

Amended

Green City Clean Waters

The City of Philadelphia's Program for Combined Sewer Overflow Control
Program Summary

Amended by the Philadelphia Water Department
June 1, 2011



The creation and implementation of our *Green City, Clean Waters* vision is made possible as a result of the contributions of our partner City agencies and departments that provided, and continue to share their expertise, guidance and support toward the realization of this plan.

Streets Department

Mayor's Office of Sustainability

Philadelphia Parks & Recreation

Planning Commission

Office of Housing and
Community Development

Housing Authority

School District

Parking Authority

Redevelopment Authority

Licenses and Inspections

Zoning Commission

Commerce Department

Philadelphia Industrial
Development Corporation

Health Department

PWD also recognizes the invaluable contributions of our watershed partnerships, special service districts and other non-governmental organizations in making this vision a reality.

The Philadelphia Water Department is pleased to announce the approval by the Commonwealth of Pennsylvania of our *Green City, Clean Waters* plan as amended through negotiations with the Pennsylvania Department of Environmental Protection (PA DEP) since its submission in September, 2009. This program represents the City of Philadelphia's commitment towards meeting our regulatory obligations while helping to revitalize our City. Our Combined Sewer Overflow (CSO) Long Term Control Plan Update (LTCPU) submitted in September, 2009 explains how this vision and the commitment to its implementation grew out of our history, built on our extensive watershed analysis and planning, and is continually informed by local and national policy trends. The full LTCPU document is available online for download at www.philly-watersheds.org/ltcpu/.

Through evaluation of a number of alternative implementation approaches, we determined that a green stormwater infrastructure-based approach would provide maximum return in environmental, economic, and social benefits within the most efficient timeframe, making it the best approach for the City of Philadelphia.

The *Green City, Clean Waters* Program has been amended as follows:

- Program commitment: \$1.2B net present value (represents \$2.4B capital construction plus operating and maintenance costs, in terms of actual future expenditures) for addressing water quality goals as set both by the Pennsylvania and the National CSO Control Policies. These projects will be implemented over a 25-year period, with metrics and milestones developed to measure progress along the way.
- The stream restoration program included in the original LTCPU has been removed from the Program's CSO compliance goals. However, the City intends to continue its stream restoration and wetland creation efforts and is committed to spending \$125M net present value (\$260M future expenditures) toward achieving the goal of restoring the biological resources of the City's streams.
- The City's plan is based on a Presumption Approach, as described in the National CSO Policy, to approach the water quality requirements of the Clean Water Act (CWA) and the Pennsylvania Clean Streams Law as follows: The City will construct and place into operation the controls described as the selected alternative in the amended LTCPU to achieve the elimination of the mass of the pollutants that otherwise would be removed by the capture of 85% by volume of the combined sewage collected in the Combined Sewer System (CSS) during precipitation events on a system-wide annual average basis.

Over the next five years, the Philadelphia Water Department will lay the foundation for achieving the *Green City, Clean Waters* vision over the full 25 year implementation period of this plan and beyond. The cost and affordability of those programs and the additional value they will leverage were analyzed and vetted extensively. The desire to ensure our watersheds are healthy while building a competitive, sustainable future for Philadelphia is shared by other City agencies, partner organizations, and residents, who have expressed enthusiastic support for achieving our vision of *Green City, Clean Waters*.



Introduction

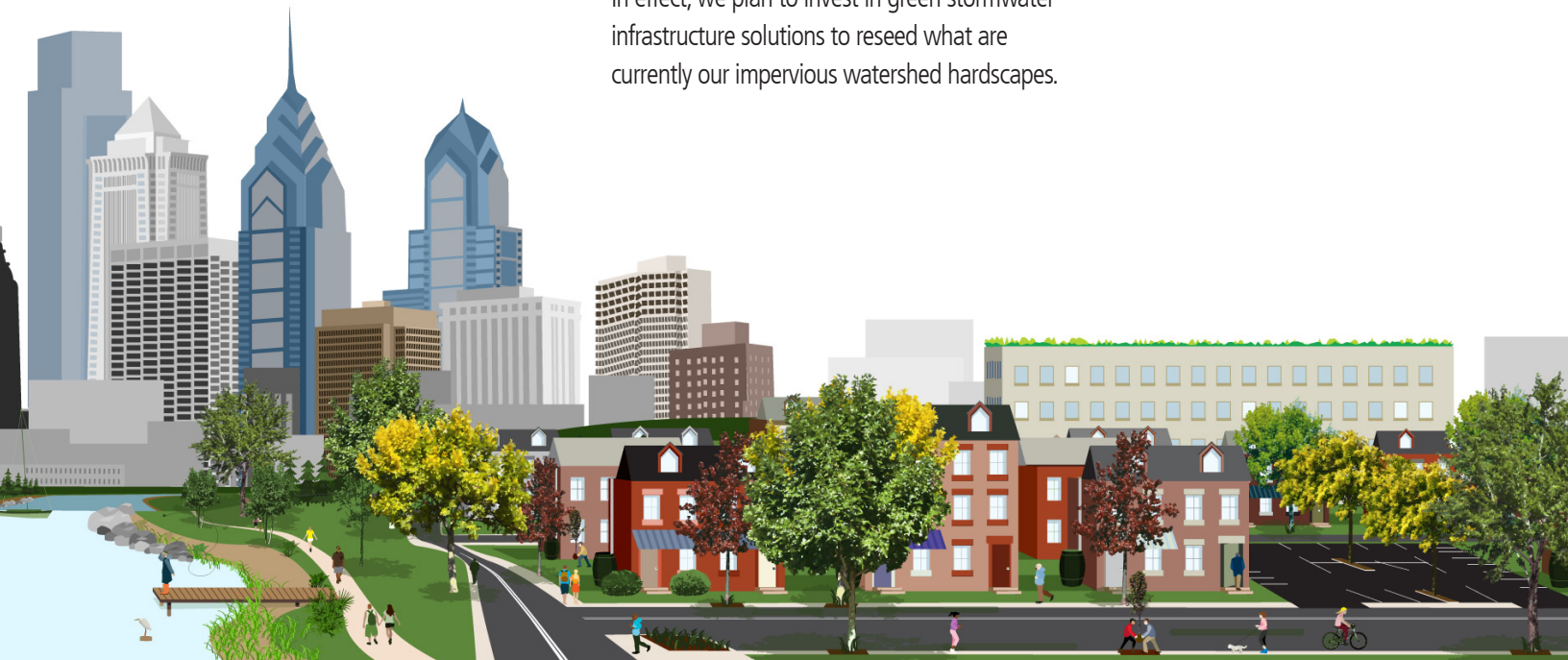
The Philadelphia Water Department (PWD) developed a robust plan for supporting an effort that will resonate with the values and hopes of Philadelphia's neighborhoods and **provide a clear pathway to a sustainable and resilient future**, while strengthening the utility, broadening its mission and complying with environmental laws and regulations.

Nationwide, water utilities find themselves under increasing pressure as they confront a new set of complex environmental, demographic and financial challenges while also trying to meet expanded customer expectations for a safe and affordable water supply; the collection and high level treatment of wastewater and stormwater; flood protection; and clean, attractive, fishable, swimmable rivers and streams. Unfortunately this dilemma comes at a time when the City is grappling with some very real problems of population and financial decline.

Also significant are our new challenges to water quality and quantity, aging infrastructure, and the impacts of climate change on human health and our ecosystems. While changing demographics and conservation have resulted in an infrastructure system that has, in some places, provided capacity that exceeds overall needs, new regulations, energy, climatic and environmental issues will require significant new investments. Meeting these challenges requires either a significant new investment in infrastructure, or a paradigm shift in our approach to urban water resources.

During the past decade, PWD has created, tested and implemented new integrated strategies that promote the economic and social growth of the City and that meet the environmental, ecological and business missions of the utility. As the City agency charged with ensuring optimal compliance with the Federal Clean Water Act, **PWD developed an infrastructure management program intended to protect and enhance our region's waterways by managing stormwater runoff to significantly reduce our reliance on construction of additional underground infrastructure.**

In effect, we plan to invest in green stormwater infrastructure solutions to reseed what are currently our impervious watershed hardscapes.



Our Heritage

Over three hundred years ago, William Penn created the “Greene Country Towne” vision for his beloved Philadelphia. As the City grew, it became a hub of politics, technology and business. In keeping with this innovative approach to promoting healthy communities, Philadelphia was the first city in America to supply its citizens with drinking water (1801) and, in 1855 began purchasing land along the Schuylkill River to protect the water supply, creating several thousand acres of buffer known as Fairmount Park, now the world’s largest urban park.

It is with great pride that we embrace our forefather’s appreciation of the vital connection between a green city and clean water. Today, the Philadelphia Water Department (PWD) has a unique opportunity to address modern challenges to managing our water resources and infrastructure in an innovative way. By transforming Philadelphia into a 21st Century Sustainable City, we can move toward a realization of Penn’s vision for a vibrant, healthy and green city.



What Are Combined and Separate Sewer Systems?

The City of Philadelphia has one of the first sewer systems in the country, with portions dating back to the second half of the 19th century. Much of that original infrastructure is still operational today. PWD’s significant commitment to continuously inspect and maintain the 3,000 mile system of pipes, manholes, storm drains, and control chambers will sustain the use by City residents for years to come.

The City of Philadelphia’s sewer system is comprised of both combined and separate sewer systems. A combined sewer system (CSS) is simply a single sewer system that carries both sewage and stormwater in one pipe, to a water pollution control plant for treatment before being released to a waterway. During moderate to heavy rainfall events, the system will reach capacity, overflow, and discharge a mixture of sewage and stormwater directly to our streams and rivers from the 164 permitted Combined Sewer Overflow (CSO) outfalls within the City. Forty-eight percent of the City of Philadelphia, or about 64 square miles, is within the combined sewer system drainage areas. Four watersheds, generally comprised of the older areas of the City of Philadelphia, receive CSO discharges.

The remainder of the City of Philadelphia’s sewer system is drained by what is called a separate sewer system. A separate sewer system collects stormwater in a storm sewer pipe and discharges it directly to a waterway, while the sanitary sewage collected from homes, businesses, and industry is collected in a sanitary sewer pipe and taken to the water pollution control plant for treatment before being released to the waterways.

Watersheds Receiving CSO Discharges	mi² drained within Phila.	served by CSS (approx)
Tookany/Tacony-Frankford Creek	19	80%
Cobbs Creek	6	80%
Delaware River	40	71%
Schuylkill River	36	40%

This amounts to 64 square miles of Combined Sewer Service drainage area for potential implementation.

Combined Sewer System



Our Vision

The *Green City, Clean Waters* program is the realization of PWD's land-water-infrastructure philosophy. We have put less emphasis on the use of traditional infrastructure as it is cost prohibitive while also missing the restoration mark, instead pledging our valuable investments toward greening the City as a means to provide specific benefits to the residents of the City of Philadelphia while meeting ecological restoration goals.

Our vision is to unite the City of Philadelphia with its water environment, creating a green legacy for future generations while incorporating a balance between ecology, economics, and equity.

We will integrate CSO and water resources management into the socioeconomic fabric of the City by creating amenities for the people who live and work here.

PWD's *Green City, Clean Waters* program integrates management of Philadelphia's watersheds into a larger context. It is designed to provide many benefits beyond the reduction of combined sewer overflows, so that every dollar spent provides a maximum return in benefits to the public and the environment.

Our Vision Includes

Large-scale implementation of green stormwater infrastructure to manage runoff at the source on public land and reduce demands on sewer infrastructure

Requirements and incentives for green stormwater infrastructure to manage runoff at the source on private land and reduce demands on sewer infrastructure

A large-scale street tree program to improve appearance and manage stormwater at the source on City streets

Increased access to and improved recreational opportunities along green and attractive stream corridors and waterfronts

Preserved open space utilized to manage stormwater at the source

Converted vacant and abandoned lands to open space and responsible redevelopment

Restored streams with physical habitat enhancements that support healthy aquatic communities

Additional infrastructure-based controls when necessary to meet appropriate water quality standards.

Our Commitment

**More than
\$356 million
in commitments
already in place**

**\$2.4 billion
invested by PWD
by 25-year mark**

**More than
\$3 billion
full investment
in plan through
the addition
of leveraged
activities**

We have heard a theme echoed in civic and public forums, in our watershed partnerships, and throughout Philadelphia's neighborhoods. People want to see more "green" in their communities, and they are ready to commit both time and effort to make it happen.

Our pledge is to put mechanisms in place over the coming years to equip the City to function as a "Green Machine." Long into the future, even beyond the limited timeframe of our 25-year planning horizon. Every time land is touched by development or redevelopment (for streets, homes, business, industry and so on), the principles of sustainability and stormwater management will be incorporated into the design and engineering of the development.

Our strategy is to focus on improving the water resources and revitalizing the City of Philadelphia. Commitments made in this plan will lay the foundation for a sustainable Philadelphia by greening our neighborhoods, restoring our waterfronts, improving our outdoor recreation spaces, and enhancing our quality of life. With the assistance of many public and private partners, we envision greening at least one third of the existing impervious cover in our Combined Sewer System drainage areas over the next two and a half decades, transforming them into "Greened Acres" that will filter or store the first inch of rainwater runoff each time it rains.

At the close of this 25 year implementation period, PWD will have invested approximately \$2.4 billion (\$1.2 billion in 2009 dollars) to initiate the largest green stormwater infrastructure program ever envisioned in this country, providing for the elimination of the mass of the pollutants that otherwise would be removed by the capture of 85% by volume of the combined sewage collected in the Combined Sewer System (CSS) during precipitation

events on a system-wide annual average basis.

This *Green City, Clean Waters* commitment is made in addition to numerous CSO-related PWD program elements already in place, including:

- Approximately \$200 million spent toward PWD's 1997 LTCP commitments (including Nine Minimum Controls, capital projects, and watershed planning)
- Approximately \$2 million committed annually to reviewing private sector development plans for compliance with PWD's Stormwater Regulations
- Approximately \$125 million committed to stream restoration in the Cobbs and Tookany/ Tacony-Frankford (TTF) watersheds—as outlined in the Integrated Watershed Management Plan (IWMP) commitments
- Approximately \$56 million committed to relining streamside interceptor pipes in the Cobbs and Tookany/ Tacony-Frankford (TTF) watersheds—as outlined in the Integrated Watershed Management Plan (IWMP) commitments
- Approximately \$2 million committed annually to Public Outreach and Education (including support of the Fairmount Waterworks Interpretive Center, and Philadelphia Parks & Recreation Environmental Stewardship and Education Division.)

Through these and other leveraged activities by our many stakeholders and partners, we anticipate that the full investment in Philadelphia's *Green City, Clean Waters* programs will reach well over \$3 billion.

It is important that we reduce sewage overflows to our waterways in order to provide our citizens with destinations to play, fish, relax, and reconnect with nature. Our waterways are—and should be—protected and preserved to remain sources of beauty and life. Even after the close of this 25-year implementation period, the practices put in place will continue to produce Greened Acres, achieving additional cumulative reductions in combined sewer overflows to our rivers and streams. We pledge to continue this reduction.

Reducing sewage overflow to our waterways in order to provide our citizens with destinations to play, fish, relax, and reconnect with nature is the foundation of our environmental ethic.

Altogether, the following principles will help us enjoy clean, safe and accessible streams and rivers.

Basic Principles Underlying the City's *Green City, Clean Waters* Approach

- Utilizing rainwater as a resource by recycling, re-using, and recharging long neglected groundwater aquifers rather than piping it away from our communities into our already stressed tributaries
- Maintaining and upgrading one of the nation's oldest water infrastructure systems
- Collaborating to revitalize our City with an emphasis on sustainability
- Energizing our citizens, partnerships, public and regulatory partners to adopt and join us in this watershed-based strategy

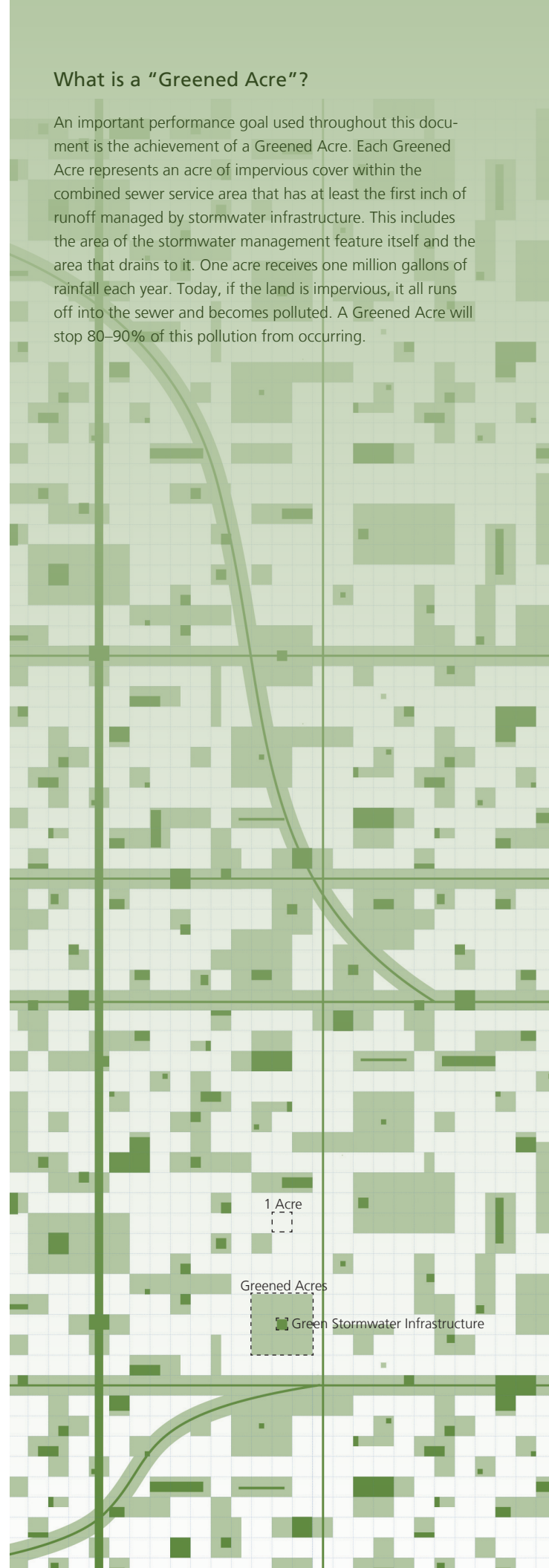
This plan commits the City to reducing significantly the negative impacts of stormwater on the effectiveness of our sewer collection system. Our strategy is to reduce the stormwater burdening our sewers, changing the way that our landscape interacts with stormwater by enhancing our city's impervious cover with natural features. PWD will measure progress through Greened Acres that capture and manage the first inch of stormwater.

“Philadelphia has proposed *Green City, Clean Waters*, a novel initiative that will invest \$2 billion over the next 25 years to green our city's stormwater infrastructure and recreate the natural processes that keep storm water out of our systems,” said Mayor Michael A. Nutter. “Currently under consideration by the U.S. EPA and approved by the Pennsylvania Department of Environmental Protection, this plan will make our city greener, healthier and more liveable.”

Mayor Michael Nutter
City of Philadelphia

What is a “Greened Acre”?

An important performance goal used throughout this document is the achievement of a Greened Acre. Each Greened Acre represents an acre of impervious cover within the combined sewer service area that has at least the first inch of runoff managed by stormwater infrastructure. This includes the area of the stormwater management feature itself and the area that drains to it. One acre receives one million gallons of rainfall each year. Today, if the land is impervious, it all runs off into the sewer and becomes polluted. A Greened Acre will stop 80–90% of this pollution from occurring.



Development of the Long Term Control Plan Update

What Do the Clean Water Act and Combined Sewer Overflow Policy Require Us to Do?

- Meet water quality standard goals by substantially reducing combined sewer overflows
- Restore our waterways to enable aquatic life to thrive
- Commit PWD funding but remain affordable to our customers
- Outline our strategy of innovative and effective technologies and policies

What We've Been Doing

Since 1997, PWD has been committed to gaining a better understanding of how our sewer collection system functions every time it rains, including when the system fills to capacity, when and where overflows occur and in what volumes, as well as where and how more capacity could be added to meet our water quality standard goals.

We have also been studying our rivers and streams from a watershed wide perspective as Philadelphia occupies the downstream portions of our watersheds. For this reason, our watershed management plans are developed with our upstream suburban neighbors in Delaware, Montgomery and Bucks counties. Without their cooperation and commitment to take similar protection measures, the efficacy of our efforts would be limited. The following is a summary of our activities over the past 14 years:

- Developing Integrated Watershed Management Plans
- Conducting watershed-wide chemical and biological assessments to thoroughly understand the condition of our waterways, the diversity and health of our water ecosystems, and the physical condition of our waterways
- Implementing demonstration projects for stream renewal and stormwater management
- Modeling and characterizing the performance of our sewer collection system
- Constructing additional sewer storage capacity
- Implementing new regulations to manage stormwater for development
- Sponsoring regional, watershed-based stormwater management planning
- Transitioning to a parcel based stormwater fee

The culmination of this work has led PWD to make this commitment to the Pennsylvania Department of Environmental Protection (PADEP) and United States Environmental Protection Agency (USEPA), and more importantly, to our citizens.

Watershed Planning Approach

PWD developed our concept of regional watershed management planning after recognizing that, as the downstream most entity in each of the watersheds draining to the City of Philadelphia, the necessary long-term sustainable improvements to water quality and habitat within each waterway could not be achieved without watershed-wide stakeholder and agency support.

Watershed management fosters the coordinated implementation of programs, addresses and manages stormwater, looks to control sources of pollution, reduces polluted runoff, and promotes managed growth in the City and surrounding areas, while protecting the region's drinking water supplies, fishing and other recreational activities, and preserving sensitive natural resources such as parks and streams.

Water Quality Summary

Major issues in each of the four watersheds are summarized in the following table. Limited public awareness and sense of stewardship, and water quality impairment during dry and wet weather were identified in each of the four watersheds as major concerns. Common types of impairment include high levels of fecal coliform, elevated water temperatures, large day and night time variations in dissolved oxygen, and dissolved oxygen levels below minimum standards. During dry weather, potential sewage flows in separate sewer service areas were a concern in all watersheds. Another common dry weather concern was the presence of litter and unsightly streams, which discouraged recreational use.

In the Tookany/Tacony-Frankford and Cobbs Creek Watersheds, degraded aquatic and riparian habitats, and limited diversity of fish and other aquatic life were cited as ecosystem concerns. In those watersheds, bank and streambed erosion threatened the functions of nearby utilities and CSOs impacted both water quality and stream channels. In the Schuylkill and Delaware Watersheds, major concerns included the lack of recreational opportunities and public access to the riverfront, and the presence of PCBs which necessitated fish advisories.

Our watershed problems do not begin or end at the outfall.

Through the watershed-based planning process, PWD commits to addressing a multitude of overlapping regulatory requirements, including EPA's Combined Sewer Overflow (CSO) Control Policy, Phase I and Phase II Stormwater Regulations, PA Act 167 Stormwater Management, Total Maximum Daily Load allocations, PA Act 537 Sewage Facilities Planning, the Clean Streams Law, and Safe Drinking Water Act based drinking water source protection

programs. The planning process must also fit within a host of non-regulatory planning processes and initiatives, including existing municipal and conservation planning efforts (e.g. River Conservation Plans, Open Space Plans, municipal comprehensive plans) and stakeholder goals. **Implementation of this LTCPU commitment is just one part of PWD's larger, watershed-based commitment.**

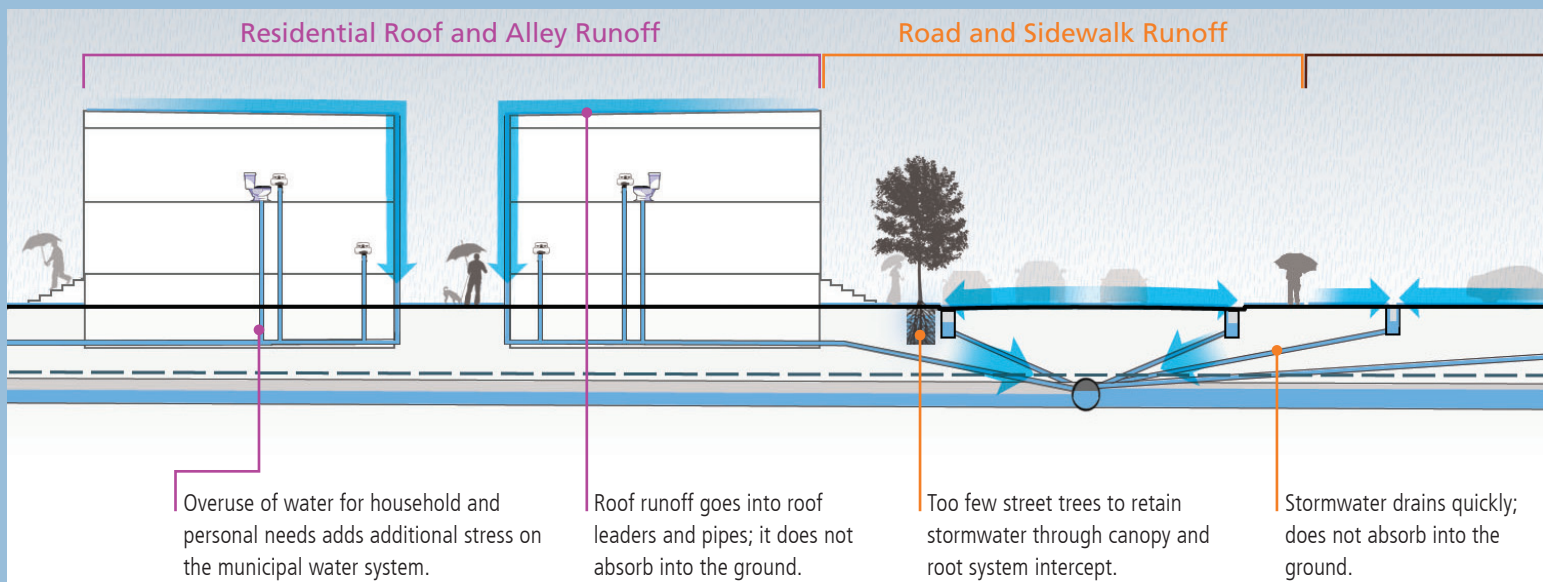
		Watersheds in the Combined Sewer Area			
		Tookany/Tacony-Frankford Creek	Cobbs Creek	Delaware River	Schuylkill River
Dry Weather Water Quality, Aesthetics and Recreation	Water quality concerns (including bacteria and dissolved oxygen)	●	●	●	●
	Potential sewage flows in separate sewer areas	●	●	●	●
	Litter and unsightly streams that discourage recreational use	●	●	○	○
	Safety concerns along streams and stream corridors	●	●	○	○
Watershed Stewardship	Limited public awareness and sense of stewardship	●	●	●	●
	Recreational opportunities and public access below potential	●	●	●	●
Healthy Living Resources	Degraded aquatic and riparian habitats	●	●	○	○
	Limited diversity of fish and other aquatic life	●	●	○	○
	Channelized stream sections	●	○	○	○
	Loss of wetlands	●	●	●	●
	Utility infrastructure threatened by bank and streambed erosion	●	●	○	○
Wet Weather Water Quality and Quantity	Water quality concerns (including bacteria and dissolved oxygen)	●	●	●	●
	CSO and stormwater impacts on stream channels	●	●	○	○
	Total Maximum Daily Load and fish advisories established for PCBs	○	○	●	●
	Little volume control and treatment of stormwater flows in separate sewer areas	●	●	○	○

This watershed planning approach recognizes that there is a direct connection between all neighborhoods in Philadelphia, whether adjacent to or miles from the City's rivers and creeks, and their watersheds. Household wastewater, roof runoff, road and sidewalk runoff, and parking lot runoff all end up in the sewers and ultimately in our waterways. Stormwater management in neighborhoods near and far from the waterways is essential. By managing stormwater at its source, it is possible to reduce the amount

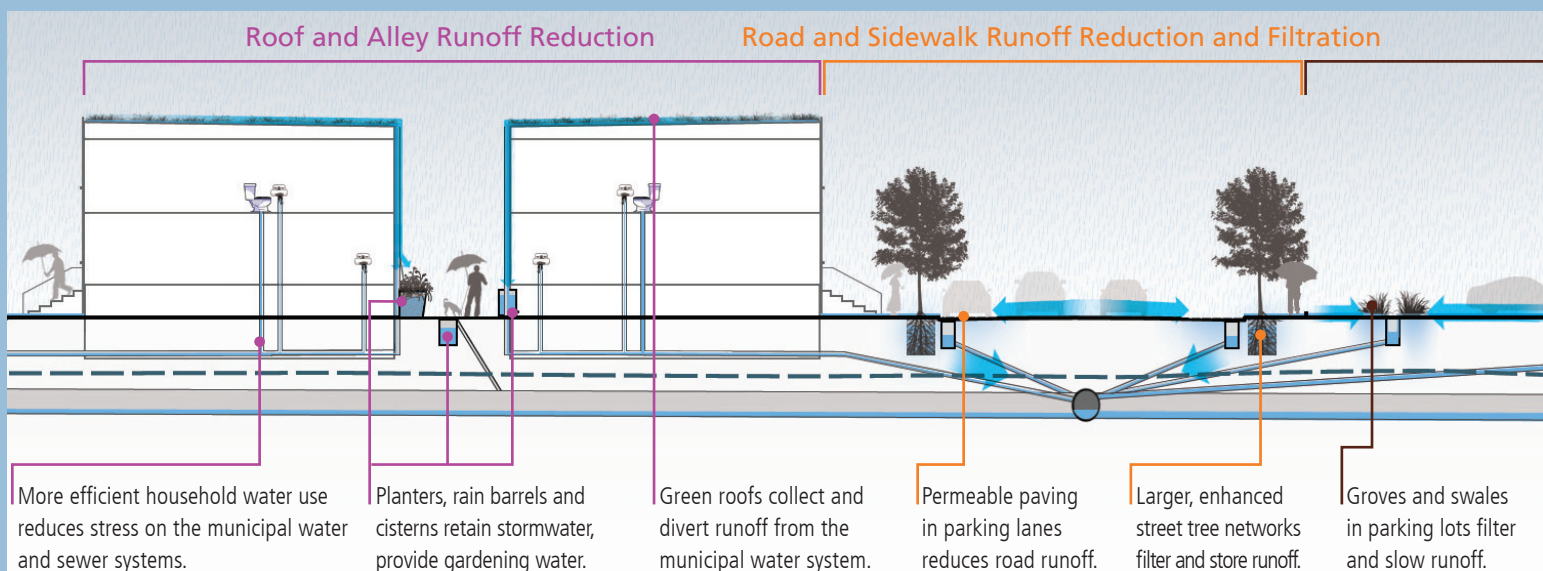
of stormwater that ends up in our rivers and creeks, simultaneously improving the quality of our neighborhoods and our waterways.

PWD is committed to developing watershed-based plans for each of the five major tributary streams that drain through the City of Philadelphia, including the Cobbs, Tookany/Tacony-Frankford, Wissahickon, Pennypack and Poquessing. Recently, PWD further committed to developing watershed-based plans for the City of Philadelphia

A **typical** urban watershed has negative effects on its creeks:



A more **sustainable** approach to stormwater will positively affect the watershed:



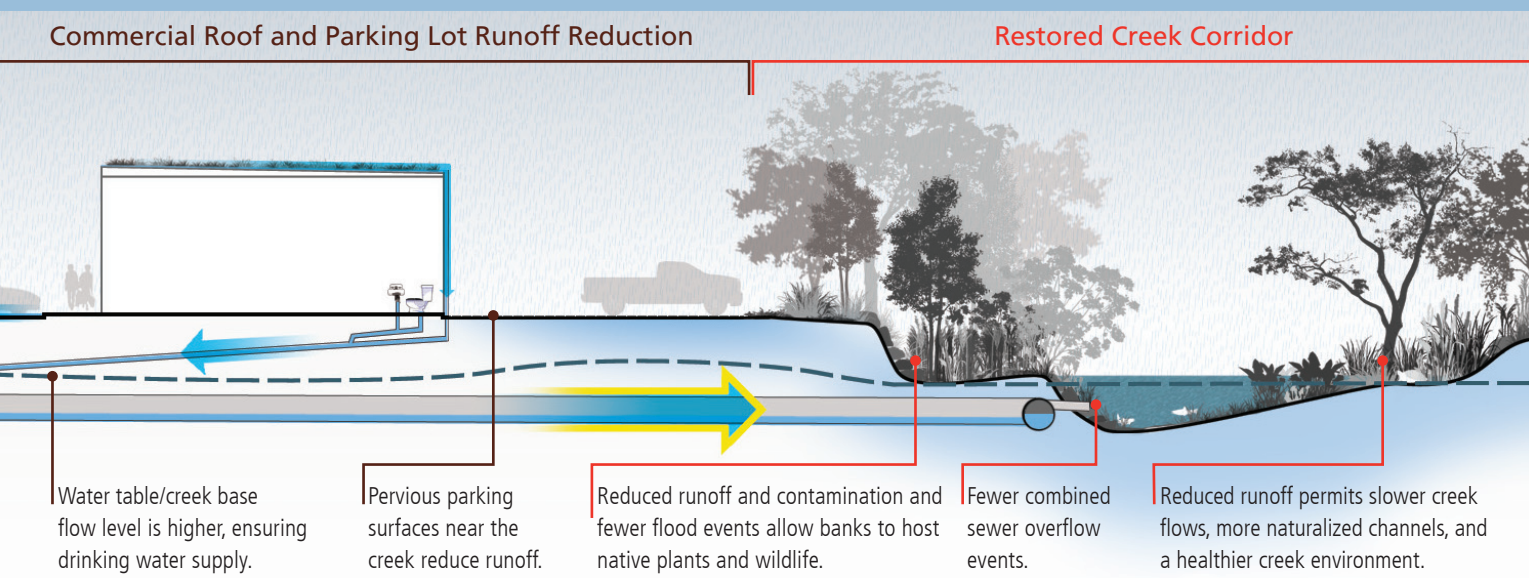
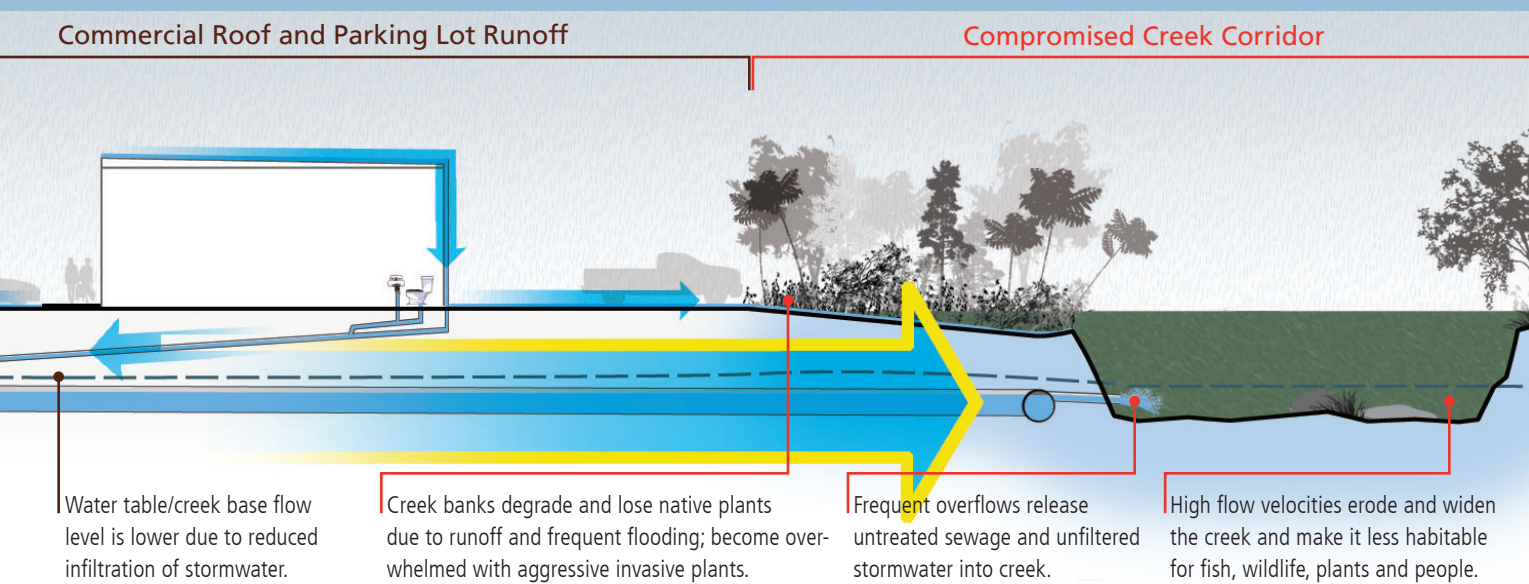
portions of the Schuylkill and Delaware River systems. To date, integrated watershed management plans has been completed for the Cobbs and Tookany/Tacony-Frankford Watersheds.

PWD's watershed-based planning process is based on a carefully crafted approach to meeting the challenges of watershed management in an urban setting. The primary intent of the planning process is to improve the environmental health and safe enjoyment of the watershed

“Philadelphia has shown a long-term commitment to the concepts of preservation and restoration applied on a watershed scale.

Although these are not new ideas, they have the feeling of something innovative, because they are winning more and more interest around the country as the best way to a sustainable water future.”

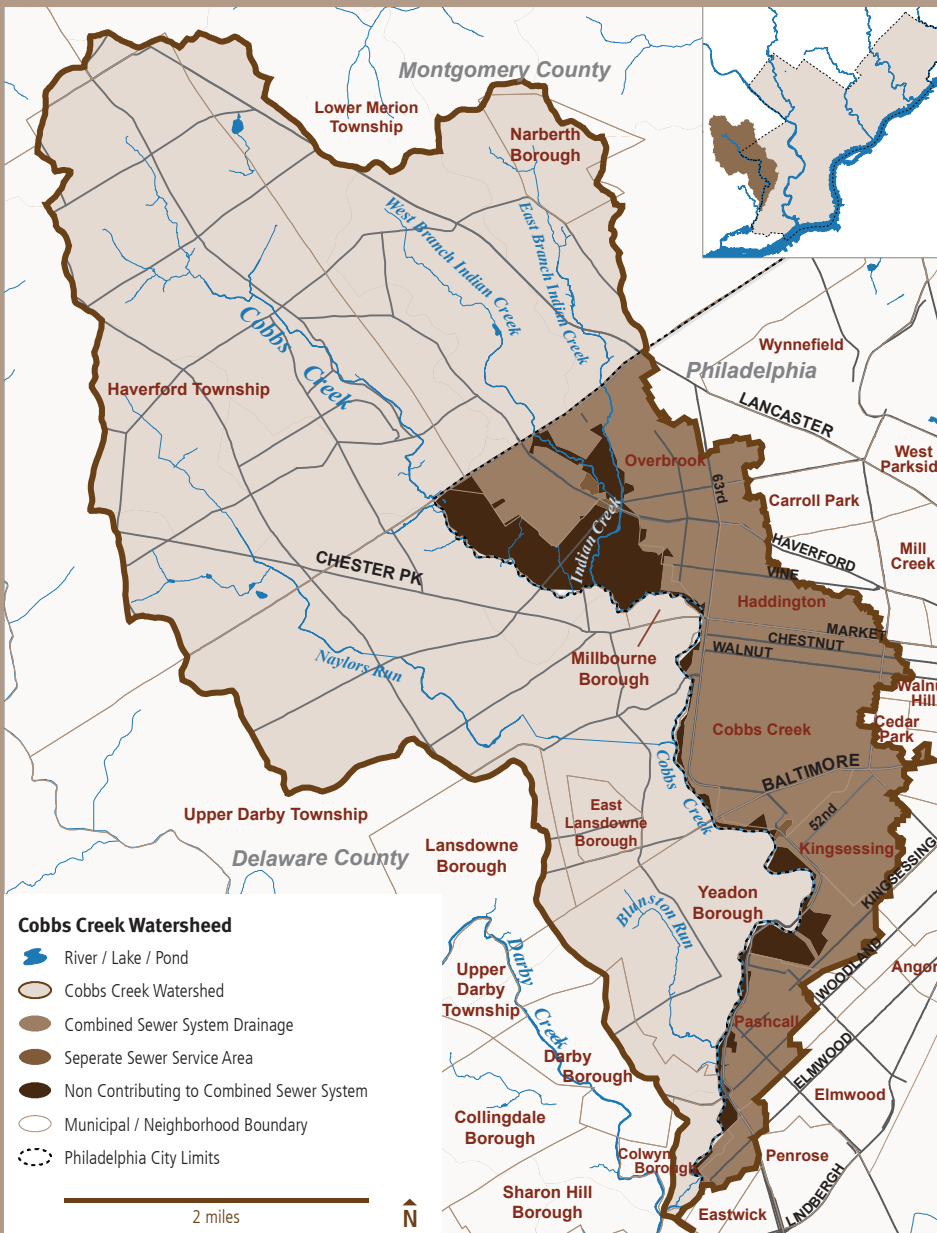
David Burke, Pennsylvania Department of Environmental Protection



on a region-wide scale by sharing resources and through cooperation among residents and other stakeholders. PWD offers the residents and stakeholders a number of resources, as this multifaceted planning approach requires a tremendous amount of coordination, characterization and planning, which the watershed stakeholders build on through the watershed-based planning process.

PWD's watershed plans are built upon a solid, scientific

foundation composed of water quality monitoring (including both wet and dry weather samples), benthic invertebrate (bug) and fish bioassessments, physical stream surveys (fluvial geomorphology as well as streamside infrastructure) and hydraulic and hydrologic computer modeling of stormwater flows and pollutant loading. Based on these extensive physical, chemical and biological assessments, the plans explore the nature, causes, and severity of water quality impairments in the watershed and



Cobbs Creek Watershed Integrated Watershed Management Plan

In 1999, the PWD formed its first watershed partnership, the Darby-Cobbs Watershed Partnership in an effort to connect residents, businesses, and government as neighbors and stewards of the watershed. Since then, the Partnership has been active in developing a vision for the watershed and guiding and supporting subsequent planning activities within the watershed. The Partnership functions as a consortium of proactive environmental groups, community groups, government agencies, businesses, residents and other stakeholders who have an interest in improving the Darby-Cobbs Watershed.

The mission of the Darby-Cobbs Watershed Partnership is to improve the environmental health and safe enjoyment of the Darby-Cobbs Watershed by sharing resources through cooperation of the residents and other stakeholders in the Watershed. The goals of the initiative are to protect, enhance, and restore the beneficial uses of the Darby-Cobbs waterways and riparian areas.

Implementation Commitment to Date: The Cobbs Creek Integrated Watershed Management Plan (CCIWMP), completed in 2004 included a long term commitment to implementation measures to address dry and wet weather water quality goals, and stream and habitat restoration goals. The first 5-year implementation plan for the CCIWMP (2006–2011) included a commitment from PWD of roughly \$16 million.

PWD and a number of the Darby-Cobbs Watershed Partners have successfully secured funding for and implemented multiple demonstration projects within the watershed. These projects stretch from the headwaters in Delaware and Montgomery Counties through the City of Philadelphia. The watershed partnership has worked over the years to understand where the information gaps exist within the community so that they could target demonstration projects that would not only achieve water quality and habitat related benefits, but also spread these demonstration projects geographically such that they would reach a diversity of community audiences educating residents about their various benefits.



A snapshot of projects implemented and/or underway within the Darby-Cobbs Watershed in 2008

PWD's watershed-based plans present logical and affordable pathways to restore and protect the beneficial and designated uses of these urban waterways.

in a safe park—along a clean creek—surrounded by a healthy stream buffer which can protect rich and diverse aquatic life in their streams. These are the tenets that watershed partners believe will result in watersheds that attain water quality and water quantity improvements, a healthier natural environment and a better quality of life for the people who live, work and play in the watersheds.

Tookany/Tacony-Frankford Creek Watershed Integrated Watershed Management Plan

Not only has this watershed partnership celebrated the success of transitioning from a loosely affiliated informal partnership structure to an independent nonprofit organization with the mission of implementing the recommendations of the IWMP, but in its first few years of existing as a non-profit, this organization has secured funding for and implemented a number of demonstration projects throughout the watershed area. On an annual basis, PWD works with the Watershed Partnership to feature a number of on-the-ground accomplishments from the previous year and shares them with our watershed stakeholders in celebration of all we have achieved.

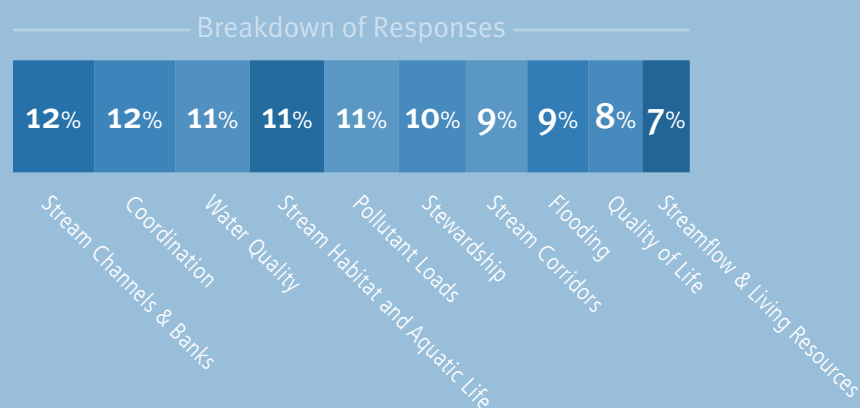


Planning Goals from the Integrated Watershed Management Plan

Over the past twelve years, the watershed-based goal-setting process initiated through IWMP development has taught PWD that our watershed stakeholders generally consider all watershed management goals of almost equal importance; there is no goal of clear “higher rank” than others. The *Green City, Clean Waters* program aligns with this equal prioritization by addressing all aspects of watershed management instead of focusing solely on selected in-stream water quality parameters.

Source: Data based on the goal-setting process for the development of the Cobbs Creek Integrated Watershed Management Plan, 2003

Watershed Goals as Prescribed by Watershed Partners



It is our goal to accomplish as many environmental improvements as possible, as quickly as feasible. We see the greatest immediate benefit to the public coming from an aggressive implementation of all the targets.

Environmental Targets

In an ideal world, flowing streams and rivers would remain in harmony with the surrounding environment. Banks would remain stable with lush, vegetative protection. Fish and benthic invertebrates (bugs) would thrive within their in-stream habitat. The floodplains surrounding the streams would be accessible, and within them one would find a mix of wetlands and mature forest cover.

Unfortunately, for the urban waterways of the Philadelphia area, streams have fallen victim to years of the effects of urbanization. As population and development have increased within and surrounding Philadelphia, so has impervious cover. This has resulted in a significant increase in stormwater runoff to be managed by existing infrastructure, ultimately making its way to these urban streams. This increase has created a “flashy” flow regime in these urban streams, meaning that they go from very low streamflows during dry weather to extremely high flows during rain events. This effect has devastated the stream systems, causing erosion and scouring of streambanks such that habitat has been all but destroyed for benthic invertebrate and fish populations.

Development of watershed planning goals through the stakeholder-led integrated watershed management planning process resulted in the establishment of three implementation targets for watershed improvement and restoration, based on consideration of ecology and human health. Targets help us to break the overwhelming end goal of “significantly improving watershed conditions” into three distinct measurable pieces on which we can consistently assess our performance during the implementation period.

Improvement of Stream Quality, Aesthetics and Recreation During “Dry” Weather:

Our focus is on achieving water quality standards in the stream during dry weather periods, which is when we believe that our stakeholders are most likely to be recreating streamside. In a given year, dry weather conditions are observed close to 65% of the time. Achievement of this target would involve the elimination of dry weather discharges to the stream from outfalls, removal of trash and litter from the waterway, improvement of public access to the waterways, as well as enhancement of streamside recreational opportunities including streamside trails and open space.

Preservation and Enhancement of Healthy Living Resources:

Part of what makes a stream so valuable is its healthy aquatic environment which results in diverse benthic invertebrate (bug) and fish populations. Implementation projects to achieve this lofty target are aimed not only at restoration of habitat, but also at measures to provide the opportunity for these organisms to seek refuge and avoid the high velocities of streamflow during storms. Achievement of this target will increase the population, health, and diversity of our benthic invertebrate and fish species within the stream.

Improvement of Wet Weather Water Quality and Quantity:

During rainstorms a great deal of stormwater is piped to our streams—resulting in abrupt changes in water quantity and quality. Through the use of Green Stormwater Infrastructure tools, we seek to reduce the impact of these abrupt changes by managing stormwater where it hits the ground, thereby reducing the amount of stormwater that reaches the waterways.

Green Stormwater Infrastructure

The use of sustainable and natural design, called green stormwater infrastructure, will bring about the renewal and expansion of the urban form. This approach has been shown to be the most environmentally beneficial and economically favorable way to remediate the effect of more than 200 years of urbanization on the City's waterways.

By investing in green stormwater infrastructure and other innovative, cost-saving strategies to manage stormwater, we are not only ensuring the rebirth of our ecological resources but are also striving to provide a host of other environmental, social and economic benefits that will catalyze our success in achieving the sought after reality of the "Greenest City in America."

Acknowledging the symbiotic relationship between land use and water resources, our definition of green stormwater infrastructure includes a range of soil-water-plant systems that intercept stormwater, infiltrate a portion of it into the ground, evaporate a portion of it into the air, and in some cases release a portion of it slowly back into the sewer system.

Green stormwater infrastructure examples include bioretention planters in sidewalks and parking lots, green roofs, and roof leaders that run off into lawns and rain gardens. These vegetated features manage rain where it hits the ground similar to the way a natural system such as a forest or a meadow would handle the rain runoff. We sincerely believe in the efficacy of using nature's own designs in which rainwater is an essential component for a thriving ecosystem. When rainwater is removed from a natural system, it is only a matter of time before the ecosystem fails. The reduction of

baseflow in urban streams is the unintended consequence of traditional infrastructure that pipes rainwater away from where it hits the ground before it has a chance to infiltrate.

Green stormwater infrastructure also involves the restoration of physical habitats in stream channels, along stream corridors, and on riverfronts. Restoration of stream habitats and riverfronts can also be combined with commitments to improve public access and amenities along the stream corridors. Public stewardship can only be guaranteed when the public is given the opportunity to see, touch and experience the streams healed by our efforts. These practices are critical to PWD's larger restoration vision; without them, the ecosystem damage resulting from two centuries of urbanization will not be reversed.

As green stormwater infrastructure becomes the standard practice, we will systematically reduce the amount of stormwater runoff from the City's built environment every time we renew the urban landscape and streetscapes. When we complete a public land transformation, the new green stormwater infrastructure will manage the first inch of rainfall which would normally flow along its street gutters and into its storm drains. We now look at our City's streets with an eye that seeks opportunities to peel back the existing concrete and asphalt and replace it with a new landscape, rich with vegetation that welcomes the rain—storing, draining and cleaning it. Our focus is on creating new standards of sustainable urban design that will guide the development and redevelopment of American cities in the 21st century.

We now look at our City's streets with an eye that seeks opportunities to peel back the existing concrete and asphalt and replace it with a new landscape, rich with vegetation that welcomes the rain—storing, draining, and cleaning it.



The *Green City, Clean Waters* program is designed so that every dollar spent provides a maximum return in benefits to the public and the environment.

Integrating with Local and National Policy

In a hallmark challenge to make Philadelphia “[The Greenest City in America](#),” Mayor Michael Nutter has committed to reducing the City’s exposure to rising energy prices, to limiting the City’s environmental footprint, and repositioning the workforce and economic development strategies to leverage an enormous competitive advantage in the emerging green economy. He created the new cabinet-level Office of Sustainability and a Sustainability Advisory Board representing public, private, and nonprofit interests from across the metropolitan area. In April 2009, the City launched “Greenworks,” an innovative action plan focusing on Energy, Environment, Equity, Economy, and engagement with ambitious targets to be addressed within the next five years.

PWD’s *Green City, Clean Waters* plan integrates management of Philadelphia’s watersheds into this larger context. It is designed to provide many benefits beyond the reduction of combined sewer overflows, so that every dollar spent provides a maximum return in benefits to the public and the environment. Philadelphia’s *Green City, Clean Waters* plan is a unique and fresh approach that supports numerous EPA initiatives at a time when our nation’s cities need 21st Century solutions to aging infrastructure problems. EPA Administrator Lisa Jackson identified five priorities for the Administration, including:

1. Protecting America’s water;*
2. Improving air quality;*
3. Reducing greenhouse gas emissions;*
4. Cleaning up hazardous-waste sites; and
5. Managing chemical risks.

PWD’s *Green City, Clean Waters* program will directly address three of these five priorities (Denoted with an asterisk).

The City of Philadelphia’s *Green City, Clean Waters* plan has been prepared in light of the recent green stormwater infrastructure guidance and policy documents developed by the United States Environmental Protection Agency (EPA). The EPA signed the “Green Stormwater Infrastructure Statement of Intent” in April 2007 and followed with the production of two memos, including “Using Green Stormwater Infrastructure to Protect Water Quality in Stormwater, CSO, Nonpoint Source and other Water Programs” and “Use of Green Stormwater Infrastructure in

Permits and Enforcement.” These EPA memos strongly support the use of green stormwater infrastructure approaches in lieu of traditional infrastructure when possible by encouraging state and federal policies to integrate green stormwater infrastructure into permitting and enforcement activities.

In March 2009, Administrator Jackson charged the EPA Office of Water with leading a new Urban Waters Initiative. The focus of this program will be to promote stewardship of urban waterways in the communities that surround them, especially in areas not historically targeted by environmental outreach. The goals of the Urban Waters Initiative are 1) to achieve water quality goals for fishable/ swimmable/drinkable rivers, 2) to improve public health and the environment and quality of life, and 3) sustain community improvements over multiple generations. This initiative will help restore urban waterways in Environmental Justice communities. [The *Green City, Clean Waters* Program embodies the intent of this Urban Waters Initiative.](#) PWD will follow this initiative as it develops and will seek opportunities for partnership synergies.

Also, the EPA has recently joined forces with the US Department of Housing and Urban Development and the Department of Transportation through an Interagency Partnership for Sustainable Communities, focusing national attention to improve access to affordable housing, more transportation options, and lower transportation costs while protecting the environment in communities nationwide. Philadelphia’s unique approach to meeting CSO requirements helps promote the goal of livable communities by investing in healthy, safe and walkable neighborhoods and coordinates all levels of policy to support our existing communities. This is yet another initiative that would dovetail with the *Green City, Clean Waters* program, presenting opportunities to partner and where possible, leverage funding such that both agencies are able to stretch their limited capital further and are able to get more out of each investment.

LTCPU Implementation Alternatives Evaluated

In order to compare the costs and benefits for multiple implementation approaches, we performed a comprehensive alternatives analysis on a number of implementation approaches (summarized below). Each infrastructure alternative was analyzed in detail for each watershed. Green Stormwater Infrastructure with Targeted Traditional Infrastructure was clearly the best alternative for several reasons. First, this alternative reduced combined sewer overflow in a cost-effective manner. Second, it meets the broader goals of PWD's Integrated Watershed Management approach while maximizing environmental, social, and economic benefits. Third, this alternative is the only one that meets all watershed goals without causing severe economic hardship for PWD's ratepayers. Finally, public feedback has expressed a clear and unambiguous preference for an alternative focused on green stormwater infrastructure.

	Affordable	Scalable	Meets Combined Sewer Overflow Policy Goals	Meets Watershed-based Planning Goals	Economic Benefits				Social Benefits			Environmental Benefits	
					Creates Jobs; Reduces Social Cost of Poverty	Enhances Recreation	Improves Community Quality of Life	Reduces Effects of Excessive Heat	Restores Ecosystems	Improves Air Quality	Saves Energy and Offsets Climate Change	Public Support	Benefits Accrual Method
Complete Sewer Separation <ul style="list-style-type: none"> construct new sanitary sewer infrastructure convert existing combined sewers to a municipal separate storm sewer system (MS4) separate combined sanitary and storm laterals on private property reconnect private properties to new system reconstruct streets and sidewalks to their existing conditions 	○	○	●	◐	○	○	○	○	○	○	○	○	at completion
Large-scale Storage (Tunnels) <ul style="list-style-type: none"> construct traditional tunnel storage to temporarily store combined sewage dewater stored sewage when capacity at water pollution control plants is available 	○	○	●	◐	○	○	○	○	○	○	○	○	at completion
Plant Expansion, Satellite Treatment <ul style="list-style-type: none"> construct decentralized satellite treatment facilities construct new consolidation sewers to convey waste water to new satellite facilities 	◐	◐	●	◐	○	○	○	○	○	○	○	○	at completion
Green Stormwater Infrastructure with Increased Transmission and Treatment <ul style="list-style-type: none"> implement large-scale application of green stormwater infrastructure construct new interceptors to increase capacity increase wet weather wastewater treatment capacity 	◐	◐	●	●	◐	●	◐	◐	●	◐	◐	◐	immediate incremental
Green Stormwater Infrastructure with Targeted Traditional Infrastructure <ul style="list-style-type: none"> implement intensive large-scale application of green stormwater infrastructure increase wet weather wastewater treatment capacity in targeted locations 	●	●	●	●	●	●	●	●	●	●	●	●	immediate incremental

Why This Approach is Best for the City of Philadelphia

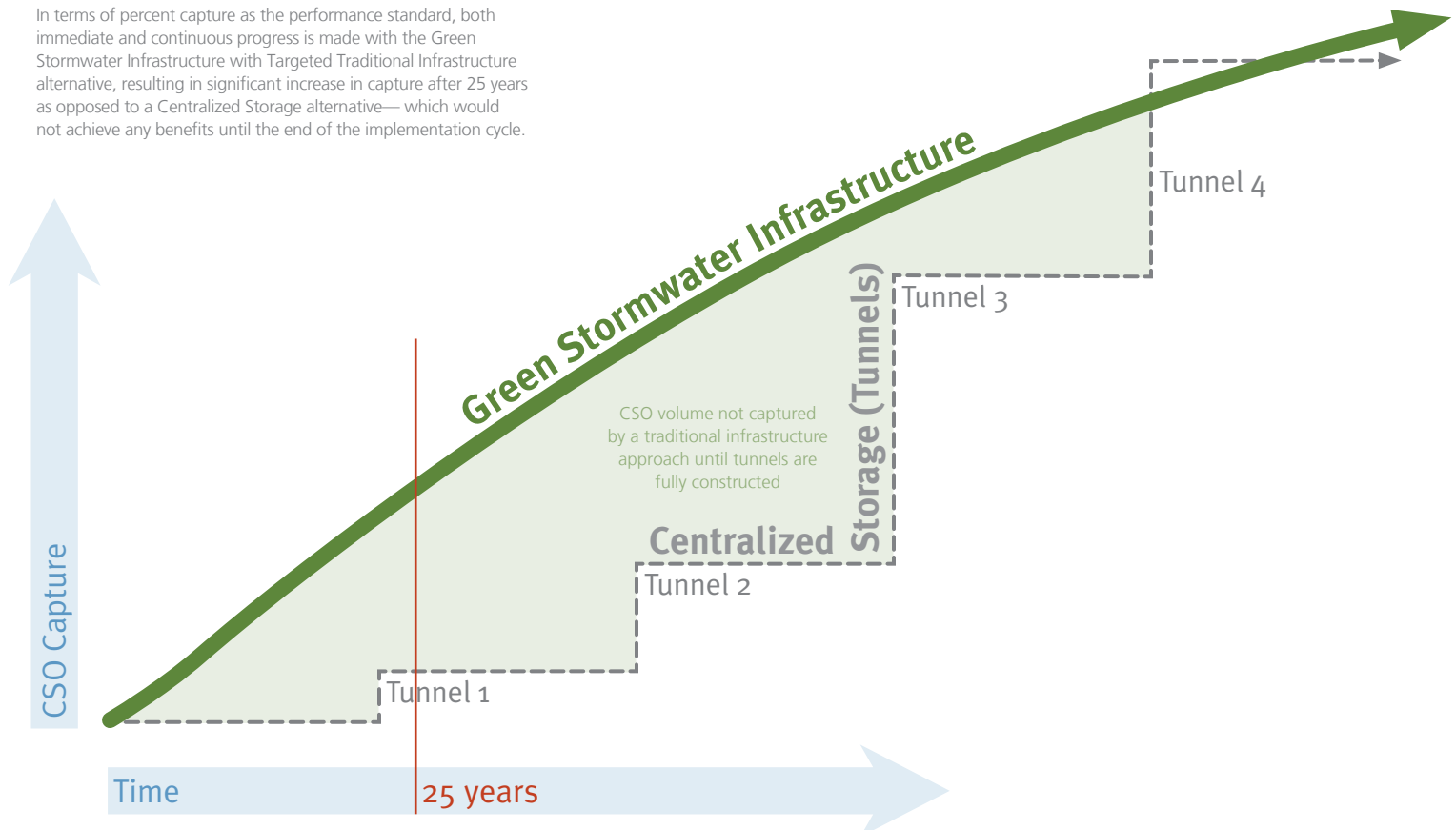
PWD considered it critical to embed the CSO program in the larger context of the various economic, social, and environmental challenges.

Multiple alternatives for meeting program objectives were developed and initially compared for their effectiveness and efficiencies in reducing combined sewer overflows. In selecting the best alternative for meeting the City's obligations for controlling CSO events, PWD considered it critical to embed the CSO program in the larger context of the various economic, social, and environmental challenges. These challenges require that government agencies break out of their traditional roles of providing narrowly defined services and seek to work together toward larger goals. PWD's LTCPU rightly focuses on significantly reducing CSOs, thereby making Philadelphia's creeks and rivers cleaner and healthier. **But as the single largest investment in the City's environment over the next 25 years, it presents a unique opportunity to be much more than just a water quality improvement program and reverse the decline in the physical infrastructure in the City. It must be designed to provide additional benefits beyond the reduction of CSOs, so that every investment made provides a maximum return in benefits to the City.**

After more than two years of significant engineering and economic analyses, the "Green Stormwater Infrastructure with Targeted Traditional Infrastructure" alternative was shown to be the most attractive alternative due to the many environmental, social, and economic benefits that can be realized, its ability to improve all four watersheds and remain within affordability guidelines, and the fact that benefits begin accruing immediately—thereby producing benefits for City residents long before the traditional infrastructure approach would. Because the alternative is implemented gradually, it is also adaptable to changing conditions and uncertainty. By comparison, due to limited financial capability, PWD could only afford a partial tunnel solution, meaning that only one watershed would benefit from this traditional infrastructure program within the 25-year implementation horizon. Instead, we chose a green and decentralized program that is adaptable over the 25-year implementation program and produces benefits throughout the combined sewer system drainage area.

Conceptual Comparison of CSO Capture Over Time for Alternatives Evaluated by the City of Philadelphia

In terms of percent capture as the performance standard, both immediate and continuous progress is made with the Green Stormwater Infrastructure with Targeted Traditional Infrastructure alternative, resulting in significant increase in capture after 25 years as opposed to a Centralized Storage alternative—which would not achieve any benefits until the end of the implementation cycle.



An important advantage of *Green City, Clean Waters* is that it lays the groundwork for the revitalization of our City in areas of public health, recreation, housing and neighborhood values. **Philadelphia is the first city to fully adopt this approach for a CSO regulatory compliance program, which accumulates multiple social benefits in addition to complying with the City's Clean Water Act responsibilities.**

To fully understand these benefits, PWD has undertaken a Triple Bottom Line analysis of the environmental, social, and economic benefits of the program. This triple bottom line accounting means expanding the traditional financial reporting framework to take into account ecological and social performance so that the total benefits can be evaluated against the financial investment. Triple Bottom Line accounting attempts to describe the social and environmental impact of PWD's infrastructure investment such that they can account for not only the water quality benefit that the infrastructure would produce, but also the additional environmental and societal benefits generated by the various alternatives evaluated.

Although some of these environmental, social, and health benefits can be extremely difficult to quantify, PWD felt it was important to analyze these "triple bottom line" benefits in an attempt to compare the green approach with other traditional infrastructure alternatives. **Understanding the full societal costs and benefits is important in justifying the program with the ratepayers, who will ultimately pay for this initiative.** With the help of leading environmental economists, PWD compared the alternatives to help quantify the social benefits. After 45 years, the *Green City, Clean Waters* program will have generated more than one dollar in benefits for every dollar invested by PWD, representing a net gain in value to the city.

"The Mayor's commitment to making Philadelphia the greenest city in America is well served by this innovative program that encourages water infrastructure to be spent in a sustainable fashion. This groundbreaking \$2 billion plan will produce financial, environmental and social benefits over the next 25 years.

I believe it will become the national model for stormwater management."

Rina Cutler, Deputy Mayor of Transportation and Utilities, City of Philadelphia

"Philadelphia is setting a national model for smarter, greener ways to clean up troubled rivers, lakes and beaches. Green infrastructure is often the best and most cost-effective way to tackle water pollution. The city is pioneering a broad investment in measures that not only deliver cleaner water, but dramatically improve the overall health and quality of life for its residents at the same time. The rest of the country would be wise to take notice."

Lawrence Levine
Natural Resources Defense Council
Senior Water Attorney

After 45 years, the *Green City, Clean Waters* program will generate more value in benefits than the cost of the program to the City.

Triple Bottom Line Benefits

Economic Benefits

Green Stormwater Infrastructure Jobs Reduce the Social Cost of Poverty. Governments at all levels incur significant costs in coping with poverty, and Philadelphia is no exception. Green stormwater infrastructure creates jobs which require no prior experience and are suitable for individuals who might be otherwise unemployed and living in poverty. These new jobs create a benefit to society in reduced poverty-related costs, in addition to the wages paid to the individual workers. The stabilizing and transforming effects of green stormwater infrastructure in neighborhoods further reinforce and support the benefits of providing employment to a population that is outside the labor force. Green stormwater infrastructure is not by itself the solution to poverty, but could serve as a valuable tool in poverty reduction.

Annually, about 250 people employed in Green Jobs.

Social Benefits

Increase of up to 10% more recreational and stream-related visits to Fairmount Park.

Green Stormwater Infrastructure Enhances Recreation.

Throughout the Fairmount Park system, residents enjoy recreation along Philadelphia's stream corridors and waterfronts, but some areas do not live up to their full potential. Improved access, appearance, and opportunities in these areas will make them more desirable destinations for the public. Recreation also will be more desirable along newly greened neighborhood streets and public places. Today, many Philadelphians enjoy recreation along our stream corridors and waterfronts such as the Forbidden Drive along the Wissahickon Creek and The Schuylkill River Trail. *Green City, Clean Waters* will improve aquatic habitat and accessibility to the Tacony Creek and the Cobbs Creek to enhance their appeal as passive recreational locations as well.

Increase of up to \$390 million in property value of homes near parks and green areas over the next 45 years.

Green Stormwater Infrastructure Improves Community Quality of Life.

Trees and parks are an important part of the recipe that together can transform an urban neighborhood into an inviting, exciting place to live, work and play. Residents clearly recognize and value this quality of life benefit of urban vegetation. One way to estimate a value is to study property values in areas that are close to parks and greenery. In Philadelphia, green stormwater infrastructure is expected to raise property values by approximately 2–5%.

Reduction of up to 140 fatalities caused by excessive heat over the next 45 years.

Green Stormwater Infrastructure Reduces Effects of Excessive Heat.

Heat waves are a fixture of summers in Philadelphia, including some severe enough to result in over 100 premature deaths (Summer of 1993). These events may be more frequent and severe in the future due to climate change. Green stormwater infrastructure (trees, green roofs, and bioretention sidewalks) reduces the severity of extreme heat events in three ways—by creating shade, by reducing the amount of heat absorbing pavement and rooftops, and by emitting water vapor—all of which cool hot air. This cooling effect will be sufficient to actually reduce heat stress-related fatalities in the City during extreme heat wave events.

Environmental Benefits

Green Stormwater Infrastructure Improves Air Quality. Like many major cities in the United States, EPA currently classifies the Philadelphia metropolitan area as exceeding federal air quality standards for both ozone (smog) and fine particles (soot). Known health impacts of these air pollutants include premature death, hospitalization for respiratory diseases, heart attacks, and lost work and school days. Green stormwater infrastructure will improve Philadelphia's air quality in two ways—by reducing emissions of pollutants (such as SO₂) and by removing ozone and particulates from the air. Reductions in energy and vehicle use will reduce emissions of pollutants. Once in the air, some ozone is taken into the leaves of trees as they “breathe.” Leaves also trap additional fine particulates, which then wash off in the rain or fall with the autumn leaf drop.

Green Stormwater Infrastructure Saves Energy and Offsets Climate Change. Green stormwater infrastructure reduces energy use, fuel use, and carbon emissions in two ways. First, the cooling effects of trees and plants shade and insulate buildings from wide temperature swings, decreasing the energy needed for heating and cooling. Second, rain is managed where it falls in systems of soil and plants, reducing the energy needed for traditional systems to store, pipe, and treat it. Growing trees also act as carbon “sinks,” absorbing carbon dioxide from the air and incorporating it into their branches and trunks.

Green Stormwater Infrastructure Restores Ecosystems. Green stormwater infrastructure improves ecosystems in two ways. First, by allowing rain to soak into the ground and return slowly to streams, thereby restoring a water cycle more similar to a natural watershed. This provides a natural water quality filter and limits erosion of stream channels caused by high flows, both of which benefit aquatic species. Second, PWD's green stormwater infrastructure approach includes physical restoration of stream channels and streamside lands, including wetlands, to restore habitat needed for healthy ecosystems.



Before and after a stream restoration of exposed interceptor pipe along Marshall Road in the Cobbs Creek Watershed.

Air quality benefits from fully-grown trees will on average lead to (each year):

Up to 1-2 avoided premature deaths
Up to 20 avoided asthma attacks
Up to 250 fewer missed days of work or school

Up to 1.5 billion lbs of carbon dioxide emissions avoided or absorbed. This is equivalent to removing close to 3,400 vehicles from the roadways each year.

Up to \$8.5 million in water quality and habitat improvements over the next 40 years including:

Up to 45 acres of wetland restored
Up to 148 acres of wetlands created
7.7 mi of stream restored in the Cobbs Creek Watershed
3.4 mi of stream restored in the Tookany/Tacony-Frankford Watershed



A vision of Cobbs Creek looking toward Woodland Avenue Dam illustrating habitat restoration and recreation enhancements.

The *Green City, Clean Waters* Approach

PWD's \$2.4 billion investment over the next 25 years will not only make our waterways cherished and thriving destinations, but will also leverage our capital investment in a way that provides multiple additional community benefits that further Mayor Nutter's Greenworks Plan and supports the vision of numerous civic and community partners for a truly sustainable city. PWD will invest \$1.67 billion in Green Stormwater Infrastructure projects throughout the city, and \$345 million in upgrades to the treatment plant capacity to handle additional stormwater flows. The remaining \$420 million represents a "flexible spending category", and could be spent on additional Green Stormwater Infrastructure or targeted gray infrastructure, whichever proves more efficient as the program evolves.

Green Stormwater Infrastructure

\$1.67 billion

Wet Weather Treatment Plant Upgrades

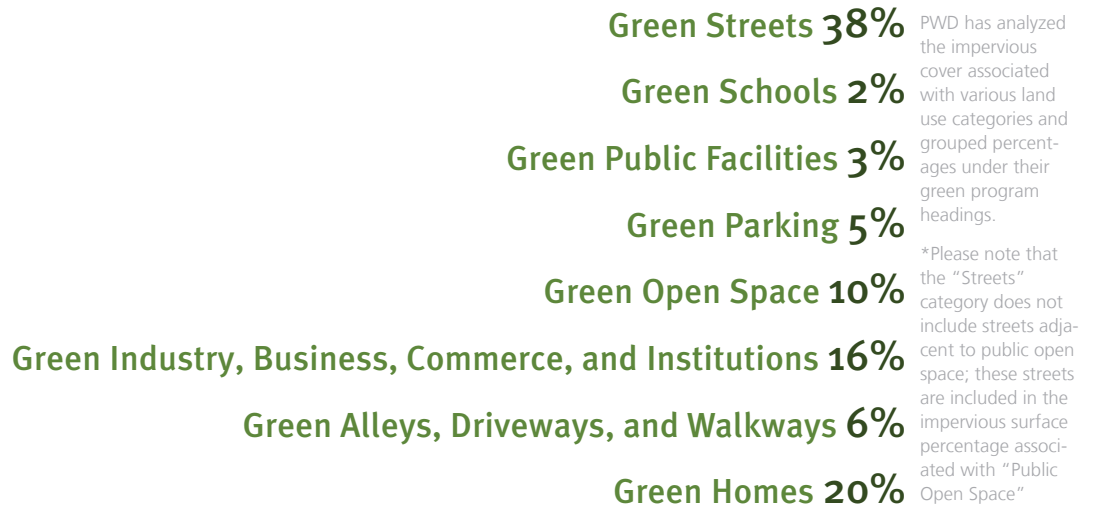
\$345 million

Adaptive Management

\$420 million

Green Stormwater Infrastructure

Breakdown of Impervious Cover within the Combined Sewer System Drainage by PWD's Green Programs



PWD's Green Stormwater Infrastructure Commitment

This commitment sets in motion a plan for converting more than one-third of the impervious cover within the combined sewer drainage area to Greened Acres. PWD has developed a number of "Green Programs," each with a number of associated implementation tools—including policy changes, regulatory tools, funding commitments and incentives through which the transformation from impervious acre to Greened Acres will occur.

Key to the success of PWD's strategy is that immense opportunity exists for implementation on publicly-owned land, such as City-owned properties, streets and rights-of-way, which constitute 45% of the impervious land area of the City. With that in mind, the initial approach to achieving management of impervious cover is to focus efforts on publicly owned impervious cover and the larger, more commercial properties, and to use programs addressing impervious cover on smaller private properties to increase the level of control as needed. Over the course of the implementation horizon, additional programmatic elements will be explored and developed.

An important performance metric used throughout this document is the achievement of a Greened Acre. This Greened Acre includes the area of the stormwater management feature itself and the area that drains to it (or the stormwater feature's own "little" watershed).

Each Greened Acre will manage the first inch of runoff from one impervious acre of the combined sewer service area. One acre receives about 1 million gallons of rain each year. Today, if the land is impervious, it all runs off into the sewer and becomes polluted. A Greened Acre will stop 80–90% of this pollution from occurring.

We have some clear ideas and have implemented many of the solutions through a variety of demonstration projects with the assistance of our partners, although deciding the precise application will be an evolving process. What is truly exciting about this plan is that it has the power to change forever the way our City renews its streets and neighborhoods. Many of these green technologies have been proven successful, but are untried on such a city-wide scale. Our plan contains built-in "milestones" that allow us to measure our progress with each element every five years and adapt as necessary. Because of the numerous possible tools available for greening acres, the plan is by its very nature adaptive.

Green Stormwater Infrastructure Tools

The Green Programs described on the following pages will each utilize a unique mix of green stormwater infrastructure tools. The majority of these examples have been implemented locally, demonstrating the use of green infrastructure in Philadelphia. The additional examples are located in Portland, Oregon, as noted.

Plants and Stormwater Management

Trees, shrubs, and flowers help manage rain, or stormwater, through catching rain drops on their leaves and branches before the stormwater becomes runoff, as it hits the ground. The stormwater collected on these surfaces can easily evaporate into the air. Additionally, plants help manage stormwater runoff not only by allowing water to infiltrate into the soil, but also by a process called evapotranspiration, in which water is taken up by plant roots and transpired through their leaves. Plants and soil also help in filtering stormwater runoff.

Stormwater Tree Trench



A stormwater tree trench is a system of trees that is connected by an underground infiltration structure. On the surface, a stormwater tree trench looks like a series of street tree pits. However, under the sidewalk, an engineered system manages the incoming runoff. This system is composed of a trench dug along the sidewalk, lined with a permeable geotextile fabric, filled with stone or gravel, and topped off with soil and trees. Stormwater runoff flows through a special inlet (storm drain), leading to the stormwater tree trench. The runoff is stored in the empty spaces between the stones, watering the trees and slowly infiltrating through the bottom. If the capacity of this system is exceeded, stormwater runoff can bypass it entirely and flow into an existing street inlet.

West Mill Creek, Philadelphia, PA

Downspout Planter



A downspout planter is a structure that collects stormwater from roof gutters and directs it into a planter box. The water is filtered by the plants and soil in the planter. Downspout planters are connected to the downspout by a pipe. They filter pollutants from the water flow in. They filter pollutants from the soil and filter sediment and debris from the water flow down through the planter. They are designed to not infiltrate runoff into the ground, but rather to store it in the planter. They rely on evapotranspiration and soil infiltration to manage stormwater. Excess water can overflow from the planter through a spout connection. Downspout planters come in many sizes and shapes, and can be made from concrete, brick, plastic lumber or other materials.

Philadelphia Water Department

Green Roof



A green roof is a roof or section of roof that is vegetated. A green roof system is composed of multiple layers including waterproofing, a drainage layer, an engineered planting media, and specially selected plants. Green roofs can be installed on many types of roofs, from small slanting roofs to large commercial flat roofs. Two basic types of green roofs have been developed, extensive and intensive. An extensive green roof system is a thin, (usually less than 6 inches), lighter-weight system planted predominantly with drought-tolerant succulent plants and grasses. An intensive green roof is a deeper, heavier system designed to sustain more complex landscapes. A green roof is effective in reducing the volume and velocity of stormwater runoff from roofs by temporarily storing stormwater, slowing excess stormwater release into the combined sewer system, and promoting evapotranspiration.

PECO Building, Philadelphia, PA

Rain Barrel



A rain barrel or cistern is a structure that collects and stores stormwater runoff from rooftops. The collected rain water can be used for irrigation to water lawns, gardens, window boxes or street trees. By temporarily holding the stormwater runoff during a rain event, more capacity can be added to the city's sewer system. However, rain barrels and cisterns only serve an effective stormwater control function if the stored water is used or emptied between most storms so that there is free storage volume for the next storm. Rain barrels are designed to overflow into the sewer system through the existing downspout connection in large storm events. Although these systems only store a small volume of stormwater, collectively, they can be effective at preventing large volumes of runoff from entering the sewer system.

Philadelphia, PA

Pervious Paving



Pervious pavement is a special type of pavement that allows water to infiltrate into the ground. It prevents it from becoming runoff. Pervious pavement provides structural support of conventional pavement. It is made of a porous surface and an underlying stone reservoir provides temporary storage for water that infiltrates into the soil. There are many types of porous surfaces including pervious concrete, pervious asphalt, and interlocking pavers. Interlocking pavers are slightly different way than pervious concrete. Rather than allowing the water to flow through the paving, pavers are spaced apart so that water can flow between the pavers that allow it to infiltrate into the ground.

Mill Creek Basketball Court, Philadelphia, PA



ure that is designed to allow
flow through and be used
ers are filled with gravel, soil,
o the roof downspout to let
nts as water infiltrates the
d are typically waterproofed,
are frequently closed systems
to the ground, rather, they
short-term storage to manage
overflow into the existing down-
planters can be constructed in
h various materials, including
r wood.

Facility, Philadelphia, PA

Bump-out



A stormwater bump-out is a vegetated curb extension that protrudes into the street either mid-block or at an intersection, creating a new curb some distance from the existing curb. A bump-out is composed of a layer of stone that is topped with soil and plants. An inlet or curb-cut directs runoff into the bump-out structure where it can be stored, infiltrated, and taken up by the plants (evapotranspiration). Excess runoff is permitted to leave the system and flow to an existing inlet. The vegetation of the bump-out will be short enough to allow for open site lines of traffic. Aside from managing stormwater, bump-outs also help with traffic calming, and when located at crosswalks, they provide a pedestrian safety benefit by reducing the street crossing distance.

NE Siskiyou Street, Portland, OR

Stormwater Planter



A stormwater planter is a specialized planter installed into the sidewalk area that is designed to manage street and sidewalk runoff. It is normally rectangular, with four concrete sides providing structure and curbs for the planter. The planter is lined with a permeable fabric, filled with gravel or stone, and topped off with soil, plants, and, sometimes, trees. The top of the soil in the planter is lower in elevation than the sidewalk, allowing for runoff to flow into the planter through an inlet at street level. These planters manage stormwater by providing storage, infiltration, and evapotranspiration of runoff. Excess runoff is directed into an overflow pipe connected to the existing combined sewer pipe.

Columbus Square, Philadelphia, PA



ly designed pavement system
through the pavement and
off. This system provides the
onal pavement, but is made up
underground stone reservoir. The
rary storage before the water
are many different types of
ous asphalt, pervious concrete,
locking pavers function in a
pervious concrete and asphalt.
ter to penetrate through the
art with gravel or grass in
s for infiltration.

Philadelphia, PA

Rain Garden



A rain garden is a garden designed to collect runoff from impervious surfaces such as roofs, walkways, and parking lots, allowing water to infiltrate into the ground. The garden is typically moderately depressed (lower than the surrounding ground level), with the bottom layer filled with stone, so runoff can collect and pond within it. The site is graded appropriately to cause stormwater to flow into the rain garden area from the nearby impervious area. The water ponds on the surface, is used by the vegetation in evapotranspiration, and infiltrates into the subsurface stone storage and soil. Rain gardens can be connected to sewer systems through an overflow structure, but usually they are sized to infiltrate the collected stormwater runoff within 72 hours. Flexible and easy to incorporate into landscaped areas, rain gardens are suitable for many types and sizes of development and retrofits. Rain gardens are effective at removing pollutants and reducing stormwater runoff volume.

Wissahickon Charter School, Philadelphia, PA

Stormwater Wetland



A stormwater wetland is a man-made shallow marsh system that is engineered to serve as both a temporary storage location as well as a natural filter for stormwater runoff. Each wetland is composed of various depths of storage areas, including surface, shallow, and deep areas, and a complex mix of wetland-appropriate landscaping. Stormwater wetlands are one of the best stormwater management tools for pollutant removal and can provide considerable aesthetic and wildlife benefits.

Saylor Grove, Philadelphia, PA



Above: Street runoff is captured at this rain garden at 47th St. and Gray's Ferry Ave. in the Combined Sewer Area within the Schuylkill River Watershed.



Above: The West Mill Creek Green Streets demonstration project in the Schuylkill Watershed includes a tree trench, permeable pavers and modified street inlets to divert stormwater into a subsurface infiltration bed.



Green Streets

Streets and sidewalks are by far the largest single category of public impervious cover, accounting for roughly 38% of the impervious cover within the combined sewer service area. (Note: impervious cover associated with streets in front of parks was not included in this percentage; these streets are included in the “Green Public Open Space” program). A green street acts as a natural stormwater management system, capturing rain or melting snow (runoff), allowing it to soak into soil, filtering it and at the same time, reducing the amount of stormwater that would otherwise make its way into Philadelphia’s combined sewer pipes.

PWD’s Green Streets designs will provide stormwater management functions while still maintaining the primary function of the street for vehicles and pedestrians. These Greened Acres will provide additional societal benefits on our streets, such as shading, cooling, traffic calming, and visual enhancement.

Some of the green stormwater infrastructure tools in our green streets tool box include street trees and the “pit” they are planted in, sidewalk trenches and planters, sidewalk bump-outs and bulb-outs (sidewalk extensions), and porous pavement. Street tree pits and trenches capture the flow of stormwater from the street and sidewalk and allow it to soak into the soil to water the trees. They provide shade, improve air quality, absorb noise and beautify the neighborhoods.

Through the use of sidewalk planters, stormwater runoff from the street and sidewalk is directed to the planter through a curb opening, allowing stormwater to be absorbed by the plant and soil materials. Sidewalk planters help protect our waterways by filtering and reducing stormwater runoff.

The use of porous pavement allows the stormwater runoff to soak right through our sidewalks, while providing the same structural support as traditional pavement. This is a tool that at the surface might not look “green,” but still provides stormwater management benefits.

PWD is working to align its green stormwater infrastructure practices with street greening programs associated with Greenwork’s ambitious greening goals. Coordination of PWD’s program with other city programs will encourage maximum effectiveness. Ultimately, the Green Streets program should result in setting a “green standard” for streets within the City. Partners include PennDOT and the City of Philadelphia Streets Department as well as special service districts to help with maintenance.

Since implementation of the *Green City, Clean Waters* program will depend highly on green streets, PWD has already started collaborating with the Streets Department and other utilities so that all projects will become streamlined and coordinated. PWD will design tree trenches and bumpouts to streets already slated for improvements. When both utility and road work can be done on each street at the same time, it lessens the project costs and the inconvenience to residents.

Additionally, Philadelphia Parks & Recreation already has an extensive street tree program. PWD will build on a successful history of working together with the park system by designing street tree trenches to be installed as street trees are installed or replaced. Not only will these trenches increase the life expectancy of the trees, they will capture even more urban runoff in the underground drainage system. The same efficiencies can be realized by installing curbside green stormwater infrastructure such as bump-outs when the City replaces or installs Americans with Disabilities Act mandated ramps on the sidewalks.

PWD has begun to prepare standard designs, and is working on appropriate regulations and incentives to retrofit streets whenever the opportunity arises. Thus, simple green designs (e.g. street trees) will be available for use where possible when streets are affected by:

- PWD infrastructure repair/replacement
- PWD storm flood relief related construction
- Cable/Gas/Phone infrastructure repair/replacement
- Routine repaving by either the Philadelphia Streets Department or PennDOT

Green Schools

Schools make up 2% of all impervious cover in the combined sewer drainage area but are highly visible, thereby offering excellent opportunities to educate the local community on green stormwater infrastructure. An array of stormwater measures can be implemented on school properties, such as rain gardens, green roofs, porous pavement, trees, rain barrels and cisterns. For example, porous pavement and trees on both parking and recreational facilities on school campuses can transform what are now heat-trapping asphalt surfaces into more welcoming, cooler, green havens.

Right: Harmony Garden enhances the school yard and curriculum at Wissahickon Charter School. Green stormwater infrastructure features here include rain gardens, pervious pavers and a subsurface infiltration system.





Green Public Facilities

Public parcels make up 3% of impervious cover in the combined sewer drainage area. The value in retrofitting them with green stormwater infrastructure is primarily to lead by example. This cannot be underestimated, both for establishing the credibility of the program in the eyes of the public, and to demonstrate the effectiveness of the measures to still skeptical individuals within the development community. PWD is leading this initiative by evaluating opportunities for the greening of its own facilities. Additionally, PWD encourages the installation of green streets surrounding major public facilities to maximize the potential stormwater management benefits.

Left: Green roof being planted on the Free Library of Philadelphia in the Schuylkill Watershed.



Green Parking

Parking lots, at 5% of the impervious cover, present a great opportunity to reduce stormwater runoff. Parking lots have a significant visual impact on the City, and green parking lots can contribute to the overall improvement in the appearance of the City's commercial and business districts. A variety of stormwater measures can be used to renovate parking lots, including vegetative strips, infiltration beds (which temporarily store runoff and clean it), trees, porous pavement, sand filters, and even green roofs on parking garages.

City-owned parking facilities will be targeted as a demonstration of the City's commitment to green stormwater infrastructure. Additionally, the incentives provided by PWD's Parcel Based Billing Initiative, which resulted in a reallocation of stormwater fees should make retrofits aimed at reducing stormwater fees more attractive such that private parking lots might begin to seek opportunities for retrofit. The City may also consider an ordinance to mandate a green buffer around all parking facilities that also function as a stormwater infiltration measure.



Above: A vegetated swale collects and infiltrates stormwater from an employee parking lot at the Philadelphia International Airport in the Schuylkill Watershed.





Green Public Open Space

Public Open Space with the inclusion of streets adjacent to parks makes up about 10% of the City's impervious cover. Impervious cover associated with the park lands itself is quite low, but PWD sees opportunities for utilizing the streets surrounding these parcels to route and manage stormwater from the surrounding areas where this can be done without adversely impacting the quality of the public land itself.

Recreational centers are important community focal points in Philadelphia, many of which are in need of restoration and upgrades. PWD will continue to identify opportunities to implement green stormwater infrastructure on these large parcels while enhancing community amenities.

Above: The stormwater demonstration project at Cliveden Park captures runoff from adjacent streets and uses the park's natural topography to detain and infiltrate stormwater in the Tookany/Tacony Frankford Watershed.



Green Industry/Business/Commerce/Institutions

The combined Green Industry, Business, Commerce, and Institutions program makes up about 16% of the City's impervious cover. Philadelphia's industrial, business, commerce, and institutional properties hold significant opportunities for green stormwater infrastructure implementation. Generally, because implementation of this program is within the control of private entities, PWD will undertake a supporting role in seeing it developed programmatically. Many industries, businesses and commercial buildings would be expected to face upgrades and renovations within the 25-year time frame, making a high rate of compliance with stormwater regulations a reasonable expectation. Also, one clear incentive for private entities to consider installation of green stormwater infrastructure will be PWD's new Parcel Based Billing Initiative, which ties impervious cover to the stormwater fee. PWD anticipates that this will result in many existing large private, non-residential entities retrofitting their properties with stormwater management infrastructure in order to receive a credit in the stormwater portion of their bill.

A program to target properties and buildings owned by churches, hospitals, universities, and sports stadiums presents another highly visible opportunity for green stormwater infrastructure. Much like large commercial or industrial properties, this program will rely on compliance with the City's Stormwater Regulations for new facilities as well as the incentive for retrofit of existing facilities provided by the Parcel Based Billing Initiative. In addition, many major universities have embarked on ambitious sustainability initiatives. Where possible, PWD will seek to partner with these entities in order to produce synergies and stretch limited dollars. This may present opportunities to work with each university to separate all stormwater from the sewer system for onsite, green solutions.

Other opportunities might include greening the large areas of impervious cover associated with the sports stadium complexes and the Convention Center, which attract millions of visitors each year. When certain large facilities are renovated or constructed anew, complete separation of the facility's sanitary and storm sewers might be possible, would ideally be combined with green measures.



Green Alleys/Driveways/Walkways

Philadelphia has many smaller alleys located behind houses and commercial buildings that are currently impervious and drain to the storm and combined sewers via stormwater inlets. Though this program only makes up about 6% of all impervious cover in the City, it may offer relatively inexpensive solutions for infiltration or collection of roof runoff. These often underutilized areas present an opportunity to either use the alleys for infiltration, or to convey stormwater to green stormwater infrastructure located at the end of an alley. In addition to the alleys, there are often walkways providing access to backyards of homes, and driveways for single family homes and row houses that present other opportunities for onsite stormwater controls.



Green Homes

Residential roofs make up 20% of all impervious cover in the City. The key to success for this program may lie in the simplicity of smaller scale stormwater management solutions on homeowner's properties.

Homeowners can carry out these solutions themselves and achieve benefits at a minimal cost. Projects, such as the use of rain barrels, have already proven popular in pilot programs, and if implemented on a larger scale, can ultimately affect a significantly larger amount of impervious cover. Additionally, more ambitious (and somewhat more costly) measures should also be considered, including the installation of a green roof or capturing stormwater in larger cisterns for reuse.

Public education is a key to increasing participation in residential stormwater measures such as:

- Installing rain barrels to collect roof runoff
- Disconnecting downspouts to direct runoff to pervious areas (rain garden) or small drywells
- Using site slopes to direct stormwater runoff to rain gardens

Below: Rain barrel collecting porch roof runoff, installed in front of a Philadelphia rowhome in the Schuylkill Watershed.





Stream Corridor Restoration and Preservation

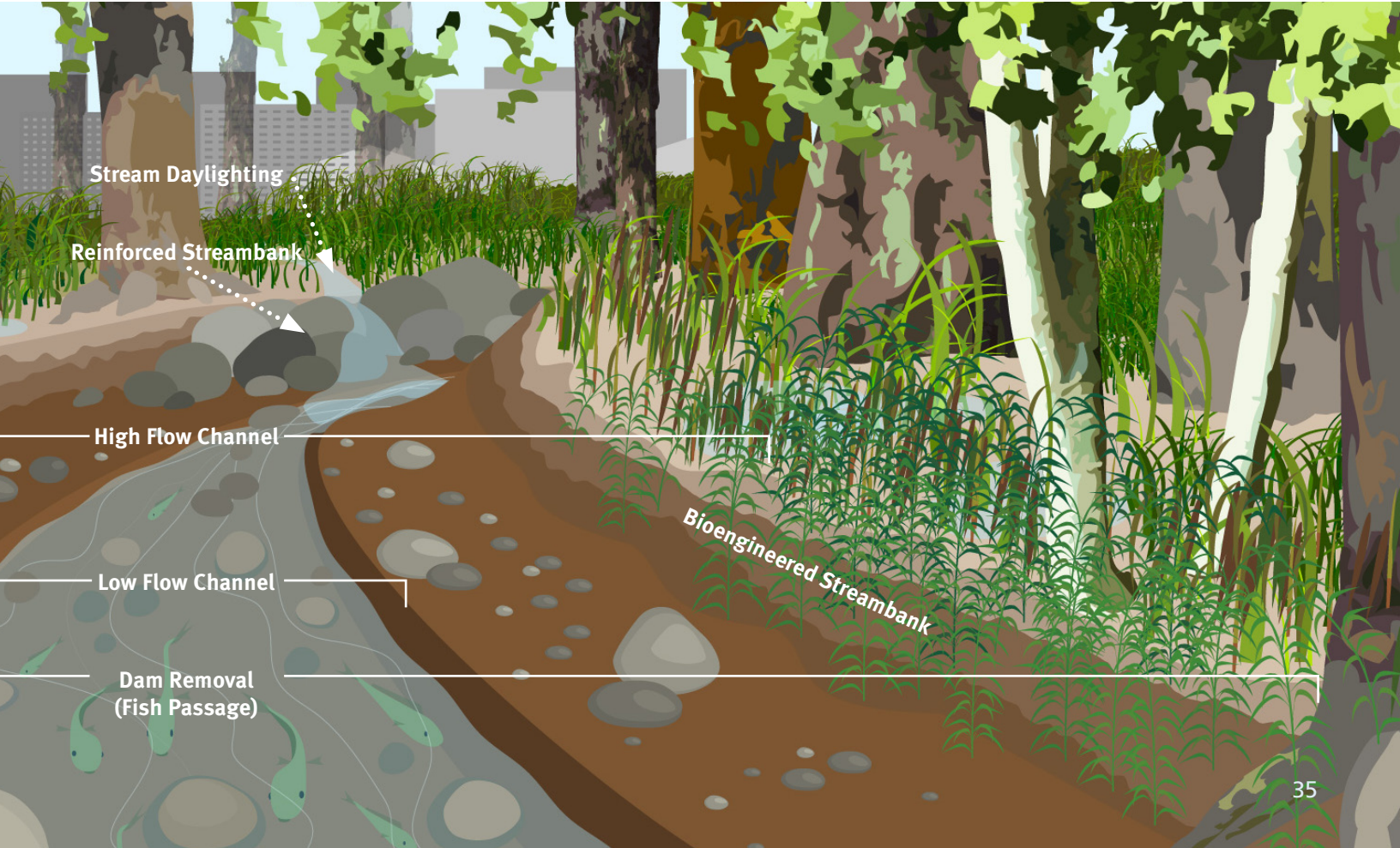
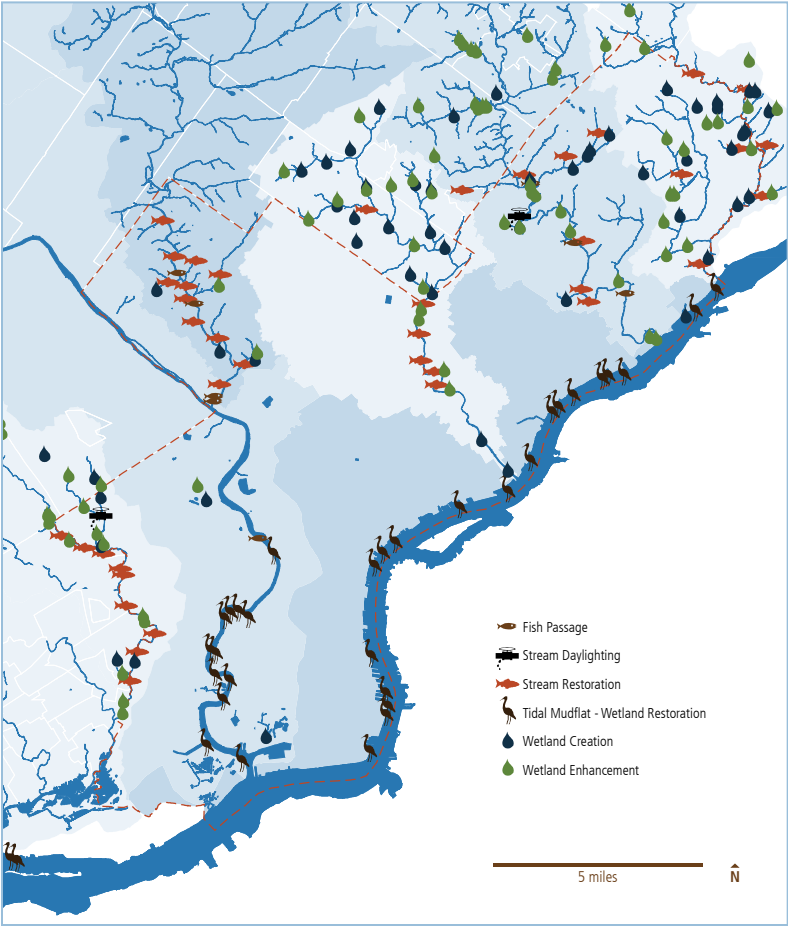
Restoration and Preservation of riverfronts, stream habitats and corridors can be combined with efforts to improve public access and amenities along the water corridors. Implicit in this effort are aspirations to re-connect Philadelphians with our extensive river network. As noted previously, at EPA's direction, the stream restoration program included in the original LTCPU was removed from the Program's CSO compliance goals. However, the City intends to continue its stream restoration and wetland creation efforts and is committed to spending \$125M toward achieving the goal of restoring the biological resources of the City's streams. This includes a commitment to restoration of 7.7 miles of the stream corridor along the Cobbs Creek and 3.4 miles of stream corridor along the Tacony Creek. Where applicable, wetland preservation, enhancement and creation within these corridors will offer additional benefits, including mitigation of adverse impacts of stormwater runoff and increases in the ecological connectivity within the region.

PWD will seek to identify locations where CSO outfalls may be consolidated or extended in order to enhance recreational opportunities

In another innovative initiative, PWD is currently assembling a Watershed Project Registry to identify and study areas for future stream restoration, wetland creation, wetland enhancement (including invasive plant management), tidal wetland creation/restoration, stream daylighting and preservation projects. In conjunction with another initiative, a proposed In-lieu Fee Program [to channel wetland mitigation efforts of the public and private sector towards stream restoration](#), these efforts will help to [leverage PWD funds with developer mitigation funds to ensure a steady progression towards the greater goal of making Philadelphia one of the greenest cities in the country as well as realizing the full ecological potential of the Fairmount Park system, which could one day serve as the model for urban forestry and river management.](#)



Restoration and Preservation Opportunities
in Philadelphia Watersheds



Wet Weather Treatment Plant Upgrades

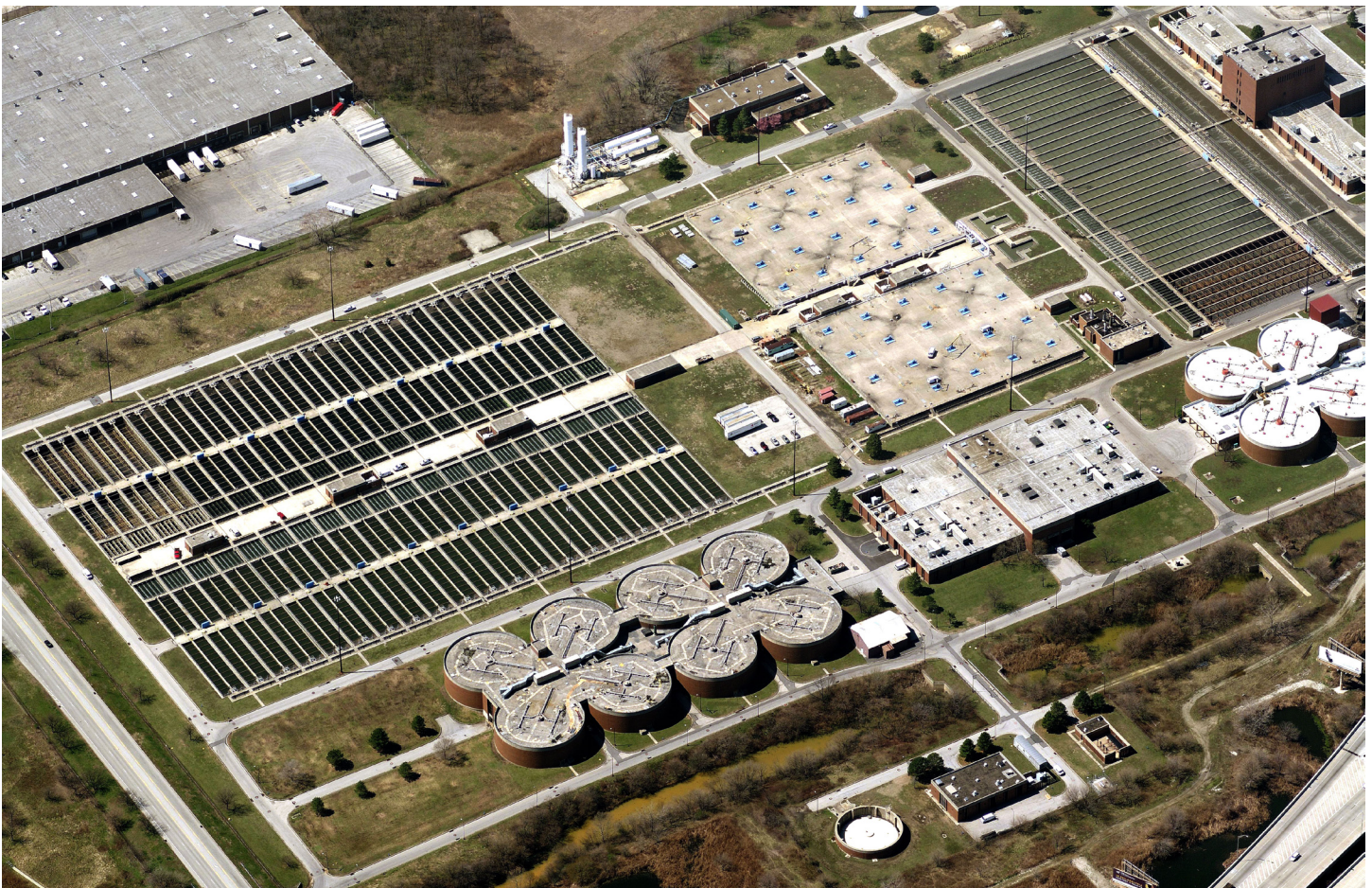
The *Green City, Clean Waters* program includes some traditional infrastructure to maximize the combined sewer overflow reduction benefits of the program. The expansion of wet weather treatment capacity at all three of PWD's existing water pollution control plants includes the following commitments:

- Expansion of the Northeast Water Pollution Control Plant to include a 215 million gallon/day secondary treatment bypass.
- Expansion of the Southwest Water Pollution Control Plant to include a 60 million gallon/day increase in secondary treatment capacity.
- Expansion of the Southeast Water Pollution Control Plant to include a 50 million gallon/day increase in the secondary treatment capacity through process and hydraulic improvements.

These plant expansions will allow PWD to better utilize the existing sewer infrastructure to capture and treat sewage.

These are complex projects that PWD has spent several years evaluating through the use of hydraulic and hydrologic computer modeling and facilities planning. Thus far PWD has obtained preliminary designs for these upgrades, but will work over the coming years to develop the necessary final designs, including detailed surveying and geotechnical investigations in order to move forward with construction of these upgrades.

Below: Image of PWD's Southwest Water Pollution Control Plant



Our Next Five Years

The first five years of the implementation commitment are the most critical for establishing the framework of the program, building the momentum to engage other City agencies to participate in developing a new set of everyday standards for managing stormwater. This represents a transformative moment for the City.

PWD's strategy for these first five years will be detailed in the Implementation and Adaptive Management Plan (IAMP). The IAMP will describe the City's plans for implementing the various components of the program, including both green stormwater infrastructure and traditional infrastructure. It will lay out the approach for tracking and reporting progress toward meeting our compliance goals, as well as outlining the City's proposal for evaluating progress at the five-year benchmarks and making decisions about adapting the program as necessary to achieve our goals.

The IAMP will describe some of the ways in which City codes, ordinances, policies, and interagency procedures have been, or will need to be, modified to optimize the implementation of the *Green City, Clean Waters* program. It also will address coordination with other City agencies and other stakeholder partners to leverage opportunities for getting the most benefit from our investment. The implementation plan will identify potential conflicts that may emerge among federal, state and local funding requirements, and the implementation goals of the program. It will include recommendations for ways to overcome potential legal issues, ownership and liability concerns, and public and private boundary issues.

In the coming years, PWD will implement a program to address wet weather inflow and infiltration in the City's separate sewer areas and will complete a sanitary sewer evaluation survey to better explore the potential for further remedial controls on sanitary sewer infiltration and inflow to reduce CSOs. Based on the results of that survey, the City will initiate a strategy to implement measures identified as having a significant potential to reduce CSO discharges.

Within the first five years of the *Green City, Clean Waters* program, PWD will implement "Early Action Areas (EAAs)." These are areas where we will seek to implement green stormwater infrastructure in a clustered or relatively concentrated area. These EAAs will help to create small "districts" throughout the city that will provide a glimpse into what a future "green city" will look like.

In addition to the IAMP, PWD will develop a Comprehensive Monitoring Plan to describe the City's plans for performing monitoring of natural and engineered systems that are associated with the CSO Program and a First Edition Green Infrastructure Maintenance Manual to ensure that green stormwater infrastructure is properly maintained. The Manual is intended for use by City agencies, and any other entity responsible for performing the maintenance of green stormwater infrastructure.

Lastly, within this initial 5 years of the implementation period, PWD also must study the risks associated with recreational use of the City's waterways as they relate to CSO discharges. The City must not only evaluate currently utilized recreational locations, but also areas likely to become recreational locations in the future as the riverfronts are redeveloped and public access is improved. Related to this investigation, PWD may initiate a Water Quality Standards Attainment Review, but will do this in a way that respects the public's very basic desire for attractive streams.

PWD believes that groundwork laid by this first five years will put the structure in place to support development of our "green machine." As we develop additional tools over the coming years, this machine will continue to gain momentum.

"Instead of investing in one project that treats one concern, green infrastructure allows us to protect the health of our waters, save money and make our communities more attractive places to buy homes and build businesses."
"We want to use the win-win strategies we see here [Big Green Block, Philadelphia] and other projects throughout the city to make every community healthier, more prosperous and more sustainable."

Lisa Jackson, U.S. Environmental Protection Agency Administrator

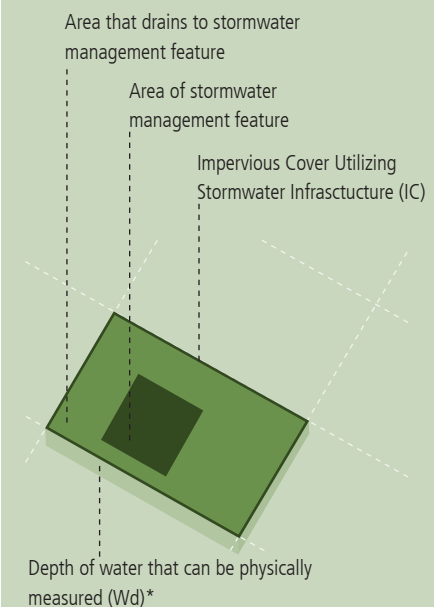
Greened Acres

Greened Acres is a metric that accounts for the conversion of a highly impervious urban landscape through the implementation of projects that reduce stormwater runoff. A Greened Acre is described as an acre of impervious cover reconfigured to utilize green stormwater infrastructure to manage the first inch of stormwater runoff from that acre.

A Greened Acre is an expression of the volume of stormwater managed by green stormwater infrastructure, based on the design for the project, and is conditional on the proper operation and maintenance of the project. One Greened Acre is equivalent to 1 inch of managed stormwater from 1 acre of drainage area, or 27,158 gallons of managed stormwater.

These volumes will be tracked as Greened Acres (GA) using the equation:

$$GA = IC \times Wd$$



* Green stormwater infrastructure designs will be aimed at controlling at least 1 inch of runoff, and up to 1.5 inches of runoff, unless otherwise deemed feasible by engineering design.

Cost and Affordability

PWD has become a national leader in its quest to demonstrate how to protect and restore stream water quality without the expenditure of billions of dollars on new pipes, tunnels and treatment systems.

To meet the requirements of the National Combined Sewer Overflow Policy, PWD is taking an approach that relies heavily on stormwater source-control measures and green stormwater infrastructure. Indeed, PWD has become a national leader in its quest to demonstrate how to protect and restore stream water quality without the expenditure of billions of dollars on new pipes, tunnels and treatment systems. Philadelphia is partnering with other urban centers, national environmental organizations' and the EPA, to recognize the value of urban infrastructure renewal and expansion using the more sustainable approach that focuses on the use of green stormwater infrastructure. *This approach has been shown to be the most environmentally and economically favorable way to remediate the effects of urbanization on the City's waterways and help make the City of Philadelphia the Greenest City in America.*

PWD currently spends upwards of \$150 million each year renewing and upgrading its existing facilities. In addition to these recurring costs, Philadelphia anticipates spending additional funds over the coming years to meet evolving drinking water quality and stormwater management goals under the Safe Drinking Water Act and Clean Water Act. In the current economic climate, securing capital funding for our existing, on-going programs, much less new initiatives, is a challenge. That is why, when money is available, it is ever more critical to ensure that every dollar is leveraged to address the myriad of issues facing our water utility.

A financial capability assessment for the City of Philadelphia's LTCPU was prepared using criteria suggested by the EPA. The EPA's approach calls for an evaluation of costs of the proposed improvements against Philadelphia citizens' median household income. In general, wastewater and stormwater control costs that exceed

1.5%-to-2% of the median household income become an unacceptable cost burden to ratepayers. The estimated cost to implement the Long Term Control Plan Update will approach \$2.4 billion by the end of the twenty-five year implementation period. Based on this estimate and implementation schedule, the affordability assessment determined that the LTCPU would result in a cost to City of Philadelphia residents above the upper limit of EPA's median household income affordability criteria.

PWD is ready to invest \$2.4 billion over the next 25 years (\$1.2 billion in 2009 dollars) to not only make our waterways cherished and thriving destinations, but also to use our citizen investment in a way that provides multiple additional community benefits that further Mayor Nutter's Greenworks Plan and supports the vision of numerous civic and community partners for a truly sustainable city.

*"The Philadelphia Water Department's **Green City, Clean Waters** initiative is a terrific way to clean up our environment and grow the economy. It is an outside-the-box, innovative, cost-effective, and green solution to the problem of sewer overflows that will improve our rivers, make our water safer, and make Philadelphia a more vibrant place to live, work, and play."*

Brian Glass, Senior Attorney for Citizens for Pennsylvania's Future (PennFuture)

Leveraging Opportunities

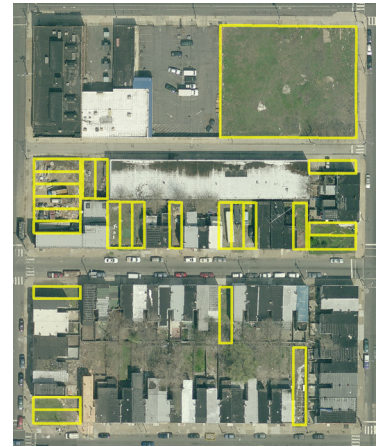
Because of the preliminary policy structures put in place over the past 12 years since the original LTCP was adopted by the City of Philadelphia, PWD is able to leverage a great deal of funding toward their Clean Water Act commitments. These are structures that PWD instituted and programmatically supports, but for which the majority of Greened Acres will not be paid for by PWD's rate payers.

The first and most significant source of leveraged funding comes from the development community. Because of the City's updated stormwater regulations adopted in January, 2006, every development/redevelopment project initiated within the City limits with an area of disturbance greater than 15,000 square feet must manage the first inch of runoff from the site—which is the same measure that PWD is utilizing for our Greened Acres concept. With a city-wide redevelopment rate of up to 1% annually, PWD estimates that more than \$1 billion (present value) will be applied toward the City's greening goals in the coming 25 years.

Another policy-related tool that will help to achieve additional Greened Acres city-wide is the Parcel Based Billing Initiative, which will be phased in over the coming years. This initiative will impact some customers much more than others—at times causing the monthly water bill to increase fourfold or more. PWD has been targeting heavily impacted customers with a program aimed at evaluating them for potential achievement of "stormwater credits" resulting from retrofits on the property to manage the first inch of runoff. This program involves the offer of free design assistance and site evaluation by a PWD contractor in order to identify potential stormwater management opportunities that might exist on the site—and to perform a cost-benefit analysis in order to help the property owner to weigh the cost of the retrofit against the annual savings on the water bill. PWD believes that the Parcel Based Billing Initiative will result in many of these large parcels being retrofitted to manage the first inch of runoff—producing additional Greened Acres.

Vacant land presents a unique opportunity for stormwater management. There are over 40,000 vacant parcels of land in the City. These present an opportunity for green redevelopment. In addition, there are many areas of the City ready for redevelopment, including areas of abandoned or substandard housing, abandoned industrial areas, or outdated commercial facilities. High priced and ever scarcer energy is changing the way Americans live, making older urban centers more and more attractive places to live and work. With a rate of redevelopment in the City that is expected to impact up to 1% of the City's impervious cover each year, vacant lands will likely become targeted focal points for redevelopment. Ensuring that all redevelopment projects contribute to a greener city will be critical to meeting ambitious green stormwater infrastructure goals.

Over the past 5 years, hundreds of millions of dollars have been awarded to fund green initiatives in the City of Philadelphia by organizations such as the William Penn Foundation as well as grant awards from Growing Greener (PA DEP and PA DCNR), the Army Corps of Engineers, and US EPA, among others. As the recipient of numerous grants and funding allocations aimed at establishing demonstration projects throughout the region, PWD has been leveraging funding toward the implementation of green stormwater infrastructure for a number of years. Through this work, PWD has developed strong working relationships with partner organizations doing similar work and when possible has worked with those organizations to stretch dollars even further. It is estimated that over the 25 year implementation period, close to \$1 billion in additional funding will be contributed by these agencies for further implementation of green stormwater infrastructure.



Vacant Land Example

The above image shows a mixed industrial and residential section of a Philadelphia neighborhood with vacant properties highlighted in yellow. This neighborhood has an 11% vacancy rate. Due to the large number of vacant properties, this neighborhood has many opportunities for neighborhood revitalization, which can lead to an expansion of the PWD customer base. The vacant properties may also provide an opportunity for placement of green stormwater infrastructure.

Achieving The Vision Together

“Green City, Clean Waters will be transformative for Philadelphia. The 25 year plan will invest \$2 billion in our infrastructure and communities, yielding tremendous benefits for our environment and water quality, while at the same time improving quality of life and stimulating economic development.”

Katherine Gajewski
Director of Mayor’s Office of
Sustainability, City of Philadelphia

PWD plays a critical role in helping the City of Philadelphia achieve its goal to be the Greenest City in America. The City currently has the necessary building blocks for a greener future; it is a City of neighborhoods with walkable streets, a regional transit structure, a huge park system, already observed successes in revitalization of vacant lands and historically significant and ecologically valuable rivers. But we cannot implement this green stormwater infrastructure program in a vacuum. **Given the number of events that are coming together at this pivotal time in the history of Philadelphia and this utility, we now need to accelerate the pace of change to cross traditional boundaries and envision a new relationship between the City, its government, water, the environment and its citizens.**

These events include:

- The release of PWD’s LTCPU
- City-wide stormwater regulations that redefine the way the City addresses stormwater
- The release of Greenworks Philadelphia with specific targets and goals for a Sustainable City through year 2015
- The release of the new Zoning Reform Commission Report and forthcoming Zoning Code
- The release of several significant new visioning and planning documents describing the revitalization and rebuilding of Philadelphia’s riverfronts
- The interest of Mayor Nutter in seeing a new way for Government agencies to work in unison to solve common problems
- Implemented stormwater parcel-based billing that will encourage stormwater management on private properties.

Together these inter-related initiatives will help realize Philadelphia’s ambitious green vision. The co-benefits of these programs—human health, aesthetics, ecological restoration, economic growth and a more vibrant City—are significant and real. It is time to accelerate the pace of change at the utility by creating interrelationships between our needs, actions and strategies and those of the City of Philadelphia.

Our challenge is to instill our programs and needs into design, construction, operation and maintenance of our City systems (transit, streets, universities, schools); the growth and nurturing of our natural systems (parks, rivers, streams, wetlands); and the protection of public health systems.

Our opportunity is to use controlled change through a slow evolution of our City to the 21st Century sustainable model described in Greenworks Philadelphia. By re-thinking how our systems work, their purpose and value to us, we can begin to integrate modifications in design of our capital facilities to meet multiple goals. By re-thinking the business of water, we can repurpose funds for water infrastructure, playgrounds, street reconstruction and transportation to leverage scarce capital dollars.

Although PWD has many green stormwater infrastructure projects already in the ground, we recognize that retrofitting a street or public facility is certainly more costly than building new infrastructure as a component of a complete renewal project. As it grows its green identity, Philadelphia will plant the seeds for a true city-wide partnership. Working together will result in an incredibly innovative, cost-effective and transformative incremental approach to how City departments revitalize neighborhoods to make them healthier and more sustainable places in our little corner of the biosphere.

PWD is laying the groundwork for partnerships with the Philadelphia Housing Authority, the Office of Housing and Commercial Development, the Streets Department, and private developers. At minimum, the current stormwater regulations ensure all new large development will move towards our goal of Greened Acres, but building partnerships will help us exceed minimal standards and look for cost-effective opportunities to maximize green elements. With each new development, the vision of how green it can be will keep growing. Assuming a redevelopment rate of .8 to 1% per year, an estimated 5,000 to 6,000 acres within the combined sewer system drainage will become greened during the 25 year program.

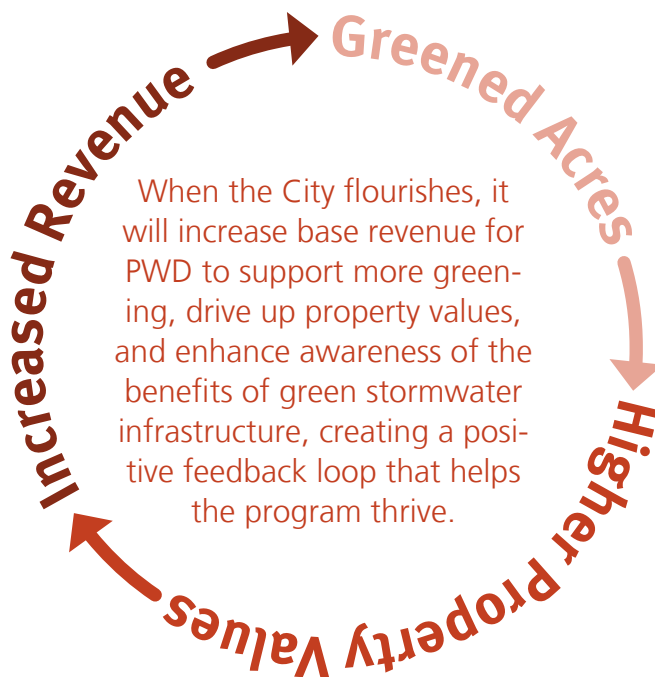
Another important partnership that will develop as a result of this program is between PWD, Philadelphia Industrial Development Corporation (PIDC), Department of Commerce and Special Service Districts such as Center City District. These partnerships will help transform the commercial corridors and business parks in the City. Adding stormwater management to the existing beautification projects will reduce overall maintenance costs and allow more restored corridors. The greener, safer corridors draw new customers and retailers, creating additional local and green jobs which in turn promote safety in the City.

The largest landowners in Philadelphia are often institutions of health, learning, and worship. These campuses such as hospitals, universities and churches have already been leading the field of environmental sustainability. Not only can they easily incorporate greening into their mission, they are often willing to go far beyond required stormwater management. This means a few property owners can transform the City in a big way.

These are just a few examples of the many exciting developments and synergistic relationships budding in Philadelphia. Our hope is that as the City grows its green identity, more residents may be drawn to Philadelphia. When the City flourishes, revenue increases, which supports more greening, which can increase property values, and enhances awareness of the benefits of green stormwater infrastructure, creating a positive feedback loop that helps the program thrive. The greening of Philadelphia benefits the environment as a whole.

The time is now. Never before have such opportunities aligned and a sustainable solution been so clear. The City of Philadelphia's *Green City, Clean Waters Plan* is the first of its kind, launching the transformation of Philadelphia as it leads the way for other urban areas to become 21st Century Sustainable Cities.

For more information and to stay involved with the developments of *Green City, Clean Waters*, visit our website, www.phillywatersheds.org, and our Facebook page, by searching for *Green City, Clean Waters*.



Overwhelming Public Support

Participants in the Philadelphia Water Department's *Green City, Clean Waters* public outreach program have expressed overwhelming support for green stormwater infrastructure as the preferred approach to reducing CSOs in Philadelphia. The thousands that have participated in meetings, events and other PWD activities to date have consistently expressed enthusiasm for the *Green City, Clean Waters* plan. Over ninety-two percent of the more than 700 "Green Neighborhoods through Green Streets" survey participants responded positively to the green stormwater infrastructure approach. All stakeholders, from suburban watershed partners to City residents living in the CSO drainage areas, desire a land-based approach that promotes multiple community benefits and creates truly sustainable watersheds and cleaner, safer and more accessible waterways.

Partnerships, Plans and Participation

Support for green stormwater infrastructure is echoed throughout all components of PWD's *Green City, Clean Waters* public participation program and confirms the wishes expressed over the past ten years by PWD's long-standing watershed partners during the integrated watershed management planning process.

PWD believes that a commitment to diverse watershed partners, including the residents of the City, is critical to the success of the *Green City, Clean Waters* plan. PWD has offered a variety of education and outreach programs over the past twelve years that target the residents in and outside of the City and that foster public awareness, which

facilitates public involvement. Over the past few years alone, the Philadelphia Water Department has gone beyond the required public meetings and has created multiple innovative outreach programs, including the Cobbs Green Homes Demonstration program, the GreenTreks "*Green City, Clean Waters*" video series, a Green Streets Adoption program, a *Green City, Clean Waters* Curriculum for schools, a "*Green City, Clean Waters*" art exhibit by local environmental artist, Bill Kelly, in addition to a traveling *Green City, Clean Waters* informational exhibit among other programs. Furthermore, unprecedented partnerships with civic groups and local organizations city-wide led to the implementation of PWD's first phase of Green Streets. The approximately 400 *Green City, Clean Waters* Facebook "Friends" regularly keep updated on new programs and events. The *Green City, Clean Waters* on-line blog (<http://www.phillywatersheds.org/blog>) provides information on the latest activities and events, such as accounts regarding PWD's first porous pavement street and PWD's first green roof bus shelter installation (only one in the country!).

The Demand

In recent months PWD has seen the desire for green stormwater infrastructure rapidly evolve into a demand by our residents. Through PWD's Model Neighborhoods initiative, PWD has received approximately 750 signatures between March and July of 2009, from residents petitioning for Green Streets. These residents wanted PWD to install green stormwater infrastructure on their block, in order to serve as a model green neighborhood. Today, PWD is working to meet the demand and working with civic groups throughout the city to go beyond the demand and to further our mission of spreading green stormwater infrastructure to meet all facets of communities – whether it is on a street, commercial property, schoolyard or park – and in every CSO impacted neighborhood in the city.

"Cities across the nation are now looking at Philadelphia as the preeminent model for managing stormwater through green infrastructure." "This approach will benefit Philadelphians by protecting their drinking water, making rivers and streams more attractive recreation amenities, and supporting economic growth."

Paul King
President & CEO
Pennsylvania Environmental Council

"As we evolve Philadelphia into America's most sustainable and green city, the opportunities ahead will be limited only by the confines of our imaginations and the extent of our determination."

Howard Neukrug
Philadelphia Water Commissioner

Demonstrating the Vision Throughout Philadelphia

Community Based Planning Initiatives

The Model Neighborhoods program was launched in January 2009, led by PWD and partners, to showcase green street stormwater infrastructure tools, such as stormwater tree trenches, stormwater planters and stormwater bump-outs, in addition to providing green stormwater infrastructure to residents. Model Neighborhoods were envisioned as communities in the City that would provide the Philadelphia Water Department and its partners with an early opportunity to demonstrate green stormwater infrastructure. Today, Green Streets projects are planned for neighborhoods all over the city, making practically all neighborhoods in the CSO communities “model neighborhoods”; as such PWD is now evolving our former model neighborhood program to a broader community based planning initiative program.

The communities participating in the former Model Neighborhoods initiative were selected due to their existing partnerships with the Philadelphia Water Department. These partnerships were formed as a result of flooding complaints and other water-related issues that PWD had addressed previously. The Philadelphia Water Department views every community in the combined sewer drainage areas of Philadelphia as potential model neighborhoods and hopes to implement green stormwater infrastructure in all communities throughout the City over the next twenty-five years.

Our early collaborations with neighborhoods throughout Philadelphia have informed us that the demand for green stormwater infrastructure is high and residents are enthusiastic to see green stormwater infrastructure on their streets immediately. In fact, the demand for implementation within the multiple neighborhoods has exceeded the Philadelphia Water Department’s current capacity to implement them. This is a true testament to the overwhelmingly positive response the City has received from its citizens in support of green stormwater infrastructure. In addition to increasing the Philadelphia Water Department’s capacity to implement green stormwater infrastructure throughout the City, a neighborhood outreach and planning protocol is being developed which we hope will be replicated throughout the City to educate more residents about the *Green City, Clean Waters* vision, to inform them of the challenges and opportunities that exist when planning for green stormwater infrastructure, and to engage them in identifying the best opportunities for green infrastructure within their neighborhoods. Ultimately, the goal is to partner with Philadelphians to identify the most strategic investments in green stormwater infrastructure that can meet PWD’s goal of reducing combined sewer overflows while also creating tangible physical, social, economic, and environmental benefits within our neighborhoods.



Acknowledgements

We would like to thank the members of the *Green City, Clean Waters* Advisory Committee for their investment of time and energy during the initial demonstration phase as we worked through the planning process.

Active *Green City, Clean Waters* Advisory Committee Members

Community Legal Services, Inc.

Sierra Club

PennFuture/Next Great City

Delaware River City Corporation

Northern Liberties Neighbors Association

Washington West Civic Association

Passyunk Square Neighborhood Association

Passyunk West Civic Association

Pennsylvania Environmental Council

Tookany/Tacony-Frankford Watershed Partnership

Pennsylvania Department of Environmental Protection

Philadelphia Parks & Recreation

We would also like to thank the members of an independent team that reviewed the City of Philadelphia's Green City, Clean Waters plan. The Citizens for Pennsylvania's Future, the Natural Resources Defense Council, and Clean Water Action, managed a series of independent reviews of the plan. Dr. Robert Traver of Villanova University and Michele Adams from Meliora Design were retained to evaluate the expected performance of the LTCPU based on assessment of the models, the model inputs and results, and the implementation plan. Another review, conducted by John Frondorf of Becker and Frondorf, focused on the cost estimation methodology. David Russell of Russell Consulting reviewed the financial capability assessment.

Independent Review Committee:

National Resources Defense Council

Clean Water Action

Citizens for Pennsylvania's Future

Department of Civil and Environmental Engineering,
Villanova University, Villanova, PA

Meliora Environmental Design, LLC, Phoenixville, PA

Becker & Frondorf Construction Cost Consulting,
Philadelphia, PA

David Russell, Russell Consulting, Newburyport, MA

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Facebook: Connect with us on Facebook by searching for .

