Urban Water Series: Strategies That Work

Hosted by the Greater New Orleans Foundation in partnership with the Urban Institute and over 30 local partners.
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Background

Introduction

New Orleans faces unique stormwater problems: the city is largely below sea level and served by an aging and deteriorating stormwater system that is inadequate to handle the rain that pours off almost every impervious surface in the city after even minor storms. As a result, streets and neighborhoods flood regularly, causing serious water damage and disrupting businesses and families. Because the sanitary sewer system is not in much better shape, stormwater infiltrates the sewer system in heavy rains. The result is that both systems often discharge untreated stormwater and untreated sewage into Lake Pontchartrain and other nearby water bodies after heavy rains.

Moreover, because rainwater is not absorbed into the ground, the city is experiencing major subsidence—the ground is sinking because it is not stabilized by the historic volume of groundwater. Pumping stormwater out only exacerbates a vicious cycle; the more the city pumps the water out, the lower the ground sinks, increasing flooding from every storm and leading to more pumping.

While New Orleans faces unique constraints, many communities also have stormwater challenges. They address these challenges in three major ways. The first is by building massive grey infrastructure—pipes, pumping stations, and tunnels to retain stormwater. The second is by using green infrastructure, a variety of approaches that seek to keep rain on the property where it fell, using it productively and naturally. The number of communities implementing green infrastructure approaches to managing stormwater runoff has proliferated rapidly in just the last few years.

The third, and actually most common, is a combination of grey and green infrastructure to manage stormwater runoff. Portland (OR) and Milwaukee, for example, believe that green infrastructure can only complement grey investments, while other cities, like Philadelphia, are seeking to replace most grey investments with green infrastructure.

This series of five Workshops is bringing to New Orleans major decision-makers from a small number of vanguard cities so they can share their experiences and insights with the stakeholders of the greater New Orleans area. The focus is largely on peer-to-peer exchanges—most speakers are municipal officials and water professionals who have grappled first hand with the implementation of promising green infrastructure policies and programs. They can shed light on the challenges and barriers that faced them as they attempted to implement new programs and policies—and describe how they surmounted those problems, while explaining the benefits that green infrastructure investments have created in their communities.

While none of these communities faces exactly the same issues as New Orleans, their experiences, each in a different way, have lessons for New Orleans officials. Each of these cities faced or is facing deterioration of their existing systems and serious financial exigencies, as is New Orleans. Therefore these visiting water professionals can provide clear insights and offer practical guidance on how the greater New Orleans region can move forward towards green and sustainable ways of addressing local stormwater challenges.
Green vs Grey Infrastructure for 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 urbanization, the construction of buildings, streets, and parking lots on land that used to be able to retain and absorb stormwater. The more impervious cover in a city (that is, land that can no longer retain water), the more stormwater runs off the property where it fell, picking up pollutants, debris, waste, and bacteria as it moves over the urban landscape. This leads to localized flooding and worse, even in systems that separate stormwater from sewage, as in New Orleans. The sheer volume and speed of stormwater destroys river and creek banks, making water murky with un-dissolved solids while the urban pollutants endanger human health and aquatic wildlife.

In (generally older) cities where stormwater is combined with sewage in the sanitary sewer system, the rapid volume of stormwater runoff overwhelms the capacity of the system to treat waste. The result is the discharge of untreated sewage into nearby waterways. Even in systems that separate sewage and stormwater, the volume of runoff can be so intense that it infiltrates the sanitary sewer systems, also leading to the discharge of untreated sewage. Massive infrastructure investments can address all these problems, by reducing the pressure on the combined system, and by holding stormwater and then slowly releasing it into waterways after the storm has passed. But most communities lack the funds to build and maintain more grey infrastructure.

More importantly there is a growing consciousness of the need to reduce or avoid runoff in the first place, at the source, by applying green solutions to stormwater problems, solutions which not only retain stormwater on-site but use it in productive ways. Green infrastructure approaches largely prevent stormwater from entering and burdening the grey infrastructure, in the short or long term, while at the same time creating substantial social, economic, and cultural benefits for the community.

To the extent stormwater does eventually enter waterways after being absorbed or held by green infrastructure, it does so more slowly after first being “treated”—that is, pollutants and particulates are absorbed by trees, plants, and other vegetation. In addition, the plants, greened areas, and open space are important amenities in themselves that often provide recreational opportunities and make communities more attractive places for residents, businesses, and industry.

In short, green infrastructure approaches to stormwater management not only provide effective alternatives to massive and expensive grey building projects, they can also clean the air, reduce asthma, lower heating and cooling costs, and boost the economy while supporting green jobs. A major advantage of green infrastructure approaches is that they are likely to be cheaper and more resource-conscious than grey infrastructure.

Green stormwater management strategies are rapidly gaining prominence. Once the province of a few “green” communities, many cities have adopted green approaches to stormwater management. The relatively sudden emergence of green infrastructure is due to a combination of factors, many of which are mutually supportive:

- Federal and state mandates and consent orders that require communities to substantially reduce the frequency or volume of untreated waste that they discharge into waterways as the result of storms;
- State mandates requiring greater use of green infrastructure, generally in conjunction with the renewal of
discharge permits (i.e. permission to discharge treated sewage and stormwater into nearby waterways);

- Localized flooding, often in lower income neighborhoods;
- Erosion of river banks, streams, and other waterways from rapid stormwater discharges;
- Waterway sediment and pollution caused by urban stormwater runoff from parking lots and streets;
- High costs of grey, or capital intensive, solutions to stormwater runoff and untreated discharges;
- Growing consciousness of the need to treat stormwater runoff at its source in a more environmentally conservative way that naturally treats stormwater and supports the water cycle; and,
- Recognition that stormwater concerns are linked with all water policy issues and major environmental challenges such as climate change.

A handful of American communities are the vanguard of the green infrastructure movement, pioneering the use of green strategies and green infrastructure to more effectively manage stormwater. This series of Workshops will expose the stakeholders of New Orleans to the experiences of five of those vanguard cities, each of which has implemented a variety of green infrastructure strategies.

**Green Infrastructure Strategies and Approaches**

Stormwater problems occur at the home, street, neighborhood, city, and regional level. Green stormwater solutions, in contrast to grey, apply different techniques and approaches to different stormwater problems, situations, and causes. Individual workshops in the Urban Waters series are designed to suggest how different approaches can be appropriately fashioned for and targeted to different types of problems in a way that builds to a comprehensive regional stormwater strategy.

Most green infrastructure approaches are far less capital intensive than older, more traditional, grey approaches, but not all green approaches are “natural.” Many do require capital investments and some level of construction, and most are used in conjunction with grey investments. What characterizes the vast majority of green infrastructure approaches is that they: 1) treat or retain stormwater on-site at its source, where rain originally fell to the ground, returning the rain to the environment through absorption or evaporation; 2) attempt to use stormwater constructively, for example to water gardens; 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.

We have grouped a large number of different green infrastructure approaches to stormwater management into three broad categories that parallel the organization of the Workshops in the Urban Waters Series: Strategies That Work:

- Creating Green Neighborhoods
- Developing Metropolitan and Comprehensive Stormwater Strategies
- Structuring Innovative Financial Incentives and Fees

These categories include many different strategies and programs, as shown in Table I. The table also indicates which exemplar cities engage in each of the practices discussed below.
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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 roof-top 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 runoff. 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 (OR) and Philadelphia have made a commitment to green all new, and retrofit older, streets and public right of ways 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 (OR) 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 (OR) 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 over 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 (NJ), have developed programs to identify and target those parcels of land, turning them into community gardens or rain gardens or parkland that will hold stormwater on-site, preventing additional runoff.

In so doing, 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 “eye-sores.”

Metropolitan Stormwater Strategies

Green Space Conservation

Comprehensive stormwater management requires communities to address the larger systemic issues that providing drinking water, treating wastewater, and addressing stormwater together raise. 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 (TX), 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 Green Seams 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 the various water functions of a city to be undertaken by many different departments, 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. 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 close 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 grey) 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 percent 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 percent of the property with impervious surface. Almost all the cities in Table 1 impose stormwater fees based on impervious cover.

Fees based on the percent of impervious cover clearly provide incentives for property owners to reduce the amount of impervious cover on their property, or 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 over $11,000 per month for the bucolic campus of the University of Pennsylvania but increased over $126,000 per month for the Philadelphia airport, which had nothing but impervious cover.
Rebates and Fee Reductions

Almost all cities that impose a stormwater fee which reflects impervious cover offer fee off-sets 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 in other ways taking advantage of green infrastructure strategies to retain or naturally treat stormwater on-site.

For example, Portland (OR) 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” 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-to-area ratios, 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 (OR) 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 floor area ratio 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” 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 developing a unique development incentive; they have identified areas of the city where there is the potential for leveraged partnerships involving green infrastructure. The city has paid independent experts to estimate the financial, environmental, and 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.

**Green Infrastructure Opportunities for New Orleans**

Water professionals and experts working in five cities leading the green infrastructure revolution in stormwater management will be present in New Orleans over the course of five Workshops, beginning on May 15 and ending on July 10. They are: Houston, Milwaukee, Philadelphia, Portland (OR), and the District of Columbia.

These speakers will together describe a range of green infrastructure techniques, strategies, and approaches that the stakeholders of New Orleans may wish to consider as they address the serious stormwater challenges that face the region.
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 which 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 CSO’s) 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 (grey infrastructure) in order to reduce by 96% the number of raw sewage releases (CSO’s) 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 grey 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 (SRC’s) 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 socio-economic 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 District Department of the Environment 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 grey 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 of property owners who install green infrastructure that retains the water from a 1.2” 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 expects to finalize 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 2012 appear below.

<table>
<thead>
<tr>
<th>RiverSmart Homes Stormwater Volume Reductions</th>
<th>Fiscal Year</th>
<th>RiverSmart Homes Practice</th>
<th>Number Installed</th>
<th>Impervious Surface Retrofitted (square feet)</th>
<th>Annual Runoff Retained (gallons)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>2011</td>
<td>Rain Barrels</td>
<td>428</td>
<td>89,880</td>
<td>1,506,339</td>
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<td></td>
<td></td>
<td>Rain Gardens</td>
<td>66</td>
<td>29,700</td>
<td>497,756</td>
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<td></td>
<td></td>
<td>Pervious Pavers</td>
<td>28</td>
<td>12,600</td>
<td>211,169</td>
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<td></td>
<td>2011 Total</td>
<td></td>
<td>522</td>
<td>132,180</td>
<td>2,215,264</td>
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<tr>
<td></td>
<td>2012</td>
<td>Rain Barrels</td>
<td>739</td>
<td>155,190</td>
<td>2,600,899</td>
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<tr>
<td></td>
<td></td>
<td>Rain Gardens</td>
<td>162</td>
<td>72,900</td>
<td>1,221,764</td>
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<tr>
<td></td>
<td></td>
<td>Pervious Pavers</td>
<td>23</td>
<td>10,350</td>
<td>173,460</td>
</tr>
<tr>
<td></td>
<td>2012 Total</td>
<td></td>
<td>924</td>
<td>238,440</td>
<td>3,996,123</td>
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</tbody>
</table>

*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*

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>
<thead>
<tr>
<th>Stormwater Runoff Retained by Retrofit Projects</th>
<th>Fiscal Year</th>
<th>Watershed</th>
<th>Impervious Surface Retrofitted (square feet)</th>
<th>Impervious Surface Retrofitted (acres)</th>
<th>Annual Runoff Retained (gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2011</td>
<td>Rock Creek</td>
<td>31,478</td>
<td>0.7</td>
<td>556,438</td>
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<td></td>
<td></td>
<td>Anacostia</td>
<td>261,848</td>
<td>6.0</td>
<td>3,307,912</td>
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<td></td>
<td></td>
<td>Potomac</td>
<td>37,773</td>
<td>0.9</td>
<td>667,715</td>
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<tr>
<td></td>
<td>Total</td>
<td></td>
<td>331,099</td>
<td>7.6</td>
<td>4,532,066</td>
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<td></td>
<td>2012</td>
<td>Rock Creek</td>
<td>49,332</td>
<td>1.1</td>
<td>683,325</td>
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<td>Anacostia</td>
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<td>Potomac</td>
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<td></td>
<td>Rock Creek</td>
<td>2011</td>
<td>2012</td>
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<td></td>
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<tr>
<td>2011</td>
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<tr>
<td>Rock</td>
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<td>Creek</td>
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<tr>
<td>Anacostia</td>
<td>28,777</td>
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<tr>
<td>2012</td>
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<td></td>
</tr>
<tr>
<td>Rock</td>
<td>1,780</td>
<td>0.0</td>
<td>67,464</td>
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<td></td>
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<tr>
<td>Creek</td>
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<tr>
<td>Anacostia</td>
<td>28,330</td>
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<td>Total</td>
<td>49,317</td>
<td>1.1</td>
<td>1,862,353</td>
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</table>
**GREEN NEIGHBORHOODS**

- Levies an impervious surface stormwater fee
- Operates a wetland mitigation bank which 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

**METROPOLITAN STRATEGIES**

**INNOVATIVE FINANCING**

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**BACKGROUND**

The city of Houston lies within Harris County in Southeast Texas, only 60 miles from the Gulf of Mexico. The city is the 4th largest in the nation with a population of 2.1 million; Harris County has an area of 1,778 square miles and is the 3rd most populous in the country with 4.1 million residents. The county has an extensive system of bayous and channels that stretch over 2,500 miles in length; roughly 800 miles were natural, the remainder 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 (HFCD).

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, the bayous and channels, are also prone to flooding. The natural threat of flooding in the region is heightened by high annual rainfall, impervious clay soils, increased urbanization which creates additional impervious cover (land where water cannot soak into the ground), the fact that the extensive system of bayous are very slow moving, 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 grey 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 also 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, the Harris County Flood Control District, 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 Task Force 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 utilizing 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 in order to connect a number of dispersed parks and trails along the bayou system.

In 2012, city residents voted to approve $480 million to fund the first portion of that initiative, bringing together public and private entities to add over 4,000 new acres of green spaces and 300 miles of continuous trails, equitably distributed along the bayous throughout Harris County over 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 in order 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 the Bayou Greenways 2020 and will connect 150 miles of parks and trails along the bayou 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, the city of 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, bio-retention (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 District officials were encouraged to create the manual after a 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, which was the first competition 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 to follow 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 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 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 documents 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 utilizing 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 acres 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; the Flood Control District is also 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 two 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 over 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 grey 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 two 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.

The Milwaukee Metropolitan Sewerage District’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 the District’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 CSO’s) 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), the Milwaukee Metropolitan Sewerage District began investing what would ultimately be $4 billion dollars to construct a 521 million gallon underground tunnel storage system. This grey 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, the Milwaukee Metropolitan Sewerage District completed 2035 Vision, a plan whose major goals are to completely eliminate combined sewer and stormwater overflows and sewer backups by balancing green and grey infrastructure. The plan was based, in part, on the success of a number of green infrastructure pilot projects by the District and the participation of many influential stakeholders in the development process. In January of 2013, as a condition of receiving their discharge permit, the state of Wisconsin explicitly required the District 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.*

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

The Milwaukee Metropolitan Sewerage 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. To be finalized in June 2013, the plan seeks to meet the 2035 Vision goal of capturing the first 0.5” of stormwater that falls on impervious surfaces across the planning area or the equivalent of 740 million gallons of stormwater.

The Milwaukee Metropolitan Sewerage District 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 the Milwaukee Metropolitan Sewerage District 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, the city of 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 percent of impervious cover on the property.

3) **H2OCapture** (MMSD) – The Milwaukee Metropolitan Sewerage District partnered with the Natural Resources Defense Council to create an on-line 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 over 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 over 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, the Milwaukee Metropolitan Sewerage District passed a major milestone, distributing over 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.*
• 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 U.S. The larger metropolitan area houses over four 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.

Over 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 over 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 (CSO’s), 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 over $150 million per year in grey improvements to the sewer system. In 1999, the city merged three different water programs in order 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 grey 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 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 so-called “Triple Bottom Line;” that is, it will be cost-effective not only because it will be
cheaper than traditional grey 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 grey 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. In order 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 Tookany/Tacony-Frankford (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 in order to identify opportunities for large scale, coordinated green infrastructure implementation. On April 10, 2012, the city also entered into a partnership with the U.S. EPA to advance green infrastructure research and strategies.

On September 21, 2012, the EPA and 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 NatLab, or the Natural Infrastructure Innovative Financing Lab, 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 the Philadelphia 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. In order 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 percent 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** – In order 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 over two miles of streams; and approved over 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 one million gallons of rain falls on each acre every year.

- The Tookany/Tacony-Frankford Watershed Partnership hosted over 100 meetings and events in 2012, engaging over 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 percent of that stormwater. Many of the pipes that carry combined sewage and stormwater are over 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% percent 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 six billion gallons annually in 1991 when the city started work on a 20-year, $1.4-billion grey 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 grey infrastructure strategies in order 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 regards green infrastructure as 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 over 360 acres of natural areas, including wetlands, in order 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 over $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 requiring stormwater management on all non-residential development or redevelopment projects, including city owned buildings, that include over 500 square feet of impervious surface, propose new off-site stormwater discharges, or require new sewer connections.

These requirements are listed in a document called the *Stormwater Management Manual*; developers are required to manage stormwater on-site through vegetation (to the maximum extent possible) and reduce pollutants from runoff in order 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 to implement green streets on public property in order to control and retain stormwater. Currently 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 over 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% percent 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 multifamily 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 percent 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, roofs 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 charge 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 over 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 grey 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 year 2011 and 2012, over 35,604 utility ratepayers registered for the Clean River Rewards program in order to receive discounts for retaining stormwater runoff on-site. In addition, educational programs and initiatives launched by the city provided outreach to over 15,000 students as of June 2012; over 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 over 80% of the volume from the 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 rain fall 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 over 56,000 downspouts from the combined sewer and wastewater system, thus reducing over 1.3 billion gallons of stormwater from the sewer system each year.