stormwater systems, not knowing that these materials will wash out to nearby waterways largely unchanged.

Many cities have found that it is important to make citizens aware of how costly and



Planting a rain garden.

Source: Center for Neighborhood Technology via Flickr

dangerous it is to allow stormwater to run off their property or to dump garbage and contaminants in stormwater drains. Some have developed educational and outreach programs to show property owners how they can retain stormwater on-site through a variety of green techniques that range from installing rain barrels and disconnecting downspouts on residential property to creating rain gardens and bioswales in large parking lots. Some cities mark sewer drains to remind citizens not to dump waste or garbage. Others work with public schools to create rain gardens and bioswales on school property to educate students and change their perspectives on stormwater so they in turn will change their parents' actions.

Urban Water Series: Strategies That Work

Overview

The Greater New Orleans Foundation and 30 partner agencies, in conjunction with the Urban Institute, organized a series of five 90 minute Workshops in the summer of 2013 at the New Orleans Bio-Innovation Center. The Workshops were moderated by Dr. Marco Cocito-Monoc, Director of Regional Initiatives for the Greater New Orleans Foundation. Individual Workshops were also co-moderated by several elected city officials. Every Workshop had more than 100 attendees with a standing-room-only audience. A fair number of people attended more than one Workshop (as was hoped), but over the course of the five Workshops we believe that more than 200 different people attended.

The Workshops had two goals: to provide New Orleans stakeholders with insights into green stormwater techniques successfully adopted elsewhere in the United States, and to encourage those stakeholders to identify the next steps that the city and the region could take to address stormwater problems in similar ways.

Workshops 1 through 4 were designed to meet the first goal. But their objectives went beyond simple descriptions of *potential* strategies or “good ideas.” Rather, these Workshops were designed to offer a peer-to-peer exchange; the speakers were all municipal officials or water professionals who had grappled firsthand with the implementation of promising green infrastructure policies and programs. Their talks shed light on the challenges and barriers that faced them as they attempted to implement new programs and policies. They described how they surmounted those problems, while explaining the benefits that green infrastructure investments have created in their communities.

Workshop 5 was structured to meet the second goal; it was designed to be a facilitated conversation about the next steps to be taken in the city and the region to get stakeholders to take ownership of green stormwater infrastructure approaches to New Orleans’ growing stormwater problems.

The Workshops were taped and can be viewed on the GNOF website:

www.gnof.org/urbanwaterseries/.

Taken together, these Workshops constitute a comprehensive “tutorial” on both green infrastructure approaches to stormwater management and the many issues facing New Orleans as it grapples with its worsening stormwater problems.

Workshops 1 to 4 – Informing Local Stakeholders

In Workshop 1, two local experts, Jeff Thomas and Mark Davis, outlined stormwater problems in New Orleans and provided comprehensive information about a range of regional water issues. Noah Garrison of the National Resources Defense Council described a wide variety of green stormwater approaches being tried across the United States.

The next three Workshops focused on three distinct approaches to green stormwater infrastructure as described by water professionals from Philadelphia, Houston, Milwaukee, Portland (OR), and the District of Columbia. These cities were chosen because, although different from New Orleans in important ways, they too faced major stormwater expenditures while experiencing financial exigencies and public opposition to raising fees and taxes. They focused on the following issues:

- Small changes that together create green neighborhoods, which ultimately have major impacts on stormwater damage;
- City-wide and metropolitan land use strategies that effectively integrate stormwater retention and natural treatment with recreational and open spaces; and
- Financial and regulatory strategies that encourage property owners to both pay their fair share of stormwater management and reduce their demands on the stormwater system.

Most of the speakers also described major public education and outreach efforts that had borne fruit. Several cities felt that their ability to impose new or variable stormwater fees was the result of making large segments of the population aware of stormwater problems and their personal responsibility for helping to control stormwater on their own property.

The speakers were remarkably candid about their own personal journeys that ranged from skepticism to cautious optimism to eventual enthusiasm for the role of green stormwater techniques. They described the difficulties they faced and the barriers they had to overcome to implement the strategies that they had; some described their

experiences as “a work in progress.” But all clearly felt that green stormwater infrastructure was a crucial element in any city’s efforts to address its stormwater management problems.

In Workshop 2, Julie Slavet, Director of the Tookany/Tacony-Frankford Watershed Partnership in Philadelphia, discussed Philadelphia’s revolutionary green infrastructure plan, Green City, Clean Waters, a regional effort to employ a range of green infrastructure strategies to address major stormwater problems. She described the ways in which her organization has worked to create community consensus about the use of such strategies, through outreach and education programs.

Michael Talbott, the Director of the Harris County Flood Control District in Houston (TX), described the Bayou Greenways Initiative, which will add more than 4,000 acres of green space and 300 miles of continuous trails along some of the 1,800 miles of natural and human-made bayous that form the primary off-site stormwater control system in Harris County. Thus, green space and recreational space will complement off-site natural stormwater control.

In Workshop 3, Karen Sands, the Manager of Sustainability for the Milwaukee Metropolitan Sewerage District, described 2035 Vision, a regional plan that balances green and gray infrastructure based on the success of earlier green infrastructure pilot programs. She also discussed the 6th Street Corridor Project, a partnership of local businesses that implemented a number of green infrastructure measures along a major three-mile corridor in the city, ultimately containing more than 16 acres of green stormwater retrofits. Finally, she reviewed the experiences of the extremely successful Greenseams program, which purchases land outright (or buys the easement) along waterways and wetlands to effectively combine off-site stormwater detention with open space and recreational opportunities.

Bill Owen, the Senior Engineer of the Portland (OR) Bureau of Environmental Services, described Portland’s \$55 million Grey to Green Initiative, which plans, supports, and finances a package of green infrastructure programs and projects, including the purchase of more than 260 acres of wetlands. He also discussed the city’s Green Streets program, which implements multiple and coordinated green measures to control stormwater on public streets, works extensively with neighborhood groups to develop green street plans on private property, and fully integrates green street treatments into the city’s capital improvement program. The jewel of that program is the Tabor to the

River effort, which so far has created more than 500 green streets and planted 3,500 trees in a 2.3-acre area.

In Workshop 4, Charlotte Kaiser of The Nature Conservancy described her group's work in Philadelphia identifying opportunities for economical green infrastructure retrofits as well as leveraging private capital to green urban spaces in ways that treat stormwater effectively. She described Philadelphia's efforts to develop private markets for "greened acres," a unique Philadelphia concept. These efforts include aggregating many small projects to achieve economies of scale and directing private capital to the most cost-effective projects.



Green street in Portland, OR.
Source: Steven Vance via Flickr

Brian Van Wye, the Program Implementation Chief of the Stormwater Management Division of the District of Columbia, talked about DC's innovative financing, regulatory, and incentive programs supporting green infrastructure. He explained the District's impervious cover fees that create revenues to provide gray and green infrastructure while also inducing property owners to reduce stormwater runoff through the use of a variety of green infrastructure approaches. He also described the pending development regulations that will require new developments to retain most or all stormwater on-site. A stormwater retention credit-trading program will allow those developers who can go beyond the minimum stormwater development requirements to do so, and then essentially "sell" their excess stormwater retention to developers who cannot meet the minimum requirements.

The Lessons of Workshops 1–4

The Urban Institute developed a summary list of successful green strategies and approaches discussed in the first four Workshops that might have relevance for New Orleans, and presented it to audience participants at the fifth and last Workshop. The salient recommendations or potential policies and programs fell into four categories:

- Institutional and Governance Factors;
- Revenue Sources and Financial Incentives;
- Major Public Green Infrastructure Programs; and
- Public Education and Outreach.

Institutional and Governance Factors

- **Make major changes in city administrative structures to provide coordinated, comprehensive approaches to all aspects of water management, including stormwater**

- *Integrating water management* – the Philadelphia Water Department manages all aspects of municipal water management: drinking water, sanitary sewers, and stormwater.

- **Identify and address regulatory and other barriers to greater expansion of green stormwater strategies**

- *Reviewing, revising, and updating building codes and subdivision and zoning ordinances* – Milwaukee and Portland reviewed their codes and ordinances for barriers or constraints on the use of green infrastructure and made appropriate changes.

- **Mandate that developers retain substantial stormwater on-site in each storm using approved green (and gray) stormwater control measures and approaches**

- *Imposing on-site stormwater retention requirements on new developments and major redevelopments* – Philadelphia, Washington, DC, Portland, and Milwaukee require developers of new projects or major renovations to retain most or all stormwater on-site. The threshold for activating this requirement varies; Portland is the strictest (that is, these requirements “kick in” at a very small scale of (re)development). However, Portland’s guidelines offer a hierarchy of choices: developers must prove that green infrastructure will not work on their site before being allowed to implement non-green infrastructure stormwater management options.

- **Provide detailed and explicit guidance on appropriate and approved green stormwater strategies to developers and large commercial and industrial property owners**

- *Developing comprehensive guidance for developers, builders, and large property owners* — Houston, Milwaukee, and Portland developed detailed manuals showing developers how to incorporate a wide variety of green infrastructure measures into their projects, indicating which measures met local, state, and regional standards for stormwater retention on-site.

Revenue Sources and Financial Incentives

- **Create new or improve existing monthly stormwater fees for property owners, based on the percentage of the property that will not absorb stormwater (i.e., impervious cover)**

- *Imposing new or higher stormwater fees* — Philadelphia, DC, Milwaukee, Houston, and Portland instituted monthly stormwater fees based the percentage of impervious cover on the property. The funds support green and gray stormwater infrastructure and a variety of green stormwater education programs, rebates, and subsidy programs.

- **Implement or increase storm sewer hook-up or development fees for new development or substantial redevelopment projects that seek to connect into the existing stormwater system**

- *Imposing system development charges* — Portland requires that almost all new developments with impervious areas pay a system development charge; residential properties face a fixed charge, but the charges vary for non-residential properties because they are based upon impervious area percentages.

- **Provide meaningful financial incentives for the use of green infrastructure approaches**

- *Lowering monthly stormwater fees for the use of green infrastructure* — DC, Houston, Portland, and Philadelphia offer reductions in monthly stormwater fees to property owners who install rain gardens, stormwater planters, or other green infrastructure on their property to reduce, slow, and treat runoff on-site.

- *Give financial incentives to developers using green infrastructure approaches* — DC and Milwaukee offer a cash rebate of up to \$5 per square foot of green roof

installed. Philadelphia offers developers a 25% cash rebate on the costs of installing a green roof on their properties, up to \$100,000.

Both Philadelphia and Portland also have many grant programs for developers who construct and operate green (and gray) strategies or facilities that manage stormwater runoff on-site.

Portland also offers a floor-area ratio (FAR) bonus to commercial developments that build a rooftop garden or a green roof that covers at least 50% of the roof area of the building.

- *Subsidize residential use of green stormwater infrastructure* — DC offers subsidies up to \$1,200 to homeowners who implement green stormwater measures on their property, such as rain gardens and permeable pavement.

Portland offers financial and technical assistance to homeowners who install green infrastructure and sign an Operations and Maintenance (O&M) agreement to ensure that the facilities will be cared for in good health.

- **Explore a more active role for the private profit-making sector in green stormwater management**



Green roof in the District of Columbia
Source: World Resources Institute via Flickr

- *Establishing ways for the market to help motivate the development of green infrastructure* — Washington, DC, has created stormwater retention credits, leading to a market where properties exceeding minimum stormwater retention requirements can sell their excess capacity to developers who cannot meet the minimum requirements.

- *Investigating the potential for private market green infrastructure provision* — Philadelphia (with the assistance of The Nature Conservancy) and Washington, DC, evaluated ways to encourage private profit-making ventures to provide needed green stormwater methods for individual property owners.

- **Implement innovative stormwater infrastructure financing methods**

- *Imposing environmental fees* — Washington, DC, charges 5 cents for each plastic bag used at groceries, convenience stores, etc., which helps fund many green infrastructure projects in the District.

Major Public Green Infrastructure Programs

- **Develop large-scale *green street* and *green community* programs, leveraging non-profit, private, and neighborhood resources**

- *Address neighborhoods in a comprehensive green way* — Portland's Tabor to the River program targets a 2.3-square-mile neighborhood with a combination of green and gray infrastructure, including 500 green streets and 100 stormwater facilities on private property.

Milwaukee's 6th Street Green Corridor is a partnership of local businesses and organizations that so far has created 16 acres of largely green stormwater retrofits on the three-mile corridor.

- *Establish ecoroof and rain gardens on publicly owned buildings and land* — Portland requires that 70% of new rooftop area or re-roofing projects on city-owned buildings have ecoroofs. Philadelphia is targeting publically owned land such as streets and city rooftops for comprehensive green infrastructure treatments.

- *Develop tree planting programs* — Philadelphia is increasing the tree canopy in the city, planting more than 500 trees in neighborhoods that lack and want them. Portland's Tabor to the River program is planting 3,500 trees in the targeted neighborhood.

- *Leverage volunteer resources* — Portland's volunteer maintenance program offers training and guidance to citizens interested in caring for and maintaining trees and planters on public streets and alleys.

- **Purchase land or easements to create multi-use stormwater retention facilities**

- *Combine recreation and stormwater retention* — In Houston, many organizations and public agencies are cooperatively creating 4,000 acres of green spaces and 300 miles of continuous trails along existing flood control channels.

The City of Houston's Bayou Greenways 2020 plan, with a voter-approved tax, will buy land and easements to connect 150 miles of parks and trails along

Houston bayous to aid in stormwater retention and flood control as well as provide recreational space.

Milwaukee's Greenseams program purchases land/easements along waterways and in wetlands to preserve open space for natural retention of stormwater off-site as well as recreation.

- *Wetlands and Stream Mitigation Banking* — The Houston County Flood Control District operates a 1,400-acre wetland preservation, conservation, and restoration effort that treats runoff from a nearby highway. The fees charged to Houston developers for obtaining mandatory wetlands credits from a mitigation bank are used to maintain, expand, and monitor wetland and stream mitigation efforts.

Public Education and Outreach

- **Create K-12 programs in which students both learn about and also become actively involved in developing green infrastructure projects on their school site**

- *Work with individual schools to green their campuses* — Portland, Philadelphia, Milwaukee, DC, and Houston partner with individual public schools to convert spaces, such as parking lots, into rain gardens. These facilities double as outdoor classrooms for science classes.

- *Use rain barrel promotion programs to get families involved* — Milwaukee sponsors contests for the best decorated rain barrels; winning barrels are raffled off. The program brings attention to stormwater management and gets families interested in more effective stormwater approaches.

- **Organize major green infrastructure public education programs**

- *Create a consistent public message* — Portland, Milwaukee, and Philadelphia stress consistent messaging about green stormwater to galvanize citizens towards a common goal.

- *Mark storm drains* — Philadelphia marks storm drains to make citizens aware of stormwater issues and to educate them not to throw waste and vegetative materials into stormwater drains.

- *Encourage homeowners to disconnect downspouts* — Milwaukee and Portland launched successful — and cost-effective — downspout disconnection programs. Milwaukee disconnected 985 downspouts in one neighborhood

alone, which contributed to a substantial decrease in basement backups after rainfalls.

Workshop 5 – Next Steps

The fifth and final Workshop brought together a number of elected officials and other stakeholders to discuss what had been learned over the course of the Workshop series and to identify relevant ideas for New Orleans. The session was facilitated by Jeff Eger, Executive Director of the



Workshop 5 of the Urban Water Series
Source: Greater New Orleans Foundation

National Water Environment Fund, who first provided an overview of successful projects in cities around the United States. This review helped remind those who had attended multiple Workshops of the many exciting ideas discussed over the course of the series while providing background information to those who had not attended all or any of the other Workshops.

Also making brief presentations as part of a panel discussion were Council Members LaToya Cantrell, Cynthia Hedge-Morrell, and Jackie Clarkson; Maria St. Martin, Director of the Sewerage and Water Board; Cedric Grant, Deputy Mayor; and Jeff Hebert, Director of the New Orleans Redevelopment Authority. David Waggonner, Principal of Waggonner & Ball Architects and an expert on water issues in New Orleans, also spoke; he stressed the need to stop just talking about these issues and instead commit to moving forward with carefully considered pilot and demonstration projects.

Prior to opening the discussion to the audience, Jeff Eger asked participants to think about the kind of stakeholders who were missing from the audience, the people who should be at the table and in the discussion, but were not. Among those identified:

- Developers;
- Business leaders;
- Banks and mortgage lenders;

- Insurance companies;
- US Environmental Protection Agency;
- US Army Corps of Engineers;
- Louisiana Department of Transportation;
- City planners;
- K-12 school leaders;
- Community groups and neighborhood associations; and
- Arts and cultural organizations.

The audience discussions were wide-ranging; many audience members asked informational questions while others made statements about their beliefs and principles. Some of the panelists stressed the financial difficulties of creating new fees or paying for demonstration projects; others talked about the political difficulties of charging developers additional stormwater fees.

There was some consensus that the energy and enthusiasm generated by the Workshop series must not be lost, that the community must begin to move forward on a number of fronts to develop green stormwater infrastructure.

Although there was no clear consensus on exactly what should be done next, there were common themes and patterns in the discussions. The major issues, suggestions, and ideas presented here appear in rough order of the amount of time they were discussed at the fifth Workshop; this is some measure of their importance to the stakeholders present.

- **Educate the public**

- Identify and widely publicize the many successful green stormwater projects under way in New Orleans and the region;
- Connect New Orleans to its past when water was treated differently and more effectively;
- Develop a wide range of K-12 programs, green the schools, and make kids water ambassadors;

- Work with community-based and neighborhood organizations to educate their members and residents;
- Create demonstrations projects and programs; monitor and disseminate the results;
- Begin using green infrastructure on all public projects; and
- Demonstrate to the public how green infrastructure will save them money (cost of water, insurance).

- **Improve the governance of water and stormwater in New Orleans**

- Better integrate/coordinate water functions at the city level;
- Force government leaders to put green stormwater and all water issues at the top of their agendas;
- Change zoning and subdivision and building regulations to require on-site retention of most or all stormwater through green measures;
- Create region-wide cooperation and involvement by getting all stakeholders at the table;
- Create and maintain a website showing property owners the green stormwater approaches they can adopt themselves; and
- Provide detailed guidance to developers on green options to retain stormwater.

- **Create innovative financing mechanisms modeled on those described**

- Establish stormwater utility fees based on the burden individual property owners put on the stormwater system; and
- Create incentives and promote ways for property owners to undertake green infrastructure treatments on their property to reduce their stormwater utility fees.

- **Combine recreation and stormwater retention**

- Find effective ways for all relevant stakeholders to move forward together to link natural off-site treatment of stormwater with recreational and open space opportunities.

- **Get more and different people at the table**
 - Develop neighborhood and community consensus about the value of green stormwater.
- **Do research through pilot and demonstration projects**
 - Don't just assume that things won't work in New Orleans that work elsewhere: test them out; and
 - Use successful pilot projects as a way to educate the public and bring them on board.
- **Link green stormwater projects to creative use of vacant land**
 - Don't automatically allow land to be used as parking lots.
- **Make clear the role of FEMA flood maps on home insurance costs**
 - Ensure that property owners learn that even if they don't personally experience stormwater flooding, their insurance rates are set by their proximity to serious stormwater flooding—they are paying far more than they have to if this problem were fixed.

Summary and Conclusions

Most American cities face large and growing stormwater problems; increasing urbanization has created more impervious surface, which in turn leads to increasing stormwater runoff. That water creates health and environmental problems, economic challenges, and funding liabilities. The traditional gray approach, in which cities continue to build larger and larger facilities to hold stormwater, ultimately exacerbates these problems by encouraging people, businesses, and industry to make the same dysfunctional decisions that have created the problem.

Green infrastructure approaches are far less capital intensive than older, more traditional, gray approaches. The vast majority of green infrastructure approaches: 1) retain and treat (at least partially) stormwater on-site at its source, returning the rain to the environment through absorption or evaporation; 2) attempt to reuse stormwater constructively; and 3) require individual property owners to take an active role in retaining and using stormwater, often in response to financial incentives or penalties but increasingly through public education and involvement as well.

The Greater New Orleans Foundation sponsored a series of five Workshops in the summer of 2013 to acquaint the New Orleans public and concerned stakeholders with exciting green stormwater infrastructure projects around the United States. Over the course of the first four Workshops, more than 200 participants learned about communities that had tackled their serious stormwater problems by adopting green stormwater management strategies, a variety of new approaches, incentives, regulatory and pricing policies, public education, and demonstration projects. None of the presenters told New Orleans that doing so had been easy, but most felt that over time, as stakeholder attitudes, preferences, and responses did change, that the public – from school kids to senior groups – came to see the wisdom of green infrastructure responses to stormwater problems.

New Orleans stakeholders present at the fifth and last Workshop agreed that there was a pressing need to move forward with implementing green infrastructure strategies to address the serious stormwater problems facing the city and the region. The participants recognized that there were political and financial problems to many promising techniques and noted the absence of many kinds of stakeholders in these discussions, from school district officials to mortgage bankers, from business groups to faith-based community advocacy organizations.

While there was no clear consensus on the exact shape of the next steps, participants gave substantial attention to creating programs to educate the public about green stormwater, improving city governance of stormwater issues, developing innovative financing mechanisms to pay for needed improvements, combining off-site retention and treatment of stormwater with complementary open space and recreational activities, getting more stakeholders at the table, developing a range of pilot and demonstration projects to test concepts in New Orleans that have been successful elsewhere, and making clear to the public how much living in a high-flooding region costs them in insurance even if they never personally experience stormwater flooding.

The Urban Water Workshop series was Phase I in the efforts of the Greater New Orleans Foundation to bring light and attention to the valuable role that green infrastructure can play in addressing the unique and serious problems facing New Orleans. It was designed to serve as the basis for Phase II, which will launch in the spring of 2014. That effort will bring new stakeholders to the table so that those undertaking a variety of community development projects around the city and region will see the need for a strong green stormwater component.

Acknowledgments

The Urban Institute cannot adequately express our gratitude to all the staff at the Greater New Orleans Foundation for their support and guidance; we want to especially thank Dr. Marco Cocito-Monoc for his foresight in seeing the need for the Workshops and working closely with us to develop the content, Julia MacMullan for her indefatigable efforts to organize every detail of the Workshops, and Martha Landrum for her guidance and support. We are very grateful to local experts, including Jeff Thomas, Dana Brown, Grasshopper Mendoza, Steve Picou, Mark Davis, and David Waggonner.

We are very appreciative to the speakers from the vanguard cities or national environmental groups who were endlessly helpful: Noah Garrison, Charlotte Kaiser, Bill Owen, Karen Sands, Julie Slavet, Mike Talbott, and Brian Van Wye. A special thank you goes to Jeff Eger for the skillful way he facilitated the fifth and last Workshop.

We are also grateful to multiple people in the following organizations who answered our questions and provided so much valuable information:

- The Nature Conservancy
- Philadelphia Water Department
- Tookany/Tacony-Frankford Watershed Partnership, Inc.
- Bureau of Environmental Services, City of Portland, Oregon
- Watershed Protection Department, City of Austin, Texas
- National Resources Defense Council
- Chicago Department of Water Management, City of Chicago
- Clean Water America Alliance
- Milwaukee Metropolitan Sewerage District
- Harris County Flood Control District
- Center for Neighborhood Technology
- American Rivers
- Water Environment Research Foundation
- US Environmental Protection Agency
- Department of the Environment, District of Columbia
- DC Water

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Appendix 1

Cities Experienced in Green Infrastructure for Stormwater Management

Creating Green Neighborhoods

Green Roofs

Many communities require or provide incentives for commercial, industrial, and multi-family residential developments to set aside a large portion of their roofs for gardens, trees, plantings, and other vegetative treatments that temporarily or permanently hold stormwater on-site. Green roofs and rooftop gardens, properly constructed and maintained, can substantially reduce stormwater runoff.

Some communities, like Portland (OR), now require that all new publicly owned buildings have such an ecoroof; a few communities require private developers of large projects to construct roof gardens or other green infrastructure. Many communities, such as Chicago and New York City, offer loans and rebates or relax development requirements for developers or the owners of existing buildings who install green roofs.

Green Streets and Alleys

Trees, rain gardens, bioswales, stormwater planters, and other vegetative treatments can be planted along streets and alleys to retain water on-site and to treat the water that does eventually run off. Done correctly, many plants and different kinds of street treatments can either hold rainwater, slowly releasing it over time, in the process removing some or all of the particulates and sediment in the water; or actually retain most or all of the water for use by the plants or for evaporation.

Many communities such as Portland and Philadelphia have made a commitment to green all new, and retrofit older, streets and public rights-of-way with different kinds of plantings and treatments that reduce stormwater runoff. Some communities, like Denver, work with major developers or housing authorities to provide green streets and alleys on-site.

Other cities offer to remove or relax some development requirements or provide financial and development incentives to developers who do construct green streets. For example, Portland collaborates with private property owners to construct green streets abutting their property.

Many communities, such as Camden (NJ), have launched ambitious tree-planting initiatives to increase the urban tree canopy. Trees capture and hold rainfall, thus slowing and reducing the volume of water that enters the sewer systems. In addition, they clean the water, provide shade, and beautify communities.

Green Public Spaces

Some cities that want to increase green infrastructure in their communities are first tackling city-owned or city-funded facilities. Projects on public facilities can serve as models of green infrastructure strategies, illustrating to the public and property owners what green roofs, rain gardens, and stormwater tree trenches look like and how they reduce or eliminate runoff. Using public spaces for multiple green approaches also demonstrate the additional benefits that such strategies bring, such as traffic calming, shade, and recreational space.

Philadelphia and Portland have adopted programs and policies that target city-owned and city-funded facilities, such as municipal buildings, neighborhood parks, and educational institutions, for green infrastructure treatments. Since public property comprises a large portion of the impervious surface area in many cities, greening public property is a natural first step in green infrastructure implementation initiatives.

Green Homes

Many cities actively encourage homeowners to adopt several approaches to keeping and using stormwater on their property. A number of them, such as Syracuse (NY), have rain barrel programs through which they provide guidance and support to homeowners using rain barrels on their property; many programs

offer the barrels for free or below cost. In 2013, Milwaukee announced that it had distributed more than 18,000 rain barrels to area residents, the annual equivalent of 1 million gallons of stormwater stored.

Homeowners can also be provided financial assistance or incentives to disconnect their roof downspouts from the sewer or stormwater system. Other programs encourage and assist homeowners to plant water-retentive plants and rain gardens. Most cities offer guidance on how homeowners can productively use the rainwater retained. While it is not common, some homeowners can also construct roof gardens.

Greening Vacant Land

In many cities, the neighborhoods that experience significant flooding from stormwater runoff and sewer and stormwater back-ups have a number of parcels of vacant or abandoned land. Several cities, like Pittsburgh and Camden, have developed programs to identify and target those parcels of land, turning them into community gardens, rain gardens, or parkland that will hold stormwater on-site, preventing additional runoff.

In doing so, these stormwater management tools create other distinctive benefits: they provide parkland or community gardens for recreation in areas that may lack such amenities while encouraging economic development by removing blight and “eyesores.”

Metropolitan Stormwater Strategies

Green Space Conservation

Comprehensive stormwater management requires communities to address the larger systemic issues raised by providing drinking water, treating wastewater, and addressing stormwater. Some communities have developed methods to protect large tracts of land along waterways or in wetlands in or near major cities in ways that naturally retain and treat stormwater in ways that do deal with larger water issues.

Houston, for example, has developed a mitigation bank, a 1,400-acre project that is preserving and conserving wetlands to offset adverse impacts elsewhere. The project is currently treating stormwater runoff from a nearby major freeway by allowing it to flow through an engineered ecosystem on the site.

Milwaukee's Greenseams program is purchasing easements on, or the land itself, along waterways and in wetlands in the region to preserve the land as open space and natural retention and treatment facilities for regional stormwater.

Unified Water Management

It is not uncommon for many different municipal departments to undertake the various water functions of a city, sometimes even for the same function. Stormwater management has often been an orphan, largely because property owners were generally not charged a separate stormwater fee (until recently at least), so there was no dedicated revenue stream associated with this function. At the extreme, in some communities very different agencies, often at different levels of government, individually provide drinking water, sanitary sewers, and stormwater management.

Water policy analysts have suggested that, because all aspects of water in urban areas are related in important ways to one another, it would be best if one agency handled all aspects of water planning, financing, treatment, and provision. While this is not the usual circumstance, some communities have integrated one or more functions; these are shown with bullets in table 1 in the main report. Philadelphia recently integrated all water-related functions into one department.

While integrating some or all water functions does not automatically improve stormwater management, it does place that function in proximity to the other water functions with which it is naturally linked. This is likely to significantly improve planning for stormwater management and encourage green infrastructure approaches.

Structuring Innovative Financial Incentives

Cities can use incentives and penalties, alone or with targeted regulations, to induce or mandate certain kinds of desirable, green behavior, as well as to raise revenue in an equitable and efficient way to finance needed green (and gray) infrastructure investments.

Impervious Cover Stormwater Fees

Many cities did not traditionally charge specific fees to some or all property owners for handling stormwater runoff. Even cities that charged some kind of stormwater fee often computed that fee either as a flat rate designed to raise a

specific amount of money averaged among all utility customers, or as a percentage of clean water consumed. This meant that there was no incentive for any individual property owner, particularly commercial and industrial property owners, to reduce stormwater runoff. Moreover, properties with substantial impervious cover but little water use, such as parking lots, paid almost nothing toward stormwater management.

In the last decade, a number of cities have imposed new or raised existing stormwater fees to fund mandated stormwater system improvements. Increasingly, they are varying that fee, at least in part, to respond to the percentage of the property with impervious surface. Almost all the cities in table 1 impose stormwater fees based on impervious cover.

Fees based on the percentage of impervious cover clearly provide incentives for property owners to reduce the amount of impervious cover on their property, retain stormwater on-site in some kind of retention facility, or both. They also raise substantial revenue to cover the costs of updating and expanding stormwater and related systems.

Philadelphia, for example, began that process in 2010, gradually increasing the impervious cover fee over a four-year period. The impact was dramatic; stormwater fees dropped more than \$11,000 per month for the bucolic campus of the University of Pennsylvania, but increased more than \$126,000 per month for the Philadelphia International Airport, which had nothing but impervious cover.

Rebates and Fee Reductions

Almost all cities that impose a stormwater fee reflecting impervious cover offer fee offsets to commercial and residential property owners who undertake green infrastructure activities. Permissible activities include developing rain gardens, planting trees or other vegetative treatments, replacing impervious parking with permeable materials, using rain barrels, or taking advantage of green infrastructure strategies in other ways to retain or naturally treat stormwater on-site.

For example, Portland offers up to 35% off monthly stormwater fees for property owners who manage all stormwater on-site; owners may also receive discounts for increasing tree coverage on their property. Utility customers in Washington, DC, may receive up to 55% off their monthly stormwater fee if they install green infrastructure that retains the water from a 1.2-inch storm. In Jacksonville (FL),

property owners may receive a 30% credit against their monthly stormwater fees for having a stormwater pond on-site.

Some cities, however, offer financial incentives independent of impervious cover stormwater fees, providing cash rebates to residential and commercial property owners who construct or use green infrastructure treatments to retain stormwater on-site. For example, Philadelphia provides grants of up to \$100,000 per “greened acre” to commercial and industrial developers who use green infrastructure to manage stormwater on-site through techniques such as green roofs and downspout planters.

Development Regulations and Charges

Cities can encourage greater use of green infrastructure in new developments or significant redevelopment projects in one or more of the following ways: 1) requiring the inclusion of specific types of green infrastructure (such as bioswales or roof gardens); 2) setting performance standards for on-site stormwater retention or green treatment (leaving the choice of methods to the developer); 3) charging stormwater development or impact fees; 4) expediting development approvals in exchange for using green infrastructure for on-site stormwater; 5) providing development bonuses, such as increased floor-area ratios (FARs), for those providing green roofs or other vegetative treatments of stormwater; and/or 6) offering rebates or fee reductions from stormwater development fees for the use of green infrastructure.

Portland has a stormwater system development charge; all new developments of any kind that have more than 500 square feet of impervious cover must pay the fee. Those constructing residential properties pay a flat charge per housing unit, while commercial and industrial developers pay a development charge based on the actual amount of impervious surface on the project. The city also offers a FAR bonus to developers who cover at least 50% of their roof with rain gardens and other green infrastructure techniques.

Philadelphia fast-tracks development projects that disconnect at least 95% of their impervious area from the combined sewer and stormwater or stormwater system.

The District of Columbia is in the process of revising stormwater regulations to require that development projects over a certain size must have ways to retain on-site all the rain from a 1.2-inch storm. However, projects may meet those

requirements by paying an in-lieu fee to a District fund that constructs green infrastructure projects throughout the city.

The District is also developing an innovative development incentive: a stormwater retention credit-trading program. Through this program, developers who cannot meet the on-site stormwater retention requirements may buy credits from developers who were able to go beyond the minimum on-site retention requirements.

This provides the incentive for developers who can do so to go beyond the minimum requirements without posing an unnecessary hardship for small developers who cannot effectively manage stormwater on-site.

Philadelphia is also creating a unique development incentive; they have identified areas of the city with the potential for leveraged partnerships involving green infrastructure. The city has paid independent experts to estimate the financial and environmental impacts as well as marketability of development on those sites. This will provide prospective developers with substantial savings since they will not then have to conduct those studies themselves.

Appendix 2

Exemplar Cities

- District of Columbia
- Houston
- Milwaukee
- Philadelphia
- Portland (OR)

District of Columbia

- Assesses monthly stormwater fees based on amount of impervious cover
 - Gives discounts from monthly stormwater fees for retaining stormwater on-site
 - Provides subsidies to property owners to retain stormwater on-site
 - Imposes a fee on disposable plastic and paper bags to finance stormwater programs
 - Developing stringent stormwater regulations for new development and redevelopment projects
 - Creating a market for stormwater retention credits as an off-site option for new developments
-

BACKGROUND

The District of Columbia, with a population of 632,323, has three main waterways: the Potomac River, the Anacostia River, and Rock Creek. About one-third of the District is served by a combined sewer system (combined wastewater and stormwater) (CSS), while the remainder of the District is served by a municipal separate storm sewer system (MS4).

DC Water, the District of Columbia Water and Sewer Authority, is an independent authority of the District created in 1996. Serving a 725-square-mile area that includes adjacent counties in Maryland and Virginia, DC Water is responsible for drinking water and wastewater services and oversees the combined storm and wastewater system. The District Department of the Environment (DDOE) oversees the separate stormwater system in the District of Columbia only.

Roughly 43% of the District's land area is covered by parking lots, buildings, and streets that prevent stormwater from being absorbed where it falls. The large amount of impervious surface leads to large volumes of rainwater runoff, ultimately causing pollution in the District's water bodies, erosion of stream banks, and serious flooding in several areas of the city. The District annually releases 1.96 billion gallons of raw sewage combined with stormwater (combined sewer overflows, or CSOs) into the three main waterways because the speed and volume of runoff after a storm prevents treatment.

Under a 2005 consent decree with the U.S. Environmental Protection Agency (EPA), DC Water originally agreed to build three underground tunnels (gray infrastructure) to reduce by 96% the number of raw sewage releases (CSOs) over 20 years. The project to meet these requirements, Clean Rivers, will cost an estimated \$2.6 billion, funded primarily by the impervious surface stormwater fee enacted in 2009 (see below).

In December of 2012, DC Water, the District government, and EPA signed a Green Infrastructure Partnership Agreement to explore the potential of green infrastructure to reduce the discharge of untreated sewage and stormwater as a partial alternative to the underground tunnels.

The District is in the process of revising stormwater management regulations to require development projects that disturb 5,000 square feet of land or more to retain all the rain from a 1.2-inch storm. Projects that involve major interior renovations of structures with a footprint of 5,000 square feet or more will be required to retain all of the rain from a 0.8-inch storm.

However, these projects may meet half of these requirements off-site by paying an in-lieu fee to the District (which will be used for green and gray programs elsewhere) or by buying stormwater retention credits from a program now being developed.

The stormwater retention credit (SRC) trading program being developed by the District will allow development projects subject to the District's stormwater regulations to purchase credits (SRCs) from the private market to meet their stormwater retention requirements off-site.

The District believes that the SRC trading program has the potential to reduce compliance costs for developers who will be subject to the new stormwater development regulations, provide greater benefits for the District's rivers and streams, and create other socioeconomic benefits that would not be achieved by requiring strict on-site stormwater retention. This approach has the potential to significantly improve the triple bottom line: creating environmental, economic, and social benefits. In fact, the District expects that regulated development will be the biggest driver of green infrastructure installation in the District.

SUCCESSFUL GREEN INFRASTRUCTURE MEASURES IMPLEMENTED

- 1) *Stormwater Impervious Fee* — Since 2009, both commercial and residential property owners in the District have paid two stormwater fees as part of their monthly water bill. The fees are based on the amount of impervious surface on their property; the fees also represent the differential costs of addressing different stormwater problems.

The DDOE uses one of the two fees to meet its mandated stormwater improvement requirements and to install green infrastructure throughout the District. That fee is currently \$2.67 per 1,000 square feet of impervious cover.

DC Water uses the second fee, the Impervious Area Charge, to implement the Clean Rivers project designed to reduce untreated sewage overflows into District water bodies. That fee is currently \$9.57 per month per 1,000 square feet of impervious cover and will increase to roughly \$30 per square feet by 2020.

Both fees are designed to meet two goals: to raise revenue to fund green and gray stormwater (and related) improvements, and to induce property owners to reduce stormwater runoff from their property (for example, by retaining stormwater in rain barrels or removing impervious cover, such as parking lots, to ensure that water infiltrates the soil on-site).

- 2) *RiverSmarts Rewards Program* — This pending program will provide a discount up to 55% of the monthly stormwater fee for property owners who install green infrastructure that retains the water from a 1.2-inch storm. These property owners will also be eligible for discounts on their DC Water Impervious Area Charge, but DC Water has not yet established the maximum discount. The District finalized the program in July 2013.
- 3) *RiverSmarts Home Program (DDOE)* — Established in 2007, this program provides homeowners with technical and financial assistance to retain stormwater on their property. Homeowners can also receive subsidies up to \$1,200 for implementing measures such as rain gardens, permeable pavements, and rain barrels.

- 4) **RiverSmart Communities (DDOE)** – Established in 2011 to extend the Home Program to multi-family residences. DDOE also provides an online tool, GreenUp DC, to suggest appropriate green infrastructure measures to property owners.
- 5) **RiverSmart Rooftops (DDOE)** – This program provides both residential and commercial property owners with a one-time cash rebate of \$5 per square foot of green roof installed on their buildings.
- 6) **Disposable Bag Fee (DDOE)** – The DC government requires all stores that sell food or alcohol in the District to charge a 5-cent fee on each disposable bag provided to customers. Instituted in 2010, this is the first fee on bag usage in the country. A portion of these funds go towards the District’s green infrastructure programs, such as RiverSmart Homes and RiverSmart Rooftops.

IMPACTS AND EFFECTS

The District’s calculations of the impact of the RiverSmart Homes Program in FY 2011 and FY 2012 appear in table 2.

Table 2. RiverSmart Homes Stormwater Volume Reductions

Fiscal Year	RiverSmart Homes Practice	No. Installed	Impervious Surface Retrofitted (sq. ft.)	Annual Runoff Retained (gallons)
2011	Rain Barrels	428	89,880	1,506,339
	Rain Gardens	66	29,700	497,756
	Pervious Pavers	28	12,600	211,169
2011 Total		522	132,180	2,215,264
2012	Rain Barrels	739	155,190	2,600,899
	Rain Gardens	162	72,900	1,221,764
	Pervious Pavers	23	10,350	173,460
2012 Total		924	238,440	3,996,123
<i>RiverSmart Homes rain barrels are assumed to treat 210 sf of rooftop area to the 1-inch level. RiverSmart Homes rain gardens assumed to retain 1 inch of runoff from 450 sf of impervious surface. RiverSmart Homes permeable pavers assumed to retain 1 inch from retrofitted surface area</i>				

These efforts and the general trend towards green building have led to the installation of 1.8 million square feet of green roofs, making the District a national leader (table 3 and table 4).

Table 3. Stormwater Runoff Retained by Retrofit Projects

Fiscal Year	Watershed	Impervious Surface Retrofitted (sq. ft.)	Impervious Surface Retrofitted (acres)	Annual Runoff Retained (gallons)
2011	Rock Creek	31,478	0.7	556,438
	Anacostia	261,848	6.0	3,307,912
	Potomac	37,773	0.9	667,715
Total		331,099	7.6	4,532,066
2012	Rock Creek	49,332	1.1	683,325
	Anacostia	344,026	7.9	3,388,578
	Potomac	17,615	0.4	294,465
Total		410,973	9.4	4,366,368

Table 4. Stormwater Runoff Retained by Green Roof Retrofit Projects

Fiscal Year	Watershed	Impervious Surface Retrofitted (sq. ft.)	Impervious Surface Retrofitted (acres)	Annual Runoff Retained (gallons)
2011	Rock Creek	5,080	0.1	192,538
	Anacostia	28,777	0.7	1,090,684
	Potomac	30,216	0.7	1,145,224
Total		64,073	1.5	2,428,446
2012	Rock Creek	1,780	0.0	67,464
	Anacostia	28,330	0.7	1,073,742
	Potomac	19,027	0.4	721,147
Total		49,317	1.1	1,862,353

Houston, TX

- Levies an impervious surface stormwater fee
 - Operates a wetland mitigation bank that treats stormwater runoff
 - Plans to incorporate water quality treatment with stormwater detention storage
 - Developing and connecting a system of parks and trails along area bayous
 - Promotes design criteria for Low Impact Development and Green Infrastructure
-

BACKGROUND

The city of Houston lies within Harris County in Southeast Texas, only 60 miles from the Gulf of Mexico. The city is the fourth largest in the nation with a population of 2.1 million; Harris County has an area of 1,778 square miles and is the third most populous in the country with 4.1 million residents. The county has an extensive system of bayous and channels that stretch more than 2,500 miles in length, of which roughly 800 miles are natural; the remainder has been created by developers and agricultural producers. There are ten major bayous in the county, four of which pass through the city of Houston: Buffalo, White Oak, Brays, and Sims.

The entire Houston region depends on municipal separate stormwater sewer systems (MS4). Local municipalities, the county, and the Texas Department of Transportation are responsible for operating, maintaining, and improving these separate systems, largely roadway drainage methods that range from storm sewers to roadside ditches. Most of the cities in the county experience serious localized flooding as these methods overflow and back-up. These entities deliver the stormwater they have collected, untreated, to the county's bayous and channels managed by the Harris County Flood Control District (HCFCD).

The Flood Control District (HCFCD) was established by the state in 1937 in response to devastating local floods. It is a special-purpose district that includes the 22 main watersheds in Harris County; its boundaries are coterminous with the county. The Flood Control District oversees flood control and maintains and constructs the primary drainage channels; that is, the network of bayous and open channels into which all the other entities discharge their stormwater.

During excessive rainfall, the primary drainage channels are prone to flooding. The natural threat of flooding in the region is heightened by high annual rainfall, impervious clay soils, increased urbanization that creates additional impervious cover (land where water cannot soak into the ground), the very slow-moving extensive system of bayous, and tropical storms. As a result, managing flooding is a priority for the city of Houston and the Flood Control District.

Houston and other cities in the county have attempted to address localized flooding and back-ups in stormwater sewers and open ditches in a number of ways. Houston has a comprehensive stormwater management program to systematically identify the parts of the existing system most in need of repair and to then program gray infrastructure repair and expansion. Roughly three-quarters of these improvements have been funded by the federal government (FEMA), with additional funds from large institutional entities in the region.

The city of Houston has developed a number of programs to encourage residents to use green infrastructure approaches to retain stormwater on-site. They also have development regulations requiring large developers and commercial land owners to reduce impervious cover and use other methods to retain stormwater on-site. The city of Houston's *Infrastructure Design Manual*, which informs design requirements for infrastructure such as wastewater collection systems and stormwater quality design, includes information about low-impact development techniques that may be used to meet stormwater management requirements. Accepted green infrastructure strategies include bioretention, infiltration trenches, porous pavement, vegetative swales, green roofs, and rain barrels.

The Flood Control District addresses stormwater capacity and flooding in the primary system by widening multiple channels and maintaining hundreds of stormwater detention basins, which also act as open green space; some retention basins operate as water quality treatment lakes.

In 1998 a partnership between the city of Houston, Harris County, HCFCD, and the Texas Department of Transportation established the Storm Water Management Joint Task Force (JTF) to coordinate stormwater projects and meet federal stormwater discharge quality requirements. Since this partnership is responsible for the amount and quality of stormwater entering the bayou system, members of the JTF have encouraged stormwater management through green infrastructure.

Moreover, there has long been the possibility of expanding the use of the bayous and channels to meet multiple green goals. For almost 100 years there has been discussion of fully using the bayous as a continuous linear park. In 2011, the Houston Parks Board (a non-profit organization) commissioned a study to assess the feasibility of this goal, in part by combining green stormwater infrastructure with recreational improvements to the bayous and channels. As a result of that study, the community created a long-range plan called the Bayou Greenway Initiative to coordinate a number of city, county, state, and Federal water quality, flood control, and environmental investments to connect a number of dispersed parks and trails along the bayou system.

In November 2012, city residents voted to approve \$480 million to fund the first portion of that initiative, bringing together public and private entities to add more than 4,000 new acres of green spaces and 300 miles of continuous trails, equitably distributed along the bayous throughout Harris County, in the next 10 to 15 years. Because the Flood Control District owns or has the right-of-way for most of the land needed to connect and expand the park and trail space, it has developed formal relationships with the many involved partners. Moreover, the plan envisions that retention ponds will be built under some of the bayous to prevent recurrent flooding in the parks and facilities along the bayous and channels.

The initial installment of the overall initiative approved by Houston voters is called Bayou Greenways 2020, and will connect 150 miles of parks and trails along the bayous in the city of Houston by the year 2020. The public-private partnership undertaking that initiative harnesses \$100 million in city bonds matched with up to \$105 million in private funds. In addition to creating recreational spaces, increasing the amount of green spaces will also assist the city's stormwater and flood management efforts because the added vegetation will help retain, filter, and clean stormwater.

SUCCESSFUL GREEN INFRASTRUCTURE MEASURES IMPLEMENTED

- 1) *Drainage Utility Charge (City of Houston)* – In 2010, Houston voters approved a comprehensive City Charter amendment called ReBuild Houston to provide for the enhancement, improvement, and ongoing renewal of Houston's drainage and streets by creating a dedicated fund for drainage and streets.

One of four aspects of the funding system is a drainage utility charge based on the actual impact of a property on the drainage infrastructure. The charge is based on the property's impervious surface area (measured by mapping data), type of drainage system (curb and gutter or open ditch), and type of property (residential or non-residential). Charges may be reduced if property owners decrease the effects of impervious surface area using approved stormwater management techniques such as rain barrels, green roofs, bioretention (shallow basins with specific soils and plants), porous pavement, and stormwater detention.

- 2) ***Harris County Low Impact Development & Green Infrastructure Design Criteria for Storm Water Management (Harris County and HCFCD)*** – In 2011, Harris County and the Flood Control District developed a set of guidelines for low-impact development (LID) and green infrastructure (GI) practices, the first set of low-impact development guidelines in the state. County and HCFCD officials were encouraged to create the manual after the 2010 Low Impact Development Design Competition, organized by the Houston Land/Water Sustainability Forum, a collaborative of representatives from state, county, and city agencies as well as private organizations.

The design competition, the first of its kind in the country, exposed the land development community to the principles of designing and implementing LID and GI in three development type categories: suburban residential, urban redevelopment, and green roadway. Since then, other communities across the nation have been inspired to host similar competitions to encourage developers to implement innovative green infrastructure strategies in their neighborhoods.

Prior to the design guide, developers wishing to implement green infrastructure did not have a substantial criteria for designing and planning green infrastructure. The design guide presents developers, construction contractors, and county officials wishing to use low-impact development with a set of guidelines that explain design, construction, and maintenance of a variety of appropriate green infrastructure techniques.

By indicating which green infrastructure practices are acceptable, the guide creates more certainty and confidence about the permitting process for the developers who wish to incorporate such practices; reducing risk and uncertainty about permitting encourages the adoption of such techniques. Developers are also required to meet with the county early in the design and planning phase of the

project, further ensuring that effective techniques are adopted and projects are approved in a timely and cost-efficient manner.

Developers who have successfully shown through design and modeling that their green infrastructure tools can reduce runoff may receive a reduction in the stormwater detention requirement, a very enticing incentive for Houston developers. Furthermore, developers may receive a 20% reduction in the one-time stormwater quality permit fee for implementing green infrastructure such as bioswales or rain gardens.

- 3) ***Wetlands and Stream Mitigation Banking (HCFCD)*** – Mitigation banks are large-scale ecosystem-oriented wetland restoration projects designed to provide sustainable ecological benefits in advance of unavoidable adverse impacts on wetlands caused by human activity. Any project activity that fits that criterion under the jurisdiction of the US Army Corps of Engineers (Section 404 of the Clean Water Act) must go through the permitting process to determine eligibility for purchasing credits in a mitigation bank.

In 1997, the Flood Control District completed the first stage of The Greens Bayou Wetlands Mitigation Bank. This 1,400-acre project in northeast Harris County is a comprehensive wetland preservation, conservation, and restoration effort that also treats stormwater pollutants from a nearby highway by allowing it to flow through an engineered ecosystem.

Fees charged to developers for obtaining wetlands credits from the bank are used to maintain, expand, and monitor the Mitigation Bank. HCFCD and Harris County are also pursuing a Harris County Umbrella Mitigation Bank that will provide the mechanism for creating wetlands and stream mitigation projects throughout the county. The mitigation banking agreement is under development, and the first three projects have been identified.

- 4) ***Project Brays (HCFCD)*** – The Flood Control District has partnered with the US Army Corps of Engineers in Project Brays, a \$450 million effort to provide major flood risk reduction and stormwater capacity along 31 miles of the Brays Bayou while also adding community amenities. Planned improvements include four regional stormwater detention basins that will temporarily hold stormwater to reduce the risk of flooding while also improving stormwater quality. The project also widens and greens 18 miles of bayous and channels to increase stormwater

capacity. The channel work and stormwater detention basins have also been designed to give the community much needed green space and recreational areas.

- 5) ***Tree Planting Program (HCFCD)*** – The Flood Control District plants trees on the bayou rights-of-way and supports partnerships with organizations that are interested in tree planting. Trees correctly chosen and planted near the bayous reduce routine maintenance, support healthy ecosystems, and reduce erosion.

The District also has its own *Vegetation Management Manual* and *Tree & Shrub Field Guide* that document current maintenance philosophy and practices about plantings and vegetation along existing channels managed by HCFCD. The goal is to ensure that the proper strategies are used to reduce maintenance requirements. The *Tree & Shrub Field Guide* emphasizes ecosystem integrity and perpetual regeneration of desirable vegetation. The guide is also used to help identify desirable vegetation during maintenance operations and also to support planting operations by HCFCD and its partners.

IMPACTS AND EFFECTS

The drainage utility charges are expected to raise \$125 million in FY2014.

The *Low Impact Development & Green Infrastructure Design Criteria Manual* is increasing in popularity as the concepts become more widely accepted. Several new subdivisions and two public road projects have been developed using the principles in the manual.

A 2009 study of the Greens Bayou Wetlands Mitigation Bank (GBWMB) found that approximately 240 million gallons of stormwater from the Surge Basin (which receives runoff from the adjacent highway) entered the mitigation bank's polishing ponds that help to retain and clean runoff. In fact, the wetlands were found to have statistically reduced a number of pollutants entering the bayous and channels: total suspended solids were decreased by 60%, total phosphorous decreased by 24%, and total inorganic nitrates decreased by 20%. The amount of aquatic habitat also increased from .42 acre to 63.5 acres since the creation of the mitigation bank.

Due to the high demand for credits for the Bank, the Flood Control District is not currently accepting applications. The Flood Control District is opening up more land and establishing more credits at the Bank as well as establishing a Harris County

Umbrella Mitigation Bank that will provide more flexibility in implementing appropriate land-banking activities throughout the county.

Project Brays' four stormwater detention basins, which total about 900 acres of land, are designed to retain more than 2 billion gallons of stormwater annually. The project is half complete and is already providing flood damage reduction benefits.

Ultimately, it will provide flood protection to 15,000 homes and businesses during a 1% flood event (100-year).

The Flood Control District plants around 20,000 trees per year along the bayous and stormwater detention basins. HCFCD has planted more than 160,000 trees since 2001, making it the second highest governmental tree-planting agency in the county.

Milwaukee, WI

- Imposes stormwater management charges based on impervious cover
 - Undertook a sophisticated analysis of how to balance gray and green infrastructure investments
 - Developed an online tool to allow the public to calculate and promote the benefits of green infrastructure
 - Piloted project to develop green infrastructure development standards
 - Created an innovative conservation program along urban waterways
-

BACKGROUND

Milwaukee is located on the western shore of Lake Michigan at the confluence of the Milwaukee, Menomonee, and Kinnickinnic rivers. A city of almost 600,000 people, Milwaukee is spread over roughly 97 square miles. The metropolitan area of roughly 2 million people is served almost entirely by a municipal separate storm sewer system (MS4). However, about 25% of the city of Milwaukee, in generally older areas, relies on a combined sewer system (CSS) that mixes sewage and stormwater. Each of the 28 municipalities in the region collect their own sewage and stormwater, but send it downstream to the Milwaukee Metropolitan Sewerage District (MMSD), which collects, stores, and treats the region's sewage and stormwater.

MMSD's planning area is 411 square miles and covers six watersheds, most of which drain into Lake Michigan, the drinking water source for the area's residents. Just over 90 square miles, or 22%, of MMSD's planning area is impervious cover, or land that cannot absorb stormwater because it is covered with buildings, streets, and parking lots.

As it urbanized, the Milwaukee region experienced increased combined sewer overflows (that is, the discharge of untreated sewage and stormwater into nearby waterways, or CSOs) from the combined sewage and stormwater system because the system was unable to handle the sheer volume of water during heavy storms. These overflows occurred even though the majority of stormwater was handled within a separate system. The region also experienced substantial flooding after heavy rains, especially along urban waterways.

Beginning in 1994 (and as the result of a 1977 consent agreement with EPA), MMSD began investing what would ultimately be \$4 billion to construct a 521-million-gallon underground tunnel storage system. This gray infrastructure response has been successful in reducing the number of overflows of untreated water from approximately 60 a year to only two or three annually (a few still occur because the tunnel system is still unable to control overflow created by the very largest storms).

In 2011, MMSD completed the 2035 Vision plan, whose major goals are to completely eliminate combined sewer and stormwater overflows and sewer backups by balancing green and gray infrastructure. The plan was based in part on the success of a number of green infrastructure pilot projects by MMSD and the participation of many influential stakeholders in the development process. In January 2013, as a condition of receiving their discharge permit, the State of Wisconsin explicitly required MMSD to implement green infrastructure projects to retain at least 1 million gallons of stormwater per wet weather event for each of the five years of the permit.*

MMSD feels that an emphasis on green infrastructure (together with some traditional or gray infrastructure fixes) provides a more practical, less expensive option for the remaining stormwater problems facing the region. The District also conducted a study on how to strike a strategic balance between green and gray infrastructure in eliminating sewer overflows and the triple bottom line benefits that may be gained through the adoption of green infrastructure strategies.

The District is currently working with the city of Milwaukee, 27 other municipalities, and a broad range of stakeholders to develop a Regional Green Infrastructure Plan. The plan seeks to meet the 2035 Vision goal of capturing the first 0.5 inches of stormwater that falls on impervious surfaces across the planning area, or the equivalent of 740 million gallons of stormwater.

MMSD believes that this will be the first plan for a major metropolitan area that considers green infrastructure in BOTH combined and separately sewered areas, the first that considers how green infrastructure complements extensive inflow/infiltration reduction efforts, and the first that makes recommendations for widespread soil amendments.

SUCCESSFUL GREEN INFRASTRUCTURE MEASURES IMPLEMENTED

- 1) *Greenseams (MMSD)* — This program, established in 2001, is a partnership of the Milwaukee Metropolitan Sewerage District and The Conservation Fund. MMSD purchases land outright or buys the easements along waterways and wetlands so the land can be preserved and, ultimately, returned to its natural state.

Preserving such properties allows stormwater to continue to be captured, retained, and cleaned naturally on-site, and helps to lower the extra capacity or reserve that the District builds into downstream flood management facilities.

The state of Wisconsin specifically requires MMSD to retain 1 million gallons of stormwater through green infrastructure as a condition of maintaining the right to discharge treated water into nearby waterways. However, the state allows 75% of that retention to come in the form of land that the Greenseams program acquires and preserves.

- 2) *Stormwater Management Charge (City of Milwaukee)* — In 2012, Milwaukee began assessing a monthly or quarterly Stormwater Management Charge against both residential and commercial property owners. Residential properties are assessed a flat fee based on the amount of impervious cover on the property of an average or representative home (1,610 square feet). Thus, all residential utility payers are charged the same amount, regardless of the size of their property or the actual impervious surface.

The fee for non-residential properties is based on the actual amount of impervious cover on the property and is calculated as a multiple of the residential average, 1,610 square feet. Revenues from these charges go to support projects that prevent stormwater pollution as well as the operation and maintenance of the stormwater systems.

Nearly three-quarters of the other municipalities in the region have stormwater fees based in part on impervious cover; some even base residential charges on the actual percentage of impervious cover on the property.

- 3) *H2OCapture (MMSD)* — The Milwaukee Metropolitan Sewerage District partnered with the Natural Resources Defense Council to create an online calculator that ultimately became part of H2OCapture, an educational website promoting green infrastructure in the Milwaukee region. The site also contains a cost savings calculator to help residents understand the potential benefits of

green infrastructure as well as information about programs that provide guidance and financial support for the use of green infrastructure.

- 4) ***6th Street Green Corridor*** — A partnership of local businesses and organizations implemented a number of green infrastructure measures along a high-profile transportation corridor running between the airport, port, and train station, a stretch prone to flooding because of proximity to the Wilson Park Creek, which regularly floods. The partnership has completed more than 16 acres of stormwater retrofits that retain stormwater on a three-mile stretch of the South 6th Street Corridor.
- 5) ***Green Infrastructure Portfolio Standard (City of Milwaukee)*** — The city partnered with the Center for Neighborhood Technology, American Rivers, and other organizations to undertake the Green Infrastructure Portfolio Standard (GIPS) pilot project, the nation's first green infrastructure portfolio standards. The standards were developed to help communities plan for and implement green infrastructure in developed, urban areas with a cost-efficient, strategic, and comprehensive approach. Two pilot neighborhoods with significant flooding issues have already implemented several green infrastructure projects.
- 6) ***Rain Barrels (MMSD)*** — This program of the Milwaukee Metropolitan Sewerage District distributes rain barrels throughout the region, sold at cost; rain barrels capture and hold 55 gallons of stormwater for later lawn and garden use. They are also a major educational tool that helps the general public understand basic stormwater management approaches and what they can do to help.
- 7) ***Green Roofs (MMSD)*** — The Milwaukee Metropolitan Sewerage District has funded 9.8 acres of different kinds of green roofs since 2003. Of those, 7.4 acres have been already been constructed and hold up to 320,000 gallons of stormwater when it rains.

IMPACTS AND EFFECTS

The Greenseams program has been able to conserve about 2,500 acres of land since its inception; the program also planted more than 17,000 trees in 2012, which brings the total number of trees planted to 75,000. The green infrastructure projects within the 6th Street Corridor collaboration are estimated to retain 550,000 gallons of stormwater during heavy rainfalls, helping to prevent flooding from nearby Wilson Park Creek. In April 2013, MMSD passed a major milestone, distributing more than

18,182 rain barrels: the equivalent of 1 million gallons of storage. They are made from reclaimed food-grade barrels, retrofitted by the Milwaukee Community Service Corps, and sold at cost.

*The Wisconsin Pollutant Discharge Elimination System (WPDES) Permit is the first wastewater discharge permit in the nation to *mandate* green infrastructure.

Philadelphia, PA

- Achieved EPA approval for largely using green stormwater infrastructure to reduce combined sewer overflows, the first city to do so
 - Using green infrastructure to reduce the impact of stormwater runoff
 - Offers financial and regulatory incentives for private property owners to incorporate green infrastructure on their property
 - Imposes monthly stormwater charges based on impervious cover
 - Integrated water, wastewater, and stormwater services
-

BACKGROUND

Philadelphia is in the southeast corner of Pennsylvania, flanked by the Delaware and Schuylkill rivers. The city itself covers roughly 143 square miles and has 1.54 million inhabitants, making it the fifth largest city in the nation. Philadelphia is the only combined city-county government in the state and one of the few in the United States. The larger metropolitan area houses more than 4 million people.

The city is part of the Delaware River Watershed and includes seven sub-watersheds. Sixty percent of the city has a combined sewer system (CSS), which conveys both sewage and stormwater. The remainder of the city, generally newer neighborhoods, has a municipal separate storm sewer system (MS4). The Philadelphia Water Department (PWD) owns and operates both systems.

In the last century, the city's growth has substantially increased the amount of impervious surface, land where water cannot soak into the ground because it is covered with buildings, parking lots, and streets. Today more than 54% of the surface area of the city is impervious to water. As a result, an increasing amount of rainwater runs off properties. During severe rain events, this stormwater runoff overwhelms the city's combined sewer and stormwater system, creating combined sewage overflows (CSOs), or the release of untreated wastewater and pollutants, into the Delaware and Schuylkill rivers and surrounding waterways. Philadelphia discharges an average of 16 billion gallons of untreated water annually.

Federal regulations and state mandates have compelled Philadelphia to take action to manage stormwater, reduce runoff, improve water quality, and engage the public in the decision-making process. In 1997, the city submitted its initial long-term

combined sewer overflow control plan to the state of Pennsylvania, committing the city to spend more than \$150 million per year in gray improvements to the sewer system. In 1999, the city merged three different water programs to more efficiently and holistically address water issues.

In 2009, Philadelphia submitted a revised plan to the state that proposed using green infrastructure to manage stormwater, in lieu of the traditional emphasis on gray infrastructure improvements. The plan, called Green City, Clean Waters, is designed to keep pollutants from entering local rivers by capturing stormwater and storing it, using green approaches such as planters, stormwater tree pits, and rain gardens. The city estimates that these measures will lead to the removal of pollutants that is equal to capturing 85% of the untreated sewage that flows into rivers and streams during combined sewer overflows. The city has committed \$1.2 billion over a 25-year period to achieving this goal.

Philadelphia argues that a green infrastructure approach to stormwater management is cost-effective when measured against the triple bottom line; that is, it will be cost-effective not only because it will be cheaper than traditional gray approaches to stormwater management, but because the green infrastructure strategy will also produce additional economic, social, and other environmental benefits such as green jobs, increased property values, and improved health through reduced air pollution. The revised plan also includes targeted gray infrastructure investments, such as upgrades to treatment plants.

By 2036 the city plans to “green” one-third of the city’s impervious cover within the areas covered by the combined sewer and stormwater system. To measure its progress, the city uses a concept they call the “greened acre.” A greened acre is an area (of any size) with impervious cover that has been retrofitted to filter or store the equivalent of one inch of stormwater runoff from one actual acre of impervious cover (27,158 gallons of stormwater) from each storm. The city will first focus on municipally owned land, which comprises about 45% of the impervious surface area in the city (public streets and sidewalks alone account for 38% of all of Philadelphia’s impervious cover).

In addition, several city agencies are collaborating to create a manual that standardizes green street components and requirements, creating a streamlined approach to planning for and investing in complementary street and sewer projects. Nonprofits like the Tookany/Tacony-Frankford (TTF) Watershed Partnership and programs like the Green City, Clean Waters Ambassadors also help to educate

neighborhoods and engage residents about the multiple benefits of using green infrastructure to address runoff.

The city has also developed integrated watershed management plans in partnership with other jurisdictions in the watershed. The city has seven watershed partnerships to coordinate planning, implementation, and educational efforts related to Green City, Clean Waters and the Integrated Watershed Management Plans. For example, the TTF Watershed Partnership coordinates with multiple municipalities to educate the public about stormwater issues and solutions and to help advance green infrastructure in the region.

On June 1, 2011, the state of Pennsylvania approved the Green City, Clean Waters Plan through a Consent Order and Agreement. In January 2012, the city awarded six contracts to expert consultants to evaluate the feasibility of projects in a number of Stormwater Management Enhancement Districts over the coming years to identify opportunities for large-scale, coordinated green infrastructure implementation. On April 10, 2012, the city also entered into a partnership with the EPA to advance green infrastructure research and strategies.

On September 21, 2012, the EPA and the City of Philadelphia signed the first formal consent order in the nation to allow the use of green infrastructure as the primary means of addressing stormwater issues. Philadelphia's approach has garnered substantial national interest and has become an American testing ground for green infrastructure's ability to effectively manage stormwater. The EPA has committed \$3 million to follow and test the impact of Philadelphia's green infrastructure approach to stormwater management, while several national foundations have also committed to working with city agencies to monitor and test outcomes over the coming years.

The city has also worked with the Natural Infrastructure Innovative Financing Lab (NatLab), a consortium of The Nature Conservancy, Natural Resources Defense Council, and EKO Asset Management Partners, to analyze the economics of the existing fee and credit system to deliver a viable investment model for stormwater retrofits. The city is continuing to collaborate with NatLab to develop a pay-for-performance mechanism to reduce the cost of greened acres delivered on public property.

SUCCESSFUL GREEN INFRASTRUCTURE MEASURES IMPLEMENTED

- 1) ***Stormwater Development Regulations*** — In 2006, the city revised land use regulations to require development projects that disturb more than 15,000 square feet of earth to capture and retain on-site the first inch of rain from each storm. Developers can use a variety of methods to meet this requirement (such as a detention or holding pond on-site). If water cannot enter the ground (for example, due to rocks or ground contamination), developers may be permitted to adopt other methods. The regulations also require developers to adopt additional measures that reduce the negative effects of stormwater runoff from their property.
- 2) ***Impervious Cover Stormwater fees*** — In 2010, the city adopted a parcel-based stormwater billing system designed to encourage both residential and commercial property owners to reduce impervious cover. The full charges are being phased in over four years to lessen the burden on the most affected property owners. Under the new formula, 80% of monthly stormwater fees are based on the total amount of the property's impervious cover, while the remaining 20% is based on the total area of the property.

Thus commercial, industrial, and other non-residential property owners are assessed varying fees based on the *actual* amount of impervious surface and total area on their individual properties. Residential property owners pay a flat fee (currently \$12.10 per month) computed as the residential share of the total amount of impervious cover on all residential properties in the city.

Basing fees on the factors that actually cause stormwater runoff (impervious cover) has had profound implications. For example, the University of Pennsylvania is paying approximately \$11,000 less per month on stormwater fees than it did in the past, while Philadelphia International Airport saw an increase in its stormwater fees of \$126,000 monthly. The city has required the change in billing to be revenue neutral. However, tying the stormwater fee to reducing stormwater runoff is designed to encourage property owners to reduce their impact on the combined sewer system.

- 3) ***Stormwater Management Incentives Program*** — This joint program between the city and the Philadelphia Industrial Development Corporation provides grants of up to \$100,000 per greened acre to non-residential property owners who use

green infrastructure to manage stormwater. To receive a grant, projects must capture the first inch of runoff from each storm on-site through green infrastructure techniques such as rain gardens, de-paving, or green roofs.

- 4) ***Stormwater Credits Program*** – This program provides a percentage fee reduction to the monthly stormwater charge to commercial property owners who manage the first inch of stormwater runoff in each storm. Credits are also available to properties with high-quality open space.
- 5) ***Fast Track Permitting Review Process*** – Development projects that disconnect at least 95% of their impervious area from either the combined sewer and stormwater system or the stormwater system qualify for a “Fast Track Permitting Review Process” that reduces stormwater reviews to five days, saving developers time and money.
- 6) ***Green Roof Tax Credit*** – The city provides businesses a 25% cash rebate on the costs of installing a green roof on their properties, up to \$100,000. (Green roof costs range from \$10 to \$20 per square foot depending on the system installed and location.)
- 7) ***Stormwater Management Enhancement Districts*** – To encourage public-private partnerships for green infrastructure in new developments, the city is identifying a number of areas larger than 10 acres that possess strong potential for leveraged investments through such partnerships. The city has contracted with experts to evaluate each district’s stormwater management potential and will also evaluate potential financial and environmental feasibility and marketability.
- 8) ***Green Homes Program*** – The city has several programs that help homeowners manage stormwater. The city’s Rain Barrel Program distributes free rain barrels to residents who participate in a workshop educating private property owners about runoff reduction. In addition, the Rain Check Program provides free stormwater property assessments and shares in the cost of installing stormwater management features such as rain gardens or downspout planters on residential property.

IMPACTS AND EFFECTS

In 2011, the first year of the Green City, Clean Waters program, the city installed 17 green infrastructure projects, including the city’s first porous street; restored more than two miles of streams; and approved more than 300,000 square feet of

green roofs for private development. In addition, 9,300 residents participated in stormwater management educational workshops and activities. Other highlights include the following:

- The city has distributed 2,766 free rain barrels to residents since 2002, which could prevent 9.6 million gallons of stormwater from entering the sewer systems. In 2012, 478 rain barrels were installed in private homes.
- The Stormwater Management Incentives Program has awarded eight non-residential property owners approximately \$3.2 million to create 65.5 greened acres, which should help manage 1.8 million gallons of untreated stormwater per rainfall.
- As of June 2011, the Fast Track Permitting Review is estimated to have kept between 1 and 1.2 billion gallons of stormwater out of the city's sewer system.
- Since 2006, 540 new development and redevelopment projects, totaling 1,261 acres, have had to meet stormwater development regulations. Each of these projects must manage the first inch of stormwater from each storm on-site. An average of 1 million gallons of rain falls on each acre every year.
- The Tookany/Tacony-Frankford Watershed Partnership hosted more than 100 meetings and events in 2012, engaging more than 2,800 residents with stormwater management issues and green infrastructure strategies.

Portland, OR

- Offers development incentives to increase on-site management of stormwater
 - Assesses a monthly stormwater management fee based on impervious area
 - Implements a comprehensive Green Streets Program
 - Operates an ecoroof incentive program
 - Created a Green Investment Fund giving grants to exemplary green infrastructure projects
-

BACKGROUND

Portland, Oregon, with a metropolitan population of 2.2 million, is situated at the confluence of the Columbia and Willamette rivers. The Columbia Slough, a narrow waterway, rests in the floodplains of the Columbia River. Nearly half of the neighborhoods in Portland are served by a combined sewer system (CSS) that carries sewage and stormwater in the same pipes. Starting in the 1950s, the city began installing new interceptor pipes to collect combined sewage and convey it to a new sewage treatment plant (which began operating in 1952).

Beginning in the 1960s, the city built the municipal separate storm sewer system (MS4). The city's Bureau of Environmental Services (BES) is responsible for managing the system that carries combined stormwater and sewage, the separate sanitary sewer system, and the separate storm sewer system. The Bureau is also responsible for wastewater collection and treatment, sewer installation, water quality protection, and watershed planning.

Portland has an average annual rainfall of 37 inches. Over the years, development has increased the amount of impervious surface area, that is, land which cannot absorb rainwater because it is covered with buildings, parking lots, and streets. The result is substantial stormwater runoff from land that would have previously retained a large percentage of that stormwater. Many of the pipes that carry combined sewage and stormwater are more than 80 years old and were not designed for the higher volume of stormwater runoff. Thus, heavy rains often cause the combined sewers to back up into basements and streets. In fact, Portland attributes 60% to 70% of the stormwater in its pipes to runoff from impervious surfaces.

Stormwater runoff during heavy rains used to cause Portland's combined sewer system to fill to capacity and overflow into the Columbia Slough and Willamette River an average of 50 times a year. Combined sewer overflow (CSO) volume averaged 6 billion gallons annually in 1991 when the city started work on a 20-year, \$1.4-billion gray infrastructure program. In 2011, Portland completed work on projects to remove stormwater from combined sewers and to increase capacity using large tunnels that collect and convey combined flows for treatment. Today, Portland's combined sewers overflow to the Willamette River on average only once every three summers and four times per winter.

The city has also introduced a series of green infrastructure initiatives designed to complement gray infrastructure strategies to control sewage overflows into rivers and streams, meet Federal and state mandates for water quality, and provide multiple ecosystem services. Portland created the Sustainable Stormwater Management Program in 2003 to promote and expand green infrastructure to manage stormwater runoff.

The city considers green infrastructure an important element in managing stormwater for watershed health. In 2008, the city launched the five-year, \$55 million Grey to Green Initiative to support, promote, and finance green infrastructure programs and projects. As part of this program, the city has purchased more than 360 acres of natural areas, including wetlands, to protect habitats that provide community benefits and manage stormwater.

Moreover, Portland's Green Streets policy requires all city-funded projects in the public right-of-way to incorporate green street improvements and meet the Stormwater Development Requirements (discussed below). If a green street facility is not possible at a particular site, then a fee is required or an offsite project must be developed. City-funded projects that do not need to meet the stormwater development requirements (because they include less than 500 square feet of impervious area) must pay a fee; the money raised goes into the 1% for Green Program (also discussed below). The city will also spend more than \$160 million repairing and replacing its aging infrastructure over the next five years.

SUCCESSFUL GREEN INFRASTRUCTURE MEASURES IMPLEMENTED

- 1) *Stormwater Development Requirements* — Since 2003, the city has imposed development requirements mandating stormwater management on all non-

residential development or redevelopment projects, including city-owned buildings, that include more than 500 square feet of impervious surface or propose new off-site stormwater discharges or new sewer connections.

These requirements are listed in the city's *Stormwater Management Manual*; developers are required to manage stormwater on-site through vegetation (to the maximum extent possible) and reduce pollutants from runoff to meet specific targets. For example, new or major redevelopment projects must remove 70% of the total solids suspended in stormwater from 90% of the stormwater that annually runs off the property.

- 2) ***The Green Streets Program*** — In 2007, the city built on its previous green streets efforts in several ways. First, the Council directed all city agencies to coordinate and implement green streets on public property to control and retain stormwater. At present, the city constructs and maintains green street facilities on public rights-of-way. Second, the city began working extensively with citizen and neighborhood groups and local organizations to develop neighborhood-based green street plans to use plants, trees, and other vegetation to retain, filter, and clean stormwater on private property.

The city fully integrated green street facilities into its capital improvement program as a solution to address capacity issues within its combined sewer system and water quality concerns in the separate storm sewer system. While several projects and plans include green streets, the largest effort is the Tabor to the River Program, covering 2.3 square miles in southeast Portland. Begun in 2008, the 15-year program includes the addition of 500 green streets, 3,500 trees, and more than 80,000 feet of repaired and replaced sewer pipes.

- 3) ***1% for Green Program*** — Per the Stormwater Development Requirements, the city requires all public and private development projects to manage stormwater on-site to the maximum extent possible with vegetated surface facilities. Some projects are exempt from these requirements; 1% of the construction budget of exempt projects is placed into a fund that helps to finance green streets projects throughout the city. Typically, this fund receives \$300,000 per year to build green street facilities.
- 4) ***Stormwater System Development Charge*** — New residential, commercial, industrial, and multi-family residential developments that contain more than 500 square feet of impervious area, propose new sewer connections, or meet other conditions must also pay a Stormwater System Development Charge. Developers

of residential properties are charged a flat fee; developers of non-residential properties must pay a fee based upon the amount of impervious surface on their property. This one-time charge can be reduced by decreasing the impervious area on the development site.

- 5) ***Ecoroof Incentive Program*** – The city offers floor-area ratio (FAR) bonuses to commercial developments that reduce the impervious area of the building’s roof with a green roof or rooftop garden. Developers in certain neighborhoods can obtain one square foot of additional floor area for each square foot of green roof area. The green roof portion must cover at least 50% of the roof area of the building, and the owner must also ensure that it is maintained.
- 6) ***Green Building Policy*** – In 2001, the city adopted a Green Building Policy that requires 70% of new rooftop area or re-roofing projects on city-owned buildings have ecoroofs or an Energy Star-rated roof material. If this proves infeasible, roof material with high reflectance must be installed. The policy has been strengthened since its passage so that new city-owned buildings must also meet LEED Gold Standard. In addition, new city-owned construction projects must achieve substantial water savings beyond the baseline code requirements, further reducing the amount of water that enters the sewer system.
- 7) ***Stormwater Management User Charge*** – Portland imposes several fees designed to ensure that property owners either pay their fair share of stormwater costs or reduce stormwater runoff (or both). Residential property owners are charged a flat monthly Stormwater Management User Charge based on the city’s calculations of the average amount of impervious cover on all residential properties in the city. However, commercial property owners are assessed stormwater charges based on the actual amount of impervious cover on their property.
- 8) ***Clean River Rewards Program*** – Through this program, created in 2006, property owners may receive up to a 35% discount on their monthly stormwater fee if they manage all of their stormwater on-site. Discounts for residential properties are based upon the ability to manage stormwater runoff from roof areas. Homeowners may also receive a smaller discount for retaining partial roof runoff or for increasing tree coverage on their property. Commercial properties receive a discount based upon their ability to manage stormwater both from their roof and from paved areas such as parking lots.

- 9) ***Green Street Stewards*** – Portland enlists resident volunteers to help with the maintenance of the city’s green street facilities with simple activities such as weeding, watering, picking up trash, and removing debris. City maintenance staff and contracted landscapers will do these activities when required as well as remove sediment, prune and trim plants, weed, and water.
- 10) ***GreenBucks Program*** – Through this program, utility customers may donate money to help public schools maintain green stormwater management facilities.
- 11) ***Innovative Wet Weather Program*** – EPA gave the city \$3.4 million between 2002 and 2009 to design and implement a variety of green infrastructure projects on public and private property to both manage stormwater and provide additional benefits to the community, such as traffic calming and additional green space.
For example, the city’s Bureau of Environmental Services partnered with the city’s Parks Department to retrofit Holman Park in northeast Portland with funds from this program. The project included green street facilities, traffic diversion, and reduction of impervious surface area using a variety of trees, plants, and rain gardens. The results were a more attractive park, reduced runoff, and useable community gathering space.
- 12) ***Green Investment Fund*** – The fund, which ran from 2001 to 2009, gave grants to more than 100 residential and commercial projects that demonstrated exemplary green-building characteristics, including environmental efficiency and green infrastructure such as green roofs. The Fund expended its budgeted funds by the end of 2009.
- 13) ***Downspout Disconnection Program*** – This program, which ran from 1993 to 2011, offered free downspout service and financial incentives to property owners to disconnect their downspouts from the combined sewer and wastewater system. Downspouts feed roof runoff into the sewer system; disconnecting downspouts and redirecting them onto vegetated areas reduces the amount of stormwater in the sewer, slows the volume of runoff entering the system, and decreases the amount of pollutants (since on-site vegetation helps to clean runoff).
The program ended in 2011 when the gray infrastructure improvements (“The Big Pipe” project) were completed, significantly reducing frequent overflows. However, the city still encourages property owners to disconnect their downspouts, especially if they are in combined sewer/stormwater pipe areas.

IMPACTS AND EFFECTS

Between 2008 and early 2013, the city completed 793 new green streets and planted nearly 30,000 trees using funds from the Grey to Green Initiative. Between fiscal years 2011 and 2012, more than 35,604 utility ratepayers registered for the Clean River Rewards program to receive discounts for retaining stormwater runoff on-site. In addition, educational programs and initiatives launched by the city provided outreach to more than 15,000 students as of June 2012; more than 19,500 residents participated in community events, workshops, and projects.

The city monitored several green infrastructure projects and found that green infrastructure techniques can retain at least 60% of stormwater volume and reduce peak flow during heavy rains by 80% to 90%. Moreover, the city concluded that:

- Rain gardens can retain more than 80% of the volume from a heavy storm that is likely to lead to serious overflows from the combined stormwater and sewage system. For example, the Glencoe rain garden can hold up to 94% of stormwater from such a storm.
- Through programs such as the Ecoroof Incentive Program, 10.72 new acres of ecoroofs were created. During intense rains, ecoroofs were found to reduce the flow of stormwater into sewers by as much as 97% during peak flows (heavy rainfall for several hours) and retain up to 61% of total stormwater. Furthermore, each square foot of green roof removed an estimated 0.04 pounds of dust and particulate matter from the air.
- Through the Downspout Disconnection Program, residential property owners disconnected more than 56,000 downspouts from the combined sewer and wastewater system, thus removing more than 1.3 billion gallons of stormwater from the sewer system each year.