CITY OF CHESTER

JUNE 2017

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

GREEN STORMWATER INFRASTRUCTURE PLAN

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

The Delaware Valley Regional Planning Commission is dedicated to uniting the region's elected officials, planning professionals, and the public with a common vision of making a great region even greater. Shaping the way we live, work, and play, DVRPC builds consensus on improving transportation, promoting smart growth, protecting the environment, and enhancing the economy. We serve a diverse region of nine counties: Bucks, Chester, Delaware, Montgomery, and Philadelphia in Pennsylvania; and Burlington, Camden, Gloucester, and Mercer in New Jersey. DVRPC is the federally designated Metropolitan Planning Organization for the Greater Philadelphia Region – leading the way to a better future.

The symbol in our logo is adapted from the official DVRPC seal and is designed as a stylized image of the Delaware Valley. The outer ring symbolizes the region as a whole while the diagonal bar signifies the Delaware River. The two adjoining crescents represent the Commonwealth of Pennsylvania and the State of New Jersey. DVRPC is funded by a variety of funding sources including federal grants from the U.S. Department of Transportation's Federal Highway Administration (FHWA) and Federal Transit Administration (FTA), the Pennsylvania and New Jersey departments of transportation, as well as by DVRPC's state and local member governments. The authors, however, are solely responsible for the findings and conclusions herein, which may not represent the official views or policies of the funding agencies. The Delaware Valley Regional Planning Commission (DVRPC) fully complies with Title VI of the Civil Rights Act of 1964, the Civil Rights Restoration Act of 1987, Executive Order 12898 on Environmental Justice, and related nondiscrimination statutes and regulations in all programs and activities. DVRPC's website, www.dvrpc.org, may be translated into multiple languages. Publications and other public documents can be made available in alternative languages and formats, if requested. DVRPC public meetings are always held in ADA-accessible facilities and in transit-accessible locations when possible. Auxiliary services can be provided to individuals who submit a request at least seven days prior to a meeting. Requests made within seven days will be accommodated to the greatest extent possible. Any person who believes they have been aggrieved by an unlawful discriminatory practice by DVRPC under Title VI has a right to file a formal complaint. Any such complaint may be in writing and filed with DVRPC's Title VI Compliance Manager and/or the appropriate state or federal agency within 180 days of the alleged discriminatory occurrence. For more information on DVRPC's Title VI program, or to obtain a Title VI Complaint Form, please call (215) 592-1800 or email public_affairs@dvrpc.org.

Acknowledgements: The authors would like to acknowledge and thank the many partners who contributed their time, expertise, and funding to the development of this plan. The City of Chester Green Stormwater Infrastructure Plan is a companion document to the Chester City Climate Adaptation Planning Elements which was adopted in June 2014 and reprinted in October 2016. Funding for this project is provided by the U.S. Department of the Interior and administered by the National Fish and Wildlife Foundation as part of the Hurricane Sandy Coastal Resiliency Competitive Grant Program. The plan is the result of the collaborative spirit and efforts of the Delaware Valley Regional Planning Commission, Pennsylvania Sea Grant, Chester City, Delaware County Planning Department, the Philadelphia Water Department, and the Eastern Delaware County Stormwater Collaborative. The authors also thank our project interns, Adriana Lacy, Ben MacLuckie, and Nora Schmidt, for their dedication and hard work. We are also grateful for the time and expertise provided throughout the planning process from all of our advisors.

CHESTER PENNSYLVANIA Settled in 1644 | DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION | delaware county planning department | Sea Grant Pennsylvania | U.S. DEPARTMENT OF THE INTERIOR MARCH 3, 1849 | NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION U.S. DEPARTMENT OF COMMERCE

Partial funding for this project was provided by the NOAA National Sea Grant College Program.

ADVISORY COMMITTEE

The team is also deeply indebted to the Philadelphia Water Department for the expertise and materials it so graciously provided in support of the project.

*The **cover illustrates** the green stormwater management demonstration project designed for Veteran's Memorial Park, Chester, PA, from a vantage point looking west on 7th street. Once constructed, the stormwater management features designed by CH2M and Viridian Landscape Studio will capture more than 73,000 gallons of rainwater runoff with each storm to reduce flooding while also helping to beautify the community.*

LETTER FROM MAYOR KIRKLAND

May, 2017

Dear Friends,

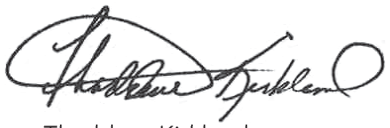
I am pleased to present the *City of Chester Green Stormwater Infrastructure Plan*. This document, which follows and complements the City's Climate Adaptation Plan, provides a framework to manage stormwater with methods that contribute to safe, attractive, and more resilient neighborhoods.

Chester, like hundreds of other cities across the country, must address stormwater pollution, flooding challenges, and resilience to climate change. We must keep stormwater out of our sewers and reduce sewer overflows to improve the water quality of the watersheds where we live. And we must prepare for more precipitation and more intense storms that will increase our City's risk to flooding.

Green Stormwater Infrastructure (GSI) can enhance our City's stormwater management, protect water quality, and help build a vibrant economy. GSI offers long-term potential to serve as a cost effective supplement or alternative to traditional gray infrastructure. By mimicking nature, GSI brings ecological services back into our City. By helping clean and green our City, GSI attracts investment and increases property values.

Implementing GSI will require ongoing collaboration between government and the many civic leaders, organizations, and businesses who are committed to improving our City. Please join us in advancing this plan and ensuring that we continue to build a great City of Chester. Together, I know we will make a difference.

Sincerely,



Thaddeus Kirkland
Mayor, City of Chester

CONTENTS

INTRODUCTION

Photo by G. Widman for Visit Philadelphia®

This Green Stormwater Infrastructure (GSI) Plan provides a framework for actions to expand the use of GSI to enhance stormwater management, reduce volume and flooding, protect water quality, and continue building a vibrant and resilient City of Chester. It is designed to assist city officials, decision-makers, community groups and residents of Chester City in better dealing with excess rainwater through the use of GSI techniques.

GSI techniques mimic nature by capturing rainwater run-off near the source so that it can soak into the ground and be filtered by the soil as it recharges the groundwater, thus reducing stormwater runoff. This management approach will also help to reduce pollution, volume, and flooding in Chester's waterways.

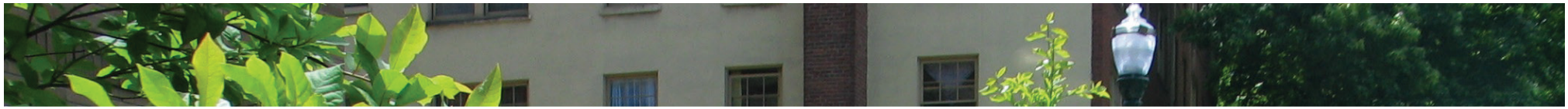
GSI helps to manage stormwater runoff at its source, rather than piping the water through a sewer to a wastewater treatment plant, river, or stream. While GSI can become a powerful tool in the City's stormwater management arsenal, it is important to remember that investments in traditional gray stormwater infrastructure (such as tunnels and storm drains) will also be critical; Chester's green and gray stormwater infrastructure will ultimately become one integrated system to effectively manage stormwater.

This plan is the next step for the City of Chester to strengthen its capacity to manage stormwater and prepare for the future. It also helps implement a goal of the *Chester Climate Adaptation Planning Elements of the Vision 2020* comprehensive plan – to develop a City GSI plan. What follows is a blueprint for implementing GSI throughout the City, recommendations on how to start pilot projects, guidance on partnering and public outreach, and suggestions for how to track program impact.

The strategies laid out in this plan should be incorporated into, and coordinated with, the work of the Stormwater Authority of the City of Chester. In June 2017, the City publicly announced the creation of a partnership between the Stormwater Authority and a private partner, Corvias, to plan, finance, build and maintain up to $50 million in green stormwater infrastructure over the next two to three decades. Fueled by a $1 million grant from PENNVEST, the Stormwater Authority will bring city officials together with the Chester Water Authority, the U.S. Environmental Protection Agency and Corvias in a Community-Based Public-Private Partnership (CBP3) to retrofit at least 350 acres of hard surfaces in the city with green stormwater practices. Accordingly, the Stormwater Authority and CBP3 are well-positioned to take advantage of the opportunities presented in this plan.

At the same time, this plan should be coordinated with and utilized to inform the Delaware county Regional Water Authority's (DELCORA's) long term control plan. Since GSI techniques reduce stormwater runoff, they can be a principle technique to achieve the reduction and elimination of combined sewer overflows that will be required by the combined sewer overflow (CSO) control plan.

Through this plan, the authors and partners offer a framework for initial actions to expand the use of GSI to enhance stormwater management, reduce volume and flooding, protect water quality, and continue building a vibrant and resilient City of Chester.



GSI DEFINED

GSI is an approach to stormwater management that protects, restores, or mimics the natural water cycle (American Rivers, 2016).

Managing runoff through green approaches mimics natural systems to capture stormwater at its source. GSI relies heavily on enhancing infiltration into the soil, uptake from plant roots, and storage to prevent water from flowing too quickly into rivers and streams. Thus, green stormwater management utilizes the planting of vegetation along with sub-surface engineering, like underground storage chambers, to reduce stormwater impacts. The benefits to streams and rivers include less flooding and non point source pollution, and better aquatic habitat. GSI systems are considered best management practices (BMPs) that are often included in low impact development (Washington State Department of Transportation, n.d.).

In many urban settings, GSI offers a more cost-effective approach to managing stormwater than gray infrastructure. But it is important to appreciate that not all of Chester's stormwater problems can be solved by GSI alone; gray infrastructure, including inlets, pipes, tunnels, pumps, and ditches, will continue to be needed.

WHY GSI?

GSI helps address stormwater management challenges, meet regulatory requirements, and deliver additional community benefits.

STORMWATER MANAGEMENT CHALLENGES

In natural areas like forests, when rain hits the surface of the land most of it soaks into the ground where it is used by trees and other vegetation or is filtered through the soil to become groundwater. Only a small amount actually runs off land surfaces into waterways.

By contrast, in cities like Chester, rooftops, streets, sidewalks, parking lots, and driveways prevent rain water from soaking into the ground. Instead, water that drains off these impervious surfaces is carried by drains and pipes to rivers and streams. This stormwater runoff presents three core challenges in the urban landscape:

Nonpoint Source Pollution

Rainwater or melted snow that drains across impervious surfaces can pick up pollutants (such as oil, gasoline, fertilizer, sediment, heavy metals, and trash) before flowing into waterways, where these pollutants can harm water quality. This type of pollution is called *nonpoint source pollution*. In addition to carrying pollutants, runoff from dark impervious surfaces can warm the water, which is harmful to the health and reproduction of aquatic life. In Chester, nonpoint source pollution goes directly into the Delaware River, Chester Creek, and Ridley Creek.

Example of sediment in nonpoint source runoff.

GSI can play a significant role in reducing nonpoint source pollution. Vegetated GSI techniques, for instance, can help to infiltrate and filter stormwater at its source, preventing it from flowing directly into rivers and streams. Runoff enters the GSI system, where vegetative plantings filter pollutants, and stormwater evaporates or soaks into the ground.

Combined Sewer Overflows

Most of Chester's sewer systems collect both stormwater and sanitary sewage into the same system. On a dry day, the regional wastewater treatment plant has enough capacity to handle the City's sewage. But during heavy rainstorms, the combined flow of sewage and excess rainwater is often more than the wastewater treatment plant can handle. The combined sewer system was designed to divert excess flow to local waterways instead of flooding the treatment plant, or allowing the back up of untreated sewage and stormwater onto streets and into buildings. Instead the sewage and stormwater is discharged through outfalls into Chester Creek, Ridley Creek, and the Delaware River.

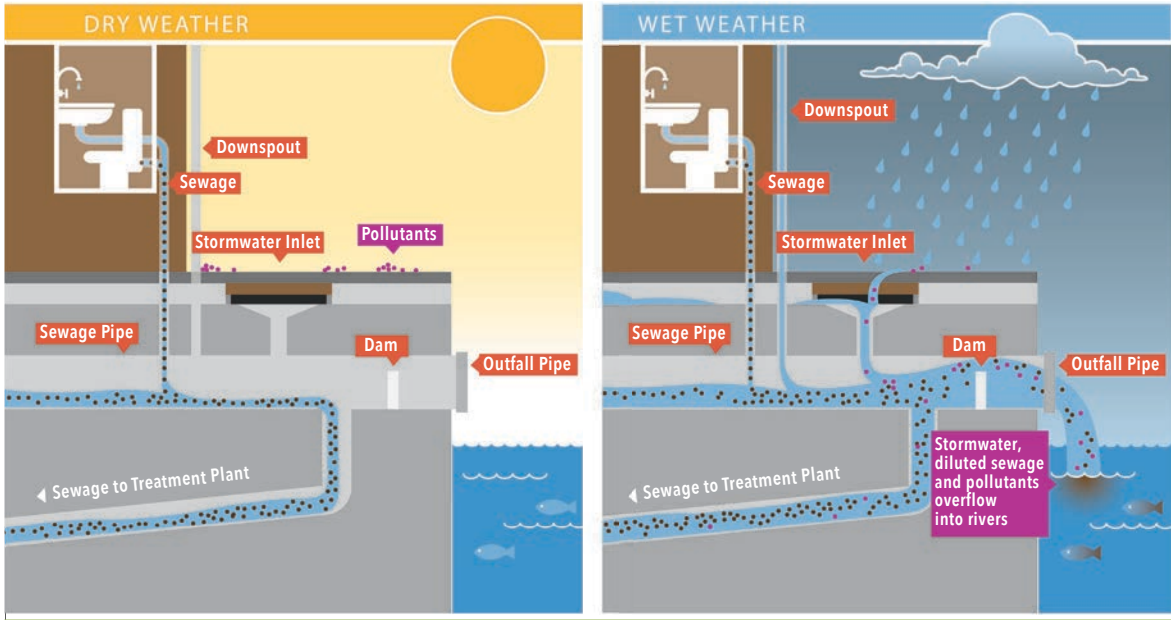
This kind of system, a combined sewer overflow, can discharge coliform bacteria, organic matter, floatables, household cleaning products, and other hazardous substances. However, Chester's sewer system is not unique.

Combined sewer overflows (CSOs) in older communities are the remnants of the country's early infrastructure. Today, CSOs are still a major water pollution concern for over 700 cities and approximately 40 million people, primarily in the Northeast, Great Lakes, and Pacific Northwest regions of the United States (Environmental Protection Agency, 2004).

There are 27 combined sewer outfalls in Chester that discharge directly to the Delaware River and the Chester and Ridley creeks (see Appendix Map 1). This system is managed by DELCORA, the Delaware County sewer authority, which is currently working on a long-term control plan to reduce these discharges. DELCORA anticipates the completion of the plan by 2019.

The goal of CSO control plans are to reduce overflows during storm events by removing stormwater from the system. This can be accomplished in multiple ways, including the use of gray infrastructure that holds the combined water in underground tanks until treatment plant capacity becomes available.

GSI is an EPA-approved method to reduce runoff. Many cities have found GSI techniques to be the most cost effective and visually attractive approach to reducing stormwater contributions to CSOs. The City of Philadelphia's *Green Cities, Clean Waters* is a 25-year initiative to achieve an 85 percent reduction in stormwater pollution using GSI to mitigate CSO pollution. This program is part of the long-term control plan the City developed with EPA to address sewer overflows. Philadelphia is utilizing a variety of GSI techniques including tree trenches, bioswales, rain gardens, and stormwater bump-outs in areas currently covered by asphalt and concrete. Chester has a similar opportunity to integrate a GSI approach to achieve compliance under its long-term control plan.



Many older cities operate combined sewer systems – pipes and tunnels designed to collect domestic sewage and surface runoff. Combined sewers can cause serious water pollution during storms, when wet-weather flows surpass the sewage treatment plant capacity and discharge untreated sewage into waterways – a combined sewer overflow event. This type of sewer design is no longer being implemented; new community designs separate sanitary sewers from storm sewers (Environmental Protection Agency, 2004 and 2014).

Flood Risk

According to the *National Climate Assessment*, the Northeast Region of the United States has experienced a greater increase in extreme precipitation over the past few decades than any other region.

From 1958 to 2010, the Northeast saw a 74 percent increase in the amount of precipitation falling during intense rainfall events (U.S. Global Change Research Program, n.d.). As a result, flood damage is also on the rise, and climate-related flood risk will continue to grow with more intense storms and an aging flood-management infrastructure. More frequent and extreme precipitation events will lead to:

- Increased localized flooding from intense rainfall that overwhelms the capacity of urban drainage systems
- Riverine flooding, where river and creek flows exceed their channel capacity

GSI can help reduce localized flooding by absorbing rainfall, thus preventing water from overwhelming pipe networks, and pooling in streets or homes. A combination of GSI, open space preservation, and floodplain management can reduce the volume and velocity of stormwater that discharges into rivers and streams, thereby protecting the natural function of floodplains, reducing infrastructure and property damage, and limiting streambank erosion that can harm streamside vegetation and aquatic habitat (Environmental Protection Agency, n.d.).

REGULATORY REQUIREMENTS

GSI can also play an important role in complying with federal and state laws that require the City of Chester to regulate and reduce stormwater runoff that originates in the City. To help better understand the laws, below is a brief summary of their origin and intent.

FEDERAL REQUIREMENTS

The Clean Water Act (CWA) is the primary federal law in the United States governing water pollution. The Environmental Protection Agency is charged with regulating stormwater and enforcing the CWA. The goal of the CWA is to restore all "waters of the United States" to their "fishable" and "swimmable" conditions. Point source discharges, which originate mostly from municipal wastewater (sewage) and industrial wastewater, have been regulated since enactment of the CWA in 1972. Pollutant loadings from these sources are tightly controlled and limited. However, despite these controls, thousands of U.S. water bodies remain classified as "impaired," meaning they contain pollutants at levels higher than is considered safe by EPA for the intended beneficial use of the water. Much of this impairment is due to nonpoint runoff and the pollution it carries. All waterways in the City of Chester are considered impaired under the Clean Water Act. (CRC Watersheds Association, n.d.).

The CWA requires that point source discharges to U.S. waters have National Pollution Discharge Elimination System (NPDES) permits. EPA has delegated administration of the NPDES to the Commonwealth of Pennsylvania. Under the CWA, construction sites one acre or greater in size are treated as "point source discharges" and are required to obtain an NPDES permit.

Originally, stormwater was not covered under the CWA. However, to address the nationwide problem of stormwater pollution, Congress enacted the 1987 Water Quality Act, which broadened the CWA definition of pollution to include discharges from municipal separate storm sewer systems (MS4). EPA has also delegated the administration of MS4 permits to state regulators, including Pennsylvania DEP (Stormwater PA, n.d.).

PENNSYLVANIA REQUIREMENTS

In Pennsylvania, stormwater is regulated by several state statutes:

- the Clean Streams Law
- the Municipal Planning Code (Act 247)
- the Stormwater Management Act of 1978 (Act 167)

Overarching all these state statutes is the federal Clean Water Act, which guides application of the Clean Streams Law on issues regulated under the CWA.

Act 247 authorizes Pennsylvania cities, boroughs, townships, and counties to prepare comprehensive plans for community development, zoning ordinances, subdivision and land development ordinances, and regulations that may include provisions for drainage and stormwater management.

Act 167 authorizes a program of comprehensive watershed-wide stormwater management which retains local implementation and enforcement of stormwater ordinances. Under Act 167, the state DEP provides grant money to counties to develop management plans for designated watersheds. Upon completion of a plan by a county and approval by the Pennsylvania Department of Environmental Protection (PADEP), municipalities in the watershed adopt ordinances consistent with the plan. Developers are then required to follow local stormwater ordinances that incorporate the standards of the watershed plan when preparing their land development plans. This planning effort is designed to result in the incorporation of sound engineering standards and criteria into local codes and ordinances to manage runoff from new development in a coordinated, watershed-wide approach.

HOW REGULATIONS APPLY TO THE CITY OF CHESTER

The City of Chester is at the bottom of the Chester and Ridley creek watersheds, both of which are largely impaired by uncontrolled stormwater runoff that scours stream banks and dumps excess sediments and pollutants into the streams (Pennsylvania Department of Environmental Protection, 2014). The City of Chester currently has a general permit for its MS4. A general permit requires that the community implement six Minimum Control Measures (MCMs): public education; public participation; illicit discharge detection and elimination; construction site runoff; post construction stormwater runoff in new and redevelopment; and pollution prevention and good housekeeping for municipal operations and maintenance (Pennsylvania Department of Environmental Protection, 2016).

While the City of Chester has a general MS4 permit, it also has discharges to streams that are designated as impaired. An impairment designation can trigger a regulatory requirement by PA DEP, such as a total maximum daily load (TMDL), which is developed to alleviate the impairments. TMDLs create what is essentially a pollution diet for the creeks, designating a pollutant limit on each impairment. Currently, no TMDLs exist for the Ridley or Chester creeks; however, future permits under the MS4 program are expected to require a Pollution Reduction Plan (PRP) for communities that discharge stormwater to impaired waterways. The PRP is, in essence, intended to achieve the same goal as the TMDL. Chester's PRP will need to address the causes of stream impairment and lay out activities that the City will implement to resolve the impairment. This will require on-the-ground changes to reduce the flow of stormwater and resulting pollution to waterways.

As stricter stormwater and water quality regulations are enacted in the next few years, the City of Chester will be required to take more action to protect and improve its waterways. Thus, GSI can play a key role in MS4 long-term planning and remediation. In addition to the volume reduction that each GSI system can provide, educational signs at each installation can also meet the education requirements for the MS4. Education is a key component of success, since GSI appearance is often unfamiliar to residents. Educational signage may also encourage residents to adopt GSI on their own properties. By getting residents to take responsibility for the stormwater coming from their individual properties, the volume of water being managed through GSI will increase significantly, thereby increasing the benefits to water quality. In an effort to promote residential GSI, the City may consider residential rain garden, rain planter, and rain barrel programs. These techniques involve disconnecting downspouts (especially from the storm sewer system), which helps to reduce stormwater flow and improve the water quality of impaired creeks.

GSI IN CHESTER'S ZONING ORDINANCE

Regulations pertaining to Chester stormwater management are found in the Zoning, Stormwater Management, and Subdivision and Land Development Ordinances (SALDO, Chester City, 2015). The City recently rewrote these ordinances, comprising the first substantial revision since 1948. The following GSI incentives and standards are now in effect:

Zoning Ordinance
Article 1361 General Regulations
Section 1361.08 Green Incentives

(c) If a building or parking structure includes an approved "green roof," the area covered by the green roof may exceed allowed maximum building coverage, up to a maximum increase of 20 percent. For example, if a district includes a maximum 30 percent building coverage, and a building footprint equal to 20 percent of the lot is covered by a green building roof, then the maximum total allowed building coverage shall be 50 percent.

(d) Porous pavement used for vehicle parking and vehicle movement shall be considered impervious for the purposes of the zoning ordinance impervious coverage requirement, except as follows: The maximum impervious coverage of a lot or a tract may be increased by up to 10 percent of the lot area if a corresponding land area is covered by City-approved porous pavement.

Subdivision and Land Development Ordinance
Article 1302 Definitions

Green Infrastructure. Small-scale stormwater management practices, nonstructural techniques, and site planning practices to mimic natural hydrologic runoff characteristics and minimize the impact of development on water resources.

Article 1310 Design Standards and Required Improvements
Section 1004 STREETS; Subsection K, Street Design and Construction Standards

1. Streets (and alleys where provided)...To the greatest extent possible, all new alleys and all reconstructed alleys shall be designed and constructed to incorporate green infrastructure for stormwater management, including but not limited to porous paving, permeable pavers, bioretention, and tree trenches.

12. Bicycling and Green Infrastructure.
    a. To the maximum extent possible, all new and reconstructed streets shall be designed to accommodate bicycles and green infrastructure.

    b. Parking lanes shall incorporate green infrastructure where underground utilities do not create insurmountable conflicts.

Section 1009. SEWAGE DISPOSAL SYSTEMS

1. Sewer mains shall be installed within a street right-of-way or utility easement. When installed in a street right-of-way, adequate space (alignment) may be required to be provided to incorporate green infrastructure in the parking area and any bike lane along the street.

Section 1010. WATER SUPPLY SYSTEMS

1. Water mains shall be installed within a street right-of-way or utility easement. When installed in a street right-of-way, adequate space (alignment) may be required to be provided to incorporate green infrastructure in the parking lane area and any bike lane along the street.

COMMUNITY BENEFITS

GSI systems can provide environmental, economic, and social co-benefits beyond just managing rainfall and runoff. Such benefits can include:

- cooling and cleansing the air, thereby reducing asthma and heat-related illnesses, and lowering cooling energy costs
- improving the attractiveness of the urban realm, thereby boosting economic development and quality of life
- generating a demand for new services, thereby creating jobs for those who install and maintain the GSI systems

Environmental

GSI, particularly those systems that use trees and vegetation, provide multiple environmental benefits. Vegetated GSI systems can improve air quality by filtering and removing pollutants from vehicles and industrial sources. Some systems can reduce the urban heat island by providing shade or converting impervious surfaces into vegetated landscapes. Increasing vegetation can also improve wildlife habitat by expanding the number of native plants and creating habitat complexity. All of these benefits help improve the quality of life for Chester residents and help achieve other environmental objectives, such as reducing energy use and building resilience to the impacts of climate change.

Beckoning Cistern, designed by Buster Simpson, Seattle, WA. *Photo by Stuart Echols.*

Public Art Opportunities

Outdoor art that reflects a location and context helps to create unique, identifiable, and stimulating environments that provide meaning and value to those who interact with it. Thus, integrating public art with stormwater projects can delight and educate the public while further reinforcing the community benefits that GSI can achieve.

The creative opportunities to integrate art with GSI are boundless – kinetic sculptures that interact with the flow of water, seating elements designed to enliven or animate the GSI, or play areas that teach children about the natural world.

Not all Chester GSI projects need to accommodate public art, but its value should be considered early in the planning of highly visible project sites. It is also important to consider involving local artists and establishing community buy-in and support for the artwork.

Economic

Widespread implementation of GSI can have significant economic benefits, such as deferring or even replacing large gray stormwater infrastructure projects. These large installations, such as major sewer expansions and deep tunnels, are costly to construct and take years to complete. They also have long lead times for planning, design, bonding, and construction, leaving them vulnerable to escalating costs from external market conditions for materials, labor, and financing. Compared to large gray infrastructure projects, the incremental construction of GSI typically uses more level cash flow that provides flexibility and better financing.

GSI reduces the costs for sewage treatment by filtering and treating rainfall naturally instead of allowing it to enter combined sewers. By capturing runoff to use for irrigation (as with rain barrels), GSI can reduce the need to use treated, potable water supplies. This decreases energy and chemical costs as well as air pollution and carbon emissions.

GSI provides many skilled and unskilled job opportunities. From design and installation to ongoing maintenance, GSI has created a new niche within the labor market. In addition to creating new opportunities within existing sectors like landscaping, paving, and building, entire new industries are emerging around GSI. In addition, recent studies have found that property values increased after green stormwater management features were installed (Center for Clean Air Policy, 2011; American Rivers, 2013).

Social

Implementing GSI provides opportunities to improve the quality of life and add neighborhood amenities. Gray infrastructure typically handles stormwater underground but provides no other social benefits. On the other hand, GSI can enhance parks, streets and sidewalks, plazas, green spaces, and public spaces with shade trees, attractive rain gardens, bioswales, and curb bump-outs in an otherwise sterile urban landscape. Recent studies have shown that people's connection to nature has health benefits, including relief from heart disease, depression, cancer, anxiety, and attention disorders. GSI can bring more nature into the city and contribute to the health and well-being of residents (City of Chicago, 2014).

CRITICAL CONSIDERATIONS

Although GSI has many potential benefits for the City of Chester, physical limitations, maintenance, and long-term commitment are critical considerations for success.

The most significant GSI limitation in an urban area is often space. And even when land can be found, it may be owned by residents, businesses, or institutions that are not interested in green approaches. Parcels and road rights-of-way controlled by public agencies, such as the PA Department of Transportation, can present complications. Other factors that can limit infiltration include underground utilities and poor draining soils. Sites with contaminated soils are generally not appropriate for GSI approaches.

Maintenance is a critical consideration because the effectiveness of stormwater management installations may diminish over time or fail entirely if they are not properly maintained. When implementing a GSI system, it is necessary to ensure that sufficient resources are available to support quality installations and trained maintenance personnel.

Finally, GSI encompasses a complex and decentralized set of systems. Unlike centralized gray stormwater infrastructure, GSI is built gradually by a wide variety of people through opportunities provided by municipal and private landowners. The effectiveness of GSI builds upon the cumulative effects of many small-scale measures that may take many years to achieve. Thus, effective GSI requires that public agencies, community groups, and private landowners have a long-term commitment to a comprehensive green stormwater management vision.

COMMON GSI TECHNIQUES

This illustration developed by the Philadelphia Water Department features a variety of green stormwater infrastructure techniques to capture and treat stormwater – an example of how multiple methods are often utilized at one location for optimal benefit.

GSI holds the water until it can soak into the ground or evaporate. Trees, shrubs, perennials, and grasses are used to help manage runoff by evapotranspiration, infiltration, and filtration. The stormwater collected by GSI is taken up by the roots of plants and is transpired through the plants' leaves into the air. This process of "evapotranspiration," along with direct evaporation of standing water, means that stormwater never has to be managed in traditional sewer and stormwater collection systems. At the same time, these techniques allow water to infiltrate directly into the soil. Both evapotranspiration and infiltration by plants and soil also help remove pollutants from stormwater runoff, thereby improving water quality.

Image above and A-H on pages 13-15 courtesy of Philadelphia Water Department

Effective approaches to reducing stormwater volume and pollutants in urban landscapes:

A RAIN GARDEN *Typical Cost: $10 to $17 per square foot*

A rain garden is designed to collect runoff from impervious surfaces such as roofs, walkways, and parking lots and allow water to infiltrate underground. The garden is typically moderately depressed (lower than the surrounding ground level), with the bottom layer typically filled with stone so that runoff can collect within. Rain gardens can be connected to sewer systems through an overflow structure, but usually they are sized to infiltrate the collected stormwater within 72 hours. Sites must be free of big tree roots and utilities (CH2M Hill, 2011).

- suitable for many types and sizes of development and retrofits, including residential properties
- enhances aesthetics and wildlife habitat
- effective at removing pollutants
- technical knowledge not always required for routine maintenance
- ideal for level spaces (less than 5% slope)

B RAIN BARREL *Typical Cost: $100 to $300 each*

A rain barrel stores roof runoff from a downspout to manage stormwater in a way that can also reduce municipal water consumption. The stored rain can be used to water plants or for outdoor cleaning. Locate rain barrels so they can overflow and drain away from structures and foundations. Since a rain barrel can only collect water if it is empty, it is important to drain it after each storm (CH2M Hill, 2011).

- easy to design, install, and maintain
- during winter, water can be slowly released to yard or side sewer to make room for more
- during summer, water can be used for irrigation and can reduce overall water use
- ideal for managing small storm events

C STORMWATER PLANTER *Typical Cost: $8 to $15 per square foot*

This specialized planter installed in the sidewalk area 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. Excess runoff is directed into an overflow pipe connected to the existing combined sewer or stormwater pipe (CH2M Hill, 2011).

- provides storage, infiltration, and evapotranspiration of runoff
- reduces stormwater runoff impact

D GREEN ROOF

Typical Cost: $5 to $50 per square foot

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, engineered planting media, and specially selected plants. Green systems 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-inch), 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 (CH2M Hill, 2011).

- 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
- insulates to increase energy efficiency; reduces heating and cooling costs
- high upfront costs and high maintenance needed until vegetation is established

E STORMWATER TREE TRENCH

Typical Cost: $850 per tree, $10 to $15 per square foot

A stormwater tree trench is a system of trees that are connected by an underground infiltration structure. On the surface, a stormwater tree trench looks just like a series of street tree pits. However, under the sidewalk, a system manages 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 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 (CH2M Hill, 2011).

- if the capacity of this system is exceeded, stormwater runoff can bypass it entirely and flow into an existing street inlet
- relatively high cost due to structural components for some variations
- enhances site aesthetics and habitat

F DOWNSPOUT PLANTER

Typical Cost: $5 to $20 per square foot

A downspout planter is designed to capture stormwater from roof gutters, to be absorbed by the plants. These planters are filled with gravel, soil, vegetation, and are connected to the roof downspout to let water flow in. Downspout planters temporarily store runoff on top of the soil, and filter sediment and pollutants as water soaks down through the planter. They are typically waterproofed, and the bottom of the planter is normally impervious. As a result, planters do not infiltrate runoff into the ground; they rely on evapotranspiration and short-term storage to manage stormwater. Excess water can overflow into the existing downspout connection (CH2M Hill, 2011).

- can be constructed in many sizes and shapes and with various materials, including concrete, brick, plastic lumber, or wood

G STORMWATER BUMP-OUT

Typical Cost: $30 per square foot

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 sight lines of traffic (CH2M Hill, 2011).

- helps calm traffic
- when located at crosswalks, can provide a pedestrian safety benefit by reducing the street crossing distance

H POROUS PAVING

Typical Cost: $7 to $15 per square foot

These specially designed surfaces reduce runoff by allowing water to soak through the pavement and into the ground below. This system provides the structural support of conventional pavement but is made up of a porous surface and an underground stone reservoir. The stone reservoir provides temporary storage before the water infiltrates the soil. There are many different types of porous surfaces, including porous asphalt, porous concrete, and interlocking pavers (CH2M Hill, 2011).

- maintains a durable surface for cars and people
- can add visual interest and design detail
- careful design and construction required
- porous pavement not suitable for all uses

COMPLEMENTARY TECHNIQUES

Depaving and Replanting with Natural Vegetation

Cost: highly variable

The removal of unnecessary impervious surfaces is also considered a GSI technique. This typically requires decompaction of the top inch of uncovered soil and amendment with 2 to 3 inches of compost to help restore permeability. Some paving, such as steel reinforcement concrete, may require professional removal (CH2M Hill, 2011).

- frees underutilized paved space for trees, plantings, and other uses, including GSI
- allows stormwater to soak into the ground where it falls instead of picking up and carrying pollutants into creeks and waterways
- can restore habitats for birds, insects, and other wildlife

Conservation Landscaping

This refers to landscaping that replaces traditional grass lawns with native plants, with the goal of reducing pollution and improving the natural environment (CH2M Hill, 2011).

- provides habitat for local and migratory animals, conserves native plants, and improves water quality
- native plant species are deeply rooted and more resistant to insects, plant disease, and drought
- reduces the time and expense of mowing, watering, fertilizing, and treating lawn areas, and offers greater visual interest than grassed lawns
- can be used to address areas with problems such as erosion, poor soils, steep slopes, or poor drainage

Native Plants in Stormwater Landscapes

Native plants occur naturally in a given location. For Chester, native plants are those that were here before Europeans arrived. Native plants do the best job of providing food and habitat for butterflies, insects, and other native wildlife (California Native Plant Society, 2016). A wide range of native plants are available, including wildflowers, grasses, ferns, shrubs, and trees.

When native plants are used in rain gardens and other stormwater management features, they are relatively easy to establish and low maintenance. Since native species are adapted to local environments, they need less watering, little or no fertilizer or pesticides, and less pruning. And since native plants have evolved defenses against local pests and diseases, they are not bothered by insect damage and grow well without pesticides (California Native Plant Society, 2016).

HERE ARE SOME ADDITIONAL TIPS TO ENSURE PLANTING SUCCESS:

- Choose native plants that match the garden conditions. For example, choose water tolerant plants for a rain garden with wet soils. Some plants prefer full sun while other plants do better in dense shade.
- Consult the Delaware County Penn State Extension, a native-plant nursery, or a landscaper who specializes in native plants to help with plant selection. The Rain Garden App is also a great resource: *http://nemo.uconn.edu/tools/app/raingarden.htm*.
- Keep in mind that more care is needed in any garden in the first 2 to 3 years. Once established, a lot less maintenance is required.
- Densely planted gardens leave little room for weeds and require little or no mulch.
- Neighborhood volunteers and community groups can offer great assistance tending rain gardens and native plantings.

Comparing the Benefits of Common GSI Techniques

	CSO/FLOODING MITIGATION		ENVIRONMENTAL BENEFITS		ECONOMIC BENEFITS		PUBLIC HEALTH/ SOCIAL BENEFITS	
GSI Technique	Stormwater Volume Reduction	Decrease & Delay of Peak Discharge	Water Quality	Wildlife Habitat	Reduced Energy Needs	Increased Property Values	Air Quality/ Cooling	Neighborhood Beautification
Rain Garden	●	●	●	○	○	○	○	●
Rain Barrel/ Cistern	○	○	○	X	X	○	X	X
Stormwater Planter	●	●	●	○	○	○	●	●
Green Roof	○	●	○	○	●	●	●	○
Stormwater Tree Trench	●	●	●	○	○	○	●	●
Downspout Planter	○	○	●	○	○	○	○	●
Stormwater Bump-out	●	●	●	○	○	○	○	●
Porous Pavement	●	●	●	X	○	○	○	○
Depaving	●	○	●	○	○	○	●	●
Conservation Landscaping	○	○	○	●	●	○	●	●

Benefit ● = Highest ○ = Partial X = Limited

POTENTIAL GSI OPPORTUNITIES

Building GSI in a city requires policymakers, planners, designers, and engineers to think creatively and collaboratively about how they construct the fundamental components of the built environment, including streets and sidewalks, buildings and sites, and parks and public spaces.

Citywide Types of GSI Site Opportunities

CITY APPLICATION	APPLICABLE GSI TECHNIQUE	OPPORTUNITIES	GROUP RESPONSIBLE
Streets & Sidewalks Chester's public right-of-way includes a significant amount of the city's impervious surfaces, and represents a critical opportunity to keep stormwater out of its overtaxed sewer system. Two basic green strategies to capture and infiltrate runoff from streets, sidewalks, and alleys are to use vegetated areas or to use subsurface infiltration trenches (with or without porous pavement).	• Downspout Planter • Stormwater Tree Trench • Stormwater Bump-out • Porous Pavement	• Initial projects could occur at street corners undergoing ADA ramp upgrades and in areas slated for roadway repaving/reconstruction and streetscape improvements. • Adopt a "Green Streets" program like the Philadelphia Water Department to incorporate GSI in streetscape improvements, traffic calming devices, and greening efforts.	Streets Department
Buildings & Sites There are three basic green stormwater infrastructure strategies for public and private buildings and sites: manage water on the roof, manage water as it flows off of the roof, or manage water where it falls on site.	• Rain Garden • Rain Barrel/Cistern • Green Roof • Stormwater Tree Trench • Downspout Planter • Stormwater Bump-out • Porous Pavement	• Existing school and library properties are good candidate projects. Strategic use of rain barrels and rain gardens can tie into science curriculum and engage students. • Pavement related projects are most cost effective when the pavement is in need of replacement or the lot requires reconfiguration for other reasons.	City Departments and Authorities Private Land Owner
Parks & Open Space Chester has 27 parks of varying sizes and characteristics. Each park has the potential to utilize GSI. Typically, parkland contains significant permeable surfaces that already absorb rainwater. If properly designed and integrated into ongoing restoration work, many park sites can be enhanced to create hydraulic connections to larger land areas that are generally impervious, such as streets and sidewalks.	• Rain Garden • Rain Barrel/Cistern • Green Roof • Stormwater Tree Trench • Downspout Planter • Stormwater Bump-out • Porous Pavement • Depaving • Conservation Landscaping	• Investigate GSI retrofits during the preparation of the Park, Recreation, and Open Space Plan to be completed in 2017. • See Veterans Memorial Park case study.	Parks & Recreation Department
Vacant Land Chester has numerous vacant parcels. Although not always under public control, these parcels offer excellent opportunities for building GSI projects during the redevelopment process.	• Porous Pavement • Depaving • Conservation Landscaping	• Implementing a variety of green infrastructure techniques to manage stormwater generated on-site can also manage additional impervious areas from adjacent properties. • It is important to investigate any limitations to the use of the site when considering the incorporation of GSI on a brownfield site.	City of Chester / CEDA

STREETS AND SIDEWALKS

Chester's public right-of-way includes a significant amount of the city's impervious surfaces and represents a critical opportunity to keep stormwater out of its overtaxed sewer system. There are two basic green infrastructure strategies for streets, sidewalks, and alleys: capture stormwater in vegetated areas or use infiltration and standard pavement as an alternative to porous pavement to allow water to percolate into the ground.

Example Project: PA 291

Potential enhancements on PA 291 include a vegetated center median, removal of parking lanes, and the addition of bike lanes and new lighting. In addition to other improvements such as allowing space for new lighting and pedestrian crossing refuges, a vegetated median could be designed to capture and infiltrate runoff from the road surface. At the same time, tree trenches and stormwater planters can be integrated along the *outside* edge of the right-of-way, so long as they are designed to avoid conflicts with existing utilities. Overall, GSI can enhance the visual quality and safety of PA 291 for pedestrians and drivers alike. Vegetated medians increase roadway safety by creating a barrier between opposing lanes of vehicle traffic, while reducing the number of locations at which a left turn can be made. Landscaped medians are also a traffic calming technique designed to slow motor vehicle speeds.

View looking east from the intersection of the US 322 offramp, provided by Oak Valley Design.

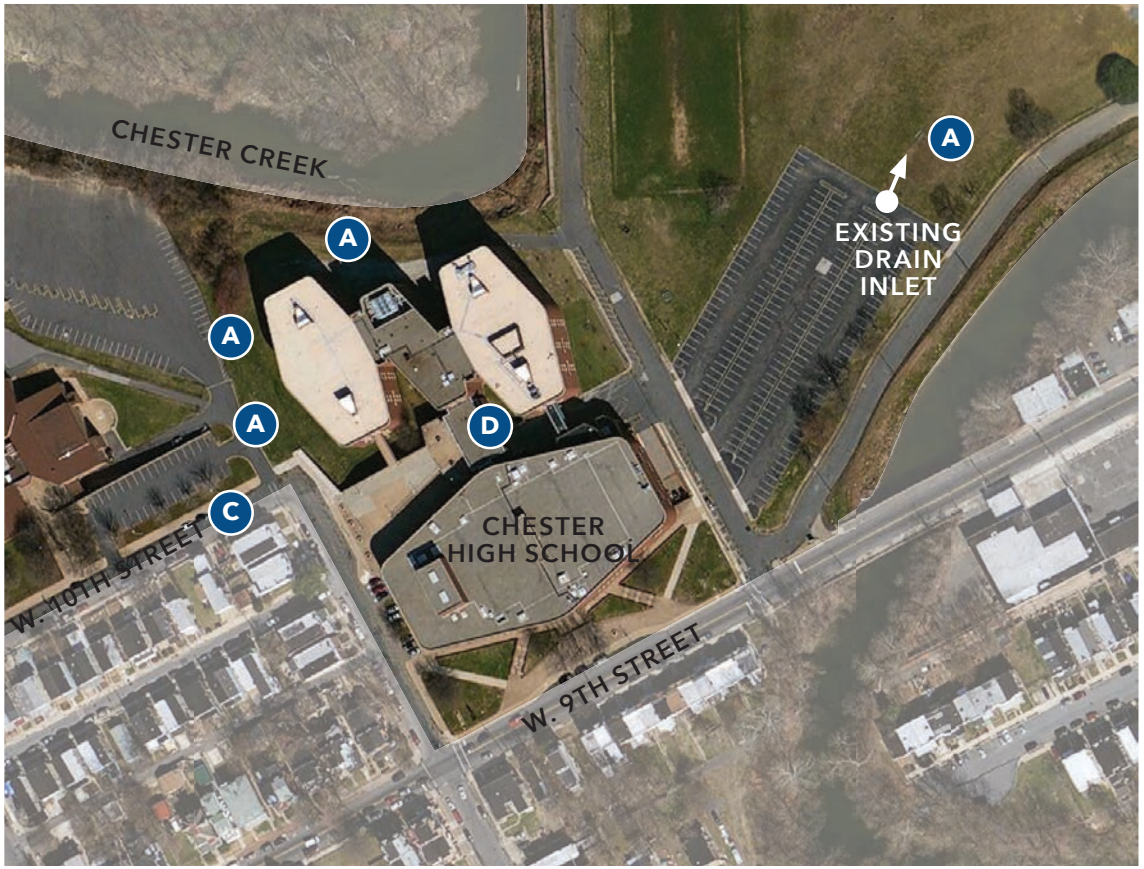
Potential GSI Treatments:

A RAIN GARDEN

C STORMWATER PLANTER

E TREE TRENCH

H POROUS PAVING



Aerial Image by Google Earth, provided by Oak Valley Design.

Potential GSI Treatments:

A RAIN GARDEN

C STORMWATER PLANTER

D GREEN ROOF

BUILDINGS AND SITES

There are three basic green stormwater infrastructure strategies for public and private buildings and sites: manage water on the roof, after it flows off the roof, and where it falls on site.

Example Project: Chester High School

GSI projects at schools provide excellent science and arts education opportunities and promote environmental stewardship among Chester's future professionals and community leaders. There are multiple areas for GSI retrofits at Chester High School. Adjacent streets could potentially accommodate stormwater planters. Open lawn areas around the school offer sites for rain gardens. Stormwater runoff from 1.65 acres of the Chester High School parking lot could be managed via two short trench drains to a rain garden. Enhancements to this rain garden could include a boardwalk, gathering area, and interpretive signage to create an engaging educational space. Small flat roof areas may be candidates for green roofs. GSI projects near the school can also provide high community visibility when the Chester Creek Trail is completed.

PARKS AND PUBLIC SPACES

Chester has 27 parks of varying sizes and characteristics. Each park has the potential to utilize GSI. Typically, parkland contains significant permeable surfaces that already absorb rainwater. If properly designed and integrated into ongoing restoration work, many park sites can be enhanced to create hydraulic connections to larger land areas that are generally impervious. Therefore, green stormwater infrastructure in parklands and natural areas can be used to capture runoff from surrounding roadways and other impervious surfaces.

Demonstration Project: Veteran's Memorial Park

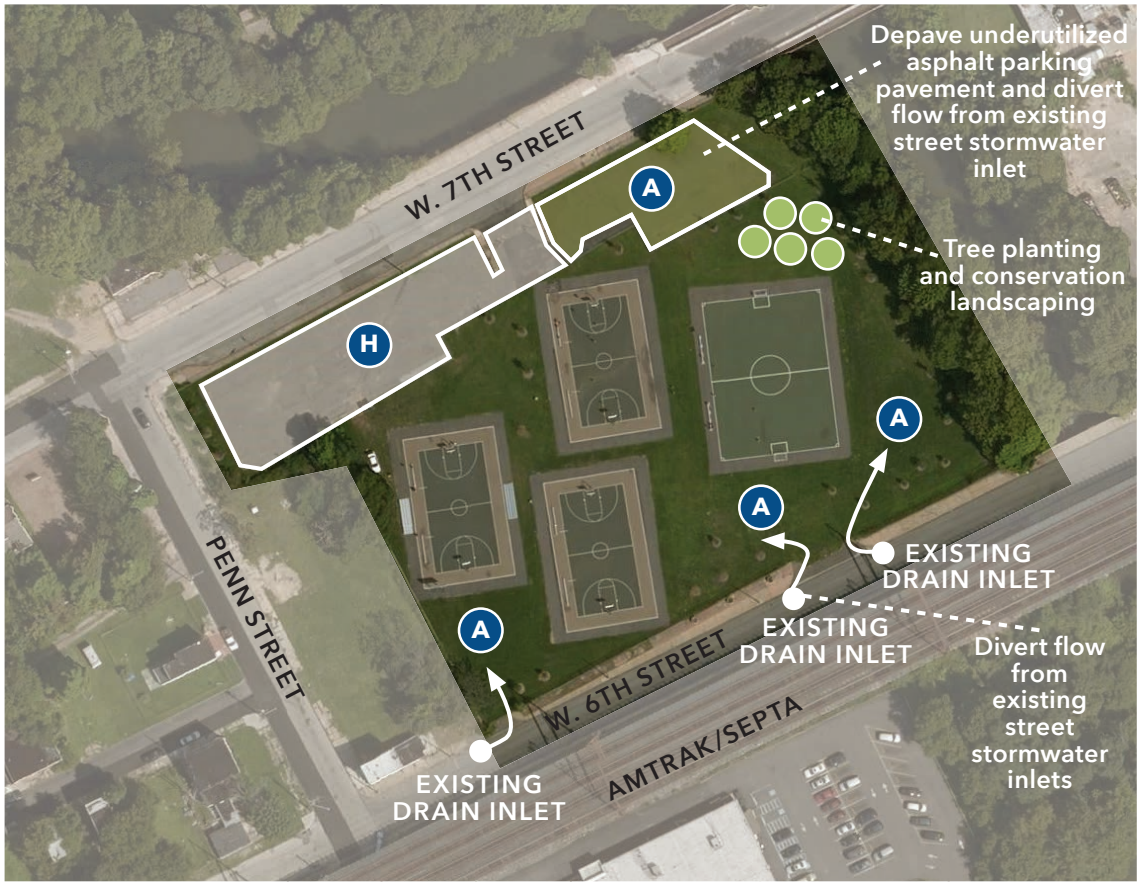
After evaluation of several public properties and the consideration of numerous factors such as storm-water capture, utility conflicts, visibility, and cost effectiveness, this park was chosen as the city's first GSI demonstration site. Upon selection, design and construction documents were prepared by a consultant engineer and landscape architect. The project is shovel ready and awaits construction funding.

Potential GSI Treatments:

A RAIN GARDEN

G STORMWATER BUMP-OUT

Images by CH2M/Viridian Landscape Studio.



Aerial Image by Google Earth, provided by Oak Valley Design.

Potential GSI Treatments:

A RAIN GARDEN

H POROUS PAVING

PARKS AND PUBLIC SPACES

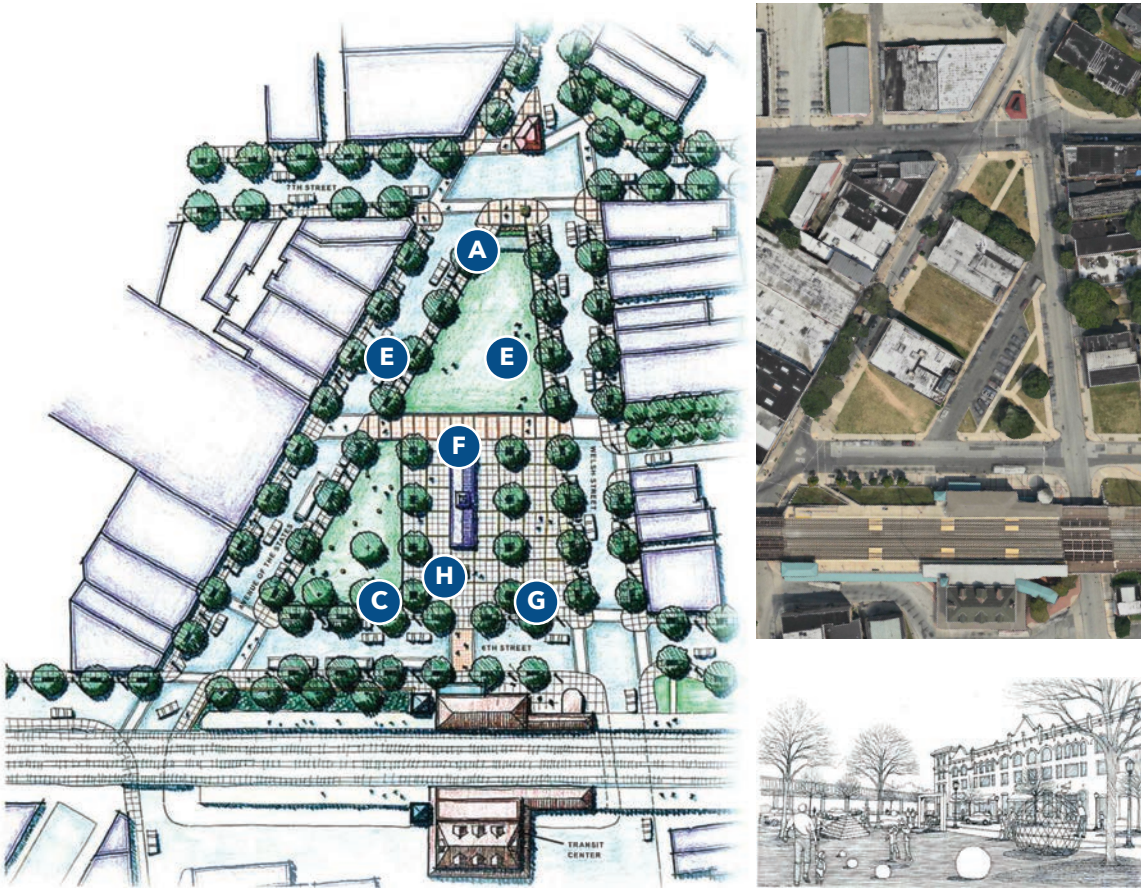
Example Project: Chester Recreation Facility, 7th and Penn Streets

Park runoff currently drains directly to the Chester Creek so stormwater management improvements would benefit water quality and reduce flood volume. Because there are minimal potential utility conflicts, this site is ideal for rain gardens, depaving, and native plantings. In addition, porous paving of the playing surfaces and parking lot could be considered. With artwork, sculpture, and educational signage, this project would enhance the surrounding neighborhoods and provide educational value.

PARKS AND PUBLIC SPACES

Vacant Land Example Project: Triangle Park

In 2004, a new multi-purpose civic space tentatively called Triangle Park was proposed just north of the Chester Transportation Center to enhance the mostly vacant, but highly visible, space in the center of Chester's downtown. The proposed park includes a hardscape plaza with a structure as a focal point and a programmable element. It also includes two open lawn areas for gatherings and an interactive sculpture garden to display local artists' work. The park space, approximately 1.25 acres, currently consists of seven publicly owned vacant lots and three privately owned lots with buildings. When the remaining private parcels are acquired, demolition of the buildings and removal of parking lot pavement will reduce stormwater runoff. In addition to the potential for GSI treatments inside the park, there may also be potential to capture and divert runoff from the surrounding street via stormwater planters and curb bump-outs.



Illustrations by AECOM (formerly EDAW, Inc.). Aerial Image by Google Earth

Potential GSI Treatments:

A RAIN GARDEN

C STORMWATER PLANTER

E TREE TRENCH

F DOWNSPOUT PLANTER

G STORMWATER BUMP-OUT

H POROUS PAVING

Potential GSI Sites Considered in this Study

LOCATION	ADDRESS	NOTES	CORRIDOR AND TARGET AREAS	POSSIBLE GSI TECHNIQUES
PA 291 & Lloyd	Intersection of PA 291 & Lloyd Street	Visible to PA 291 traffic, private property surrounds area. Floods.	Waterfront Corridor Revitalization Target Area D	Bioswales, rain gardens, tree trenches, subsurface infiltration/storage
PA 291 Median Strip *	PA 291	Turning lane on PA 291, could go the whole stretch of Chester City.	Waterfront Corridor Revitalization Target Area B	Bioswales, rain gardens, tree trenches, subsurface infiltration/storage
PA 291 & Reaney	Intersection of PA 291 & Reaney Street	Next to PPL Park, very visible, medium sized plot, on corner, high traffic, flooding area.	Waterfront Corridor Revitalization Target Area A	Tree trenches, bumpouts, rain gardens
The "Triangle" *	79 East 6th Street	Very visible, next to train and bus stop, unused vacant land, community oriented, can be used for public events.	Central Business District Revitalization Target Area D	Rain gardens, bumpouts, porous paving, tree trenches
Basketball Court	14th & Crosby Streets	Privately owned, high crime area - take care not to create hiding places, one court surrounded by steep slopes, avoid GSI on slopes.	None	Porous paving, rain gardens, tree trenches
Basketball Courts*	Bounded by 6th, 7th & Penn Streets & Chester Creek	Heavily used, newly blacktopped courts, parking lot in bad shape, well cleaned, grassy areas around courts, direct drainage to Chester Creek.	Central Business District, close to Revitalization Target Area D and proposed Chester Creek trail.	Porous paving in parking area, bioswales, rain gardens
Chester Community Charter School	214 East 5th Street	Privately owned. Not highly visible, limited green space, fenced-in so not very accessible to the community.	Partially in Central Business District	Cisterns/rain barrels, downspout planters
Chester High School*	200 West 9th Street	The front corner is visible to community, back is open but not very visible; localized basement flooding & flooding in adjacent park.	Close to proposed Chester Creek Trail	Bioswales, rain gardens, tree trenches, porous pavement, bumpouts
Chester Park Line	East Elkinton Boulevard & Edgmont Avenue	Big park, seems well maintained and attractive, lots of lawn.	None	Rain gardens, bioswales, tree trenches, bumpouts, conservation landscaping
City Hall	Edgmont & PA 291	Very visible to PA 291 and community, existing vegetation may be impacted by proposed GSI.	Waterfront Corridor, Revitalization Target Area D	Porous paving, bioswales, tree trenches, rain gardens, depaving
Columbus Elementary	Parker Street & West 10th Street	Vacant school property that may be renovated or redeveloped in the future.	Close to proposed Chester Creek Trail	Dependent on future development or future use
Crozer Park	Finland Drive & Kerlin Street	Large, hilly, visible, large parking area, primarily turf and recreation fields.	Close to proposed Chester Creek Trail	Bioswales, bumpouts, tree trenches, porous paving, rain gardens
Eyre Park	Between Chester High School & Chester Creek	Large vacant area, needs some attention, not that visible, only visible to high school; potential to partner with trails.	Partially in I-95 Corridor (Medical Education Corridor)	Rain gardens, conservation landscaping, depaving
Parker Manor	Parker & West 13th Streets	Housing across from Crozer Park, down hill, next to creek. 10 houses recently removed, floods (either from creek or runoff).	Close to proposed Chester Creek Trail	Depaving, conservation landscaping, rain gardens, bioretention
Pocket Park	Intersection of 8th and Lloyd Streets	Playground equipment outdated. Could reduce impervious surfaces and utilize the park more efficiently. High potential for green techniques.	None	Depaving, underground storage below playground, conservation landscaping, community gardens, rain gardens
Talen Energy Stadium	1 Stadium Drive	Privately owned, possibility for long term maintenance and financial support.	Revitalization Target Area A	Rain gardens, porous pavement, grassy pavers, bumpouts, tree trenches
Ruth L. Bennett Housing	1701 West 7th Street	Could be a bunch of smaller projects, visible to neighborhood, external downspouts on newer housing could be disconnected.	None	Rain gardens, tree trenches, bioswales, bumpouts, rain barrels, downspout planters
Showalter STEM High School	1100 West 10th Street	Large area in front of school with pavement around flag pole. Good location to work with schools on related educational projects; large parking areas only used part of the year.	None	Rain gardens, bioswales, bumpouts, depave/grassy pavers, porous pavement
Stetser Elementary	Melrose Avenue & East 17th Street	Large spaces, pavement/parking unused, could be depaved and planted, privately owned by Widener University.	None	Rain gardens, bioswales, bumpouts, tree trenches, porous pavement
Veterans Memorial Park & J. Lewis Crozer Library *	2300 West 7th Street	Big, lots of area, visible to community members, fields, library parking lot floods.	None	Rain gardens, bioswales, bumpouts, conservation landscape, tree trenches, porous pavement

* See pages 20-24 for more more detail at these locations. Also see Appendix Map 1 for site locations.

IMPLEMENTATION

This section offers action-oriented suggestions and first steps to expand Chester City's GSI initiatives. Steps are organized by purpose into the following four categories: Leadership, Planning, and Funding; Partnerships and Outreach; Design and Build GSI Projects; and Data Tracking and Impact Analysis.

1. LEADERSHIP, PLANNING, AND FUNDING

In order to advance this GSI implementation strategy, a champion group needs to help lead its coordination. In addition, the City needs to be involved in CSO mitigation planning while developing policies and creating GSI implementation incentives.

a. **Establish a GSI task force with the Shade Tree Commission** to advance the implementation of this GSI strategy. This group will help to:

   i. **Prioritize projects to advance and implement GSI in the City** in the near-, medium-, and long-term. Consult the list of potential GSI project locations (primarily publicly owned) in the table on page 25 and Map 1 as a starting point. As feasible, expand the project list with opportunities on privately owned land. Also, ensure GSI opportunities and approaches are incorporated into the City's updated parks, recreation, and open space plan.

   ii. **Coordinate the development and delivery of a consistent GSI message** to ensure effective materials, professional development, and workshops are available to educate and engage the private sector and city staff and residents.

   iii. **Oversee potential methods and resources to fund GSI projects** on public and private land. Explore potential public-private partnerships that design, finance, build, and operate GSI retrofits on private property through grants and other revenue sources (see also 1c). Help align grant development priorities with potential social and environmental benefits and probability for funding.

b. **Coordinate the implementation of this plan with the work of the City of Chester Stormwater Authority.** In June 2017, the Stormwater Authority announced the creation of a Community-Based Public-Private Partnership (CBP3) to plan, finance, build and maintain up to $50 million in green stormwater infrastructure over the next two to three decades. The Stormwater Authority and its partners are well-positioned to utilize the strategies and projects laid out in this plan to help it achieve its goal of using GSI as a catalyst for local economic growth and community involvement. The GSI opportunities detailed and documented by this plan are tailor-made to be considered by the CBP3 as initial GSI implementation projects.

c. **Integrate planning with the DELCORA Long Term Control Plan**. Under an EPA consent decree, DELCORA is required to develop a long-term CSO control plan to reduce sewage overflows during storm events. The EPA requires that DELCORA evaluate GSI alternatives for treating the stormwater and containing the overflow. The City and its GSI task force should collaborate with DELCORA and its consultants to ensure that GSI is included in the control plan.

d. Where feasible, **revise City ordinances to further incentivize GSI and streamline the permitting process**. See *EPA's Municipal Handbook: Incentive Mechanisms* for examples such as stormwater fee discounts, expedited permitting, grants, and rebate and installation financing.

e. **Develop a program to utilize Chester's 372 acres of vacant land** for stormwater management and beautification projects. Vacant lots provide great opportunities to absorb stormwater and beautify the community, while creating redevelopment opportunities. This not only increases opportunity sites for GSI, but also helps to create a network of open spaces, parks, and community gardens. The U.S. Forest Service developed the *Baltimore Green Pattern Book*, which could be applied to Chester (U.S. Forest Service, 2015).

f. Work with City staff to **introduce a resolution for City Council approval that establishes GSI as a critical stormwater management system** and identifies the target amount for city-wide runoff management (see data tracking on page 29).

2. PARTNERSHIPS AND OUTREACH

To increase the understanding and appreciation of GSI applications in the City of Chester, public and private sectors need to work together to:

a. Develop a framework for **public participation in GSI implementation** in the City.

i. **Develop and assemble audience-specific GSI outreach and education tools** and materials, including online resources for the City's website. Share success stories as Chester's GSI projects are completed.

ii. Develop a **schedule for community workshops and meetings** with neighborhood groups, churches, teachers, students, homeowners, business leaders, City Council, and other stakeholders.

iii. **Develop and manage a list of key partners and volunteers** to help deliver scientifically sound outreach messages, host workshops, provide support for grant funding pursuits, and implement GSI projects.

iv. **Work with partners on a backyard conservation planting program**, distribute a rain barrel to every willing homeowner, and continue to support the Shade Tree Commission's mission to educate the public about the importance of increased canopy cover.

b. Promote the benefits of GSI by **recognizing exemplary GSI projects completed within the City** with a City Council award.

c. **Collaborate with communities upstream on the Chester and Ridley creeks** to help remediate stormwater and flooding challenges in the City of Chester. Discuss with upstream communities the value of maintaining open space, improving existing green spaces, and working with large landowners to retain stormwater on site. Where feasible, implement the recommendations of the Chester and Ridley Creek Conservation Plans to obtain the co-benefits of managing stormwater while protecting open space (CRC Watersheds Association et al., 2002; GreenSpace Alliance and CRC Watersheds Association, 1998).

d. **Regional Opportunities:** The Chester and Ridley Creek Conservation Plans evaluated the land use and water quality of the watersheds and suggested opportunities for improvement (see Appendix Map 2). A very important (and still relevant) recommendation was to create inter-municipal watershed committees. The Conservation Plans further suggested that committees be funded by the PADCNR, PADEP, or a similar source (CRC Watersheds Association et al., 2002; GreenSpace Alliance and CRC Watersheds Association, 1998).

e. **Private Opportunities**: The City of Chester is fortunate to have many commercial and non-profit partners. Below are some examples of partner properties that offer opportunities for significant GSI investment:

- Widener University – a variety of GSI techniques could become the focus of sustainability initiatives
- Crozer Chester Medical Center – variety of GSI techniques
- Harrah's Casino – variety of GSI techniques, especially a green roof
- Talen Energy Stadium – variety of GSI techniques
- Schools – trees, rain gardens, rain

barrels, downspout planters, adopt-a-lot program with students
- The Wharf at Rivertown – variety of GSI techniques
- Churches – tree planting, rain gardens, rain barrels, adopt-a-lot program

3. DESIGN AND BUILD GSI PROJECTS

The implementation of GSI projects on publicly owned lands will increase the visibility and understanding among city agencies and residents of the benefits that GSI provides.

a. **Implement pilot projects on public lands** to illustrate the value of GSI techniques, showcase their application on various publicly owned lands, and build institutional capacity. Based on pilot project experience, the City can then customize maintenance plans for each project type and technology encountered within the City. Pilot projects also help to develop an increased understanding of the benefits that GSI provides among city agencies and the general public. A summary of possible GSI pilot projects is provided on page 27.

b. **Integrate GSI into existing city capital improvement and maintenance plans**, including the creation of a green streets plan and a workforce development training program. Green streets use green stormwater infrastructure to capture and manage runoff directly from the street. The City of Philadelphia has a nationally recognized green streets design manual that could easily be adapted for the City of Chester *(www.phillywatersheds.org/what_were_doing/gsdm)*.

c. Regularly engage in the **scoping of public capital projects for possible GSI project opportunities**. Proactively review capital project plans, especially those of the Pennsylvania Department of Transportation, public and private schools, Widener University, and locations of high visibility.

d. **Adopt city GSI design and construction standards** and apply those standards in capital projects where applicable. See the City of Philadelphia's standards as a reference (Philadelphia Water, 2016).

e. **Integrate GSI strategies with ongoing community development initiatives** to gain synergies and coordinate fundraising activities. Projects like the City's open space and recreational trails initiative can serve as a catalyst for co-funding and implementing GSI.

4. DATA TRACKING AND IMPACT ANALYSIS

Benchmarks and goals must be tracked and analyzed to document success and account for the full impact and benefits of GSI implementation:

a. **Inventory and assess public landholdings for impervious surface cover**, working condition, and potential value for stormwater management. Prepare site improvement concepts that integrate stormwater infiltration techniques, minimize impervious surfaces, preserve native vegetation, increase tree canopy coverage, identify no-mow and low-mow zones, and determine if existing vacant lands would be appropriate for protected open space or passive recreation.

b. **Address GIS data needs** and coordination with city planning staff to assure that the best available, parcel-based land use, and impervious cover data are used.

c. **Develop a citywide project tracking system to document completed public and private sector GSI projects**, including information such as site size, watershed size, type of GSI system, square footage, infiltration capacity, and as-built surveys.

d. **Develop an adopt-a-lot program** and inventory publicly and privately owned vacant land with potential for stormwater management and beautification projects. Vacant lots provide great opportunities to absorb stormwater, beautify the community, and increase opportunities for purchase, rehab, or development. Converted lots can add to a green space network of open spaces, parks, squares, rain gardens, urban farms, and community gardens. The U.S. Forest Service's *Baltimore Green Pattern Book* can guide Chester City (U.S. Forest Service, 2015).

e. **Identify tools and create a mechanism to compare the costs and benefits** of green versus gray approaches to ensure the best return on public and private investment (Baltimore Housing, n.d.).

FUNDING OPPORTUNITIES

Grant Name	*Sponsoring Agency*	*Link to Further Information*
FEDERAL GRANT PROGRAMS		
Targeted Watersheds Grant Program	EPA: Office of Water	http://water.epa.gov/grants_funding/twg/initiative_index.cfm
Community Development Block Grants	Funding provided by U.S. Department of Housing & Urban Development (HUD); administered by the Chester Economic Authority (CEDA)	www.phila.gov/ohcd/hud.htm
Highway Safety Improvement Program	Funding provided by USDOT, Federal Highway Administration; administered by PennDOT	http://safety.fhwa.dot.gov/hsip/
EPA Urban Waters Small Grants	EPA's Urban Waters Program	www.epa.gov/urbanwaters/funding/index.html
Transportation Alternatives Program (TAP)	Federal funding administered by DVRPC	www.dvrpc.org/tap
TIGER Grants	United States Department of Transportation	www.dot.gov/tiger
Clean Water State Revolving Fund (CWSRF)	Federal-state partnership administered by PENNVEST	www.epa.gov/cwsrf www.pennvest.pa.gov/information/funding-programs/pages/clean-water-state-revolving-fund.aspx
PENNSYLVANIA STATE GRANT PROGRAMS		
Growing Greener	Pennsylvania Department of Environmental Protection (PA DEP)	www.dep.pa.gov/Citizens/GrantsLoansRebates/Growing-Greener/Pages/default.aspx
Community Conservation & Recreation Grant	PA Department of Conservation & Natural Resources (PADCNR)	www.grants.dcnr.state.pa.us/LearnMore
Water Supply and Wastewater Infrastructure Program (PennWorks)	PA Department of Community and Economic Development (PADECD)	www.newpa.com/find-and-apply-for-funding/funding-and-program-finder/water-supply-and-wastewater-infrastructure-program-pennworks
NATIONAL PRIVATE FOUNDATION GRANT PROGRAMS		
The Heinz Endowments Funding	The Heinz Endowments	www.heinz.org
Rockefeller Foundation Funding	The Rockefeller Foundation	www.rockefellerfoundation.org/grants
Surdna Foundation Grant	Surdna Foundation	www.surdna.org/grants/grants-overview.html
Environmental & Cultural Preservation Grants	The Tiffany & Co. Foundation	www.tiffanyandcofoundation.org/apply.aspx
REGIONAL AND LOCAL GRANT PROGRAMS		
Watershed Protection Grants	William Penn Foundation	www.williampennfoundation.org/WatershedProtection.aspx
Delaware River Restoration Fund	National Fish and Wildlife Foundation	www.nfwf.org/delaware/Pages/home.aspx
The Pew Charitable Trusts Funding	The Pew Charitable Trusts	www.pewtrusts.org/program_investments_procedure.aspx

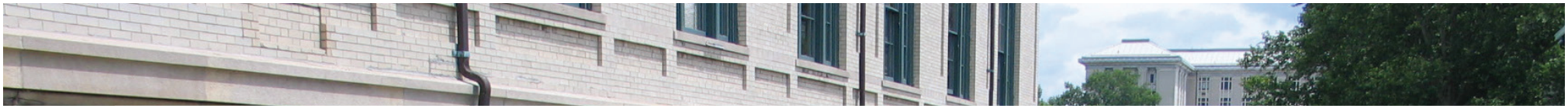
CITY OF PHILADELPHIA

Philadelphia's GSI Outreach

As part of the Green City Clean Waters program, the Philadelphia Water Department (PWD) provides assistance, creates educational opportunities, and raises awareness of GSI projects in Philadelphia neighborhoods through partner organizations, community meetings, web resources, and unique programs to engage residents on many levels. PWD's *Soak It Up Adoption Program* is one of many programs to help maintain the beauty and functionality of GSI in the city's neighborhoods. This program provides grants to civic associations that can help improve the quality of waterways and beautify Philadelphia neighborhoods. Partnerships with several environmental organizations help residents participate in transforming the city's streams and parks into valuable assets. Public outreach initiatives, watershed assessments, and watershed management plans help communicate and implement Philadelphia's vision of reconnecting the city with its waterways. Major partners include the Tookany/Tacony-Frankford Watershed Partnership, the Partnership for the Delaware Estuary, the Schuylkill Action Network, and Pennsylvania Environmental Council (Philadelphia Water Department, n.d.).

NEXT STEPS

1. Establish a GSI task force and integrate with the existing Chester Shade Tree Commission.
2. Seek funding to construct the GSI Demonstration Project at Chester Memorial Park.
3. Develop and maintain a database of vacant lots along with a detailed GIS impervious surface layer for the entire city, and develop and maintain a list of capital improvement projects in the pipeline and those likely to be constructed in the next 10 years.
4. Create a social media presence and online GSI educational and management tools.
5. Convene partner meetings to prioritize locations and identify projects that can be implemented immediately.
6. Meet with DELCORA and integrate specific Chester GSI opportunities in the 2019 DELCORA CSO Long-Term Control Plan.



CONCLUSION: INVESTING IN THE FUTURE

This GSI implementation strategy recommends transformative steps toward solving the City of Chester's stormwater management challenges. Moving forward, effective management of the City's stormwater will require meaningful and sustained collaboration among key stakeholders. All of the City's departments and authorities have a critical role to play. DELCORA is also a crucial partner with substantial stormwater management expertise and responsibility. Public-private partnerships with non-profits, businesses, and community leaders are also essential. Chester's stormwater solutions will likewise require the efforts of private landowners and citizens, since their actions are essential to implement significant projects that lead to lasting impacts.

By maintaining and restoring the natural hydrologic function of urban areas, GSI is an effective strategy to manage stormwater as a resource, protect water quality, address wet weather pollution and minor flooding, enhance environmental quality, and achieve multiple economic and community goals.

REFERENCES

American Rivers (2016). *What is Green Infrastructure?* Retrieved from American Rivers: www.americanrivers.org/initiatives/pollution/green-infrastructure/what-is-green-infrastructure

American Rivers (2013). *Staying Green and Growing Jobs: Green Infrastructure as Career Pathway Stepping Stones.* Retrieved from American Rivers: www.americanrivers.org/wp-content/uploads/2016/05/staying-green-and-growing-jobs.pdf

Baltimore Housing (n.d.). *Adopt-A-Lot Program/ Community Guide.* Retrieved from Baltimore Housing: www.baltimorehousing.org/adopt_a_lot

California Native Plant Society (2016). *California Native Plant Information.* Retrieved from CNPA: www.cnps.org/cnps/nativeplants

Center for Clean Air Policy (2011). *The Value of Green Infrastructure for Urban Climate Adaptation.* Retrieved from Association of Metropolitan Water Agencies: www.amwa.net/galleries/climate-change/Green_Infrastructure_FINAL.pdf

CH2M Hill (2011). *Green Infrastructure Plan for the City of Lancaster.* Retrieved from the City of Lancaster: http://cityoflancasterpa.com/sites/default/files/documents/cityoflancaster_giplan_fullreport_april2011_final_0.pdf

Chester City (2012). *Vision 2020: A City Beautiful Movement*. Retrieved from Chester City: www.chestercity.com/wp-content/uploads/2015/09/Vision-2020-A-City-Beautiful-Movement.pdf

Chester City (2015). *City of Chester Zoning Ordinance*. Retrieved from Chester City: www.chestercity.com/wp-content/uploads/2016/01/Zoning_Ordinance_Dec_2015.pdf

Chester Hazards and Climate Project Team (2014). *The City of Chester Vision 2020 Climate Adaptation Planning Elements*. Retrieved from Pennsylvania Sea Grant: http://easternpaseagrant.org/Chester/documents/ClimateAdaptationElementsFinal26-June-14.pdf

City of Chicago (2014). *City of Chicago Green Stormwater Infrastructure Strategy.* Retrieved from the City of Chicago: www.cityofchicago.org/content/dam/city/progs/env/ChicagoGreenStormwaterInfrastructureStrategy.pdf

CRC Watersheds Association, Delaware County Planning Department, Chester County Planning Department, and the Pennsylvania Environmental Council (2002). *Chester Creek Conservation Plan.* Retrieved from Pennsylvania Department of Conservation and Natural Resources: www.dcnr.state.pa.us/cs/groups/public/documents/document/D_001895.pdf

CRC Watersheds Association (n.d.). *Chester Creek Watershed.* Retrieved from CRCWA: www.crcwatersheds.org/chester-creek.html

Environmental Protection Agency (2004). *Report to Congress on Impacts and Control of Combined Sewer Overflows and Sanitary Sewer Overflows*. Retrieved from EPA: www3.epa.gov/npdes/pubs/csossoRTC2004_chapter02.pdf

Environmental Protection Agency (n.d.). *Delaware County Regional Water Quality Control Authority Clean Water Act Settlement.* Retrieved from EPA: www.epa.gov/enforcement/delaware-county-regional-water-quality-control-authority-clean-water-act-settlement

Environmental Protection Agency (n.d.). *Green Infrastructure Manage Flood Risk.* Retrieved from EPA: www.epa.gov/green-infrastructure/manage-flood-risk

Environmental Protection Agency (n.d.). *Greening CSO Plans: Planning and Modeling Green Infrastructure for Combine Sewer Overflow (CSO) Control.* Retrieved from EPA: www.epa.gov/green-infrastructure/greening-cso-plans-planning-and-modeling-green-infrastructure-combine-sewer

Environmental Protection Agency (n.d.). *Implementing Clean Water Act, Section 303(d): Impaired Waters and Total Maximum Daily Loads (TMDLs).* Retrieved from EPA: www.epa.gov/tmdl

Environmental Protection Agency (n.d.). *National Pollution Discharge Elimination System: What is NPDES?* Retrieved from EPA: www.epa.gov/npdes

Environmental Protection Agency (n.d.). *Stormwater Discharges from Municipal Sources: Developing an MS4 Program.* Retrieved from EPA: www.epa.gov/npdes/stormwater-discharges-municipal-sources#developing

Environmental Protection Agency (n.d.). *What are Combined Sewer Overflows (CSOs)?* Retrieved from EPA: www3.epa.gov/region1/eco/uep/cso.html

Pennsylvania Department of Environmental Protection (2016). *PAG-13 MS4 General Permit*. Retrieved from PA DEP: www.elibrary.dep.state.pa.us/dsweb/View/Collection-9457

Pennsylvania Department of Environmental Protection (2014). *2014 Pennsylvania Integrated Water Quality Monitoring and Assessment Report, Clean Water Act Section 305(b) Report and 303(d) List*. Retrieved from PA DEP: http://files.dep.state.pa.us/Water/Drinking%20Water%20and%20Facility%20Regulation/WaterQualityPortalFiles/2014%20Integrated%20List/2014_Pennsylvania_Integrated_Water_Quality_Monitoring_and_Assessment_Report.pdf

GreenSpace Alliance and CRC Watersheds Association (1998). *Ridley Creek Conservation Plan*. Retrieved from Pennsylvania Department of Conservation and Natural Resources: www.dcnr.state.pa.us/cs/groups/public/documents/document/D_001863.pdf

Philadelphia Water (2016). *Green Stormwater Infrastructure Planning & Design*. Retrieved from Philadelphia Water: http://philadelphiawater.org/gsi/planning-design

Philadelphia Water (2006). *A Homeowner's Guide to Stormwater Manage*ment. Retrieved from Philadelphia Water: www.phillywatersheds.org/doc/Homeowners_Guide_ Stormwater_Management.pdf

Philadelphia Water (n.d.). *Community Outreach*. Retrieved from Philadelphia Water: www.phila.gov/water/educationoutreach/programs/Pages/default.aspx

Philadelphia Water (n.d.). *Green City, Clean Waters*. Retrieved from Philadelphia Water: www.phillywatersheds.org/what_were_doing/green_infrastructure

Philadelphia Water (n.d.). *Residents*. Retrieved from Philadelphia Water: www.phillywatersheds.org/residents

Philadelphia Water (n.d.). *Soak it Up*. Retrieved from Philadelphia Water: www.phillywatersheds.org/category/blog-tags/soak-it

Soil Science Society of America (n.d.). *Soils Sustain Life - Green Roofs*. Retrieved from SSSA: www.soils.org/discover-soils/soils-in-the-city/green-roofs

Soil Science Society of America (n.d.). *Soils Sustain Life – Grey Infrastructure*. Retrieved from SSSA: www.soils.org/discover-soils/soils-in-the-city/green-infrastructure/important-terms/grey-infrastructure

Stormwater PA (n.d.). *MS4 Program*. Retrieved from Stormwater PA: www.stormwaterpa.org/ms4-program.html

U. S. Fish and Wildlife Service (n.d.). *Homeowner's Guide Conservation Landscaping*. Retrieved from USFWS: www.fws.gov/chesapeakebay/conlascp.htm

U.S. Forest Service of the Department of Agriculture (2015). *Green Pattern Book*. Retrieved from USFS: www.fs.fed.us/nrs/baltimore/local-resources/downloads/nrs_inf_32-15-green-pattern.pdf

U.S. Global Change Research Program (n.d.). *National Climate Assessment*. Retrieved from USGCPR: http://nca2014.globalchange.gov/report

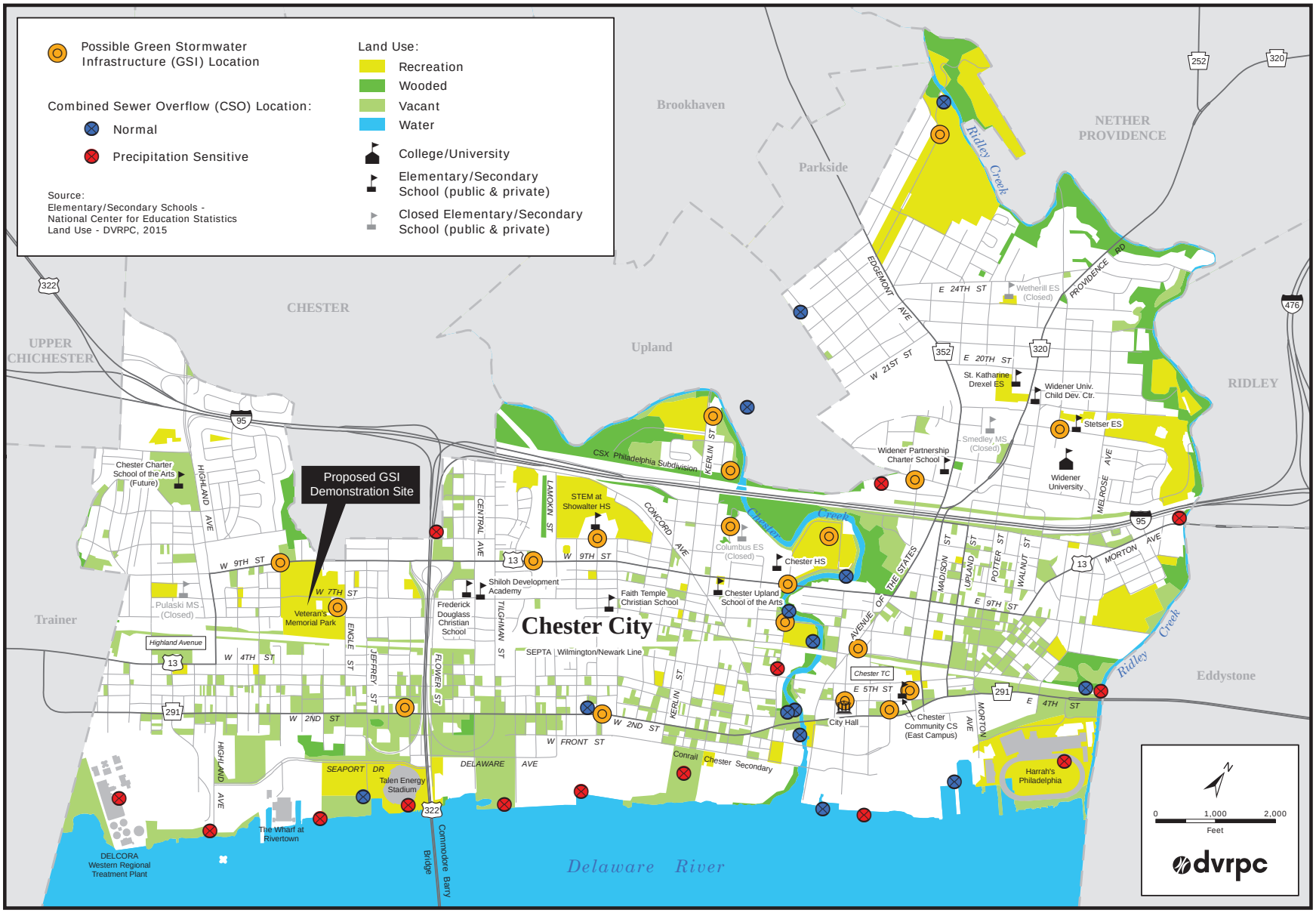
U.S. National Arboretum (n.d.). *Native Plants*. Retrieved from USNA: www.usna.usda.gov/Gardens/faqs/nativefaq2.html

Virginia Department of Conservation and Recreation (2016). *Native Plants for Conservation, Restoration and Landscaping*. Retrieved from VDCR: www.dcr.virginia.gov/natural-heritage/nativeplants

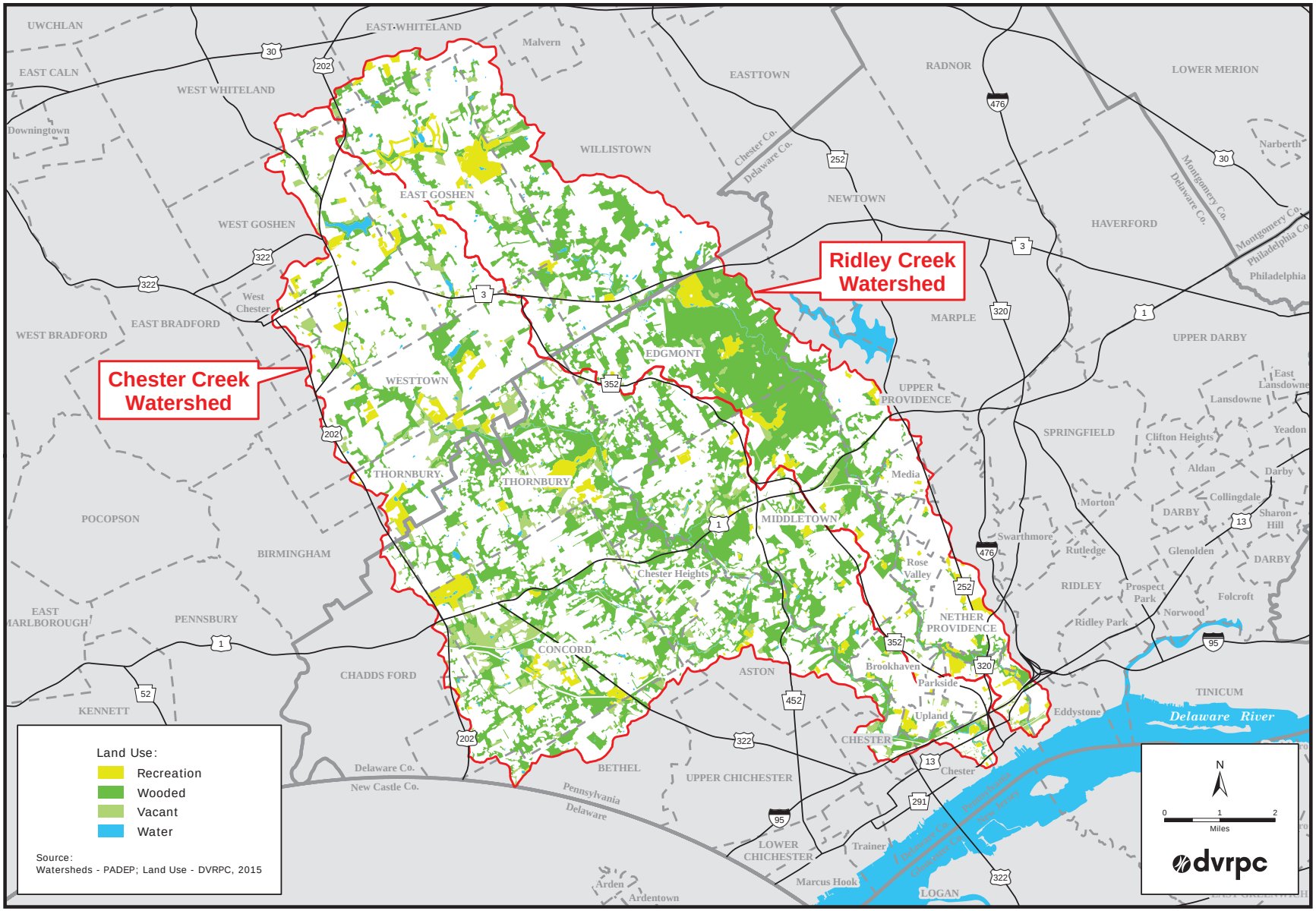
Washington State Department of Transportation (n.d.). *Chapter 6. BMPs for Stormwater*. Retrieved from WSDOT: www.wsdot.wa.gov/NR/rdonlyres/893753B8-AE04-4C15-84DB-05B88D977898/0/Chapter6BMPsforStormwater.pdf

APPENDIX

Map 1: Potential Green Stormwater Infrastructure Opportunity Sites

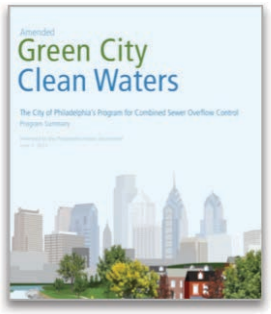


Map 2: Selected Land Use Categories in the Chester and Ridley Creek Watersheds



RESOURCES

Philadelphia Water Department (PWD)
Green Stormwater Infrastructure (GSI) Design Resources



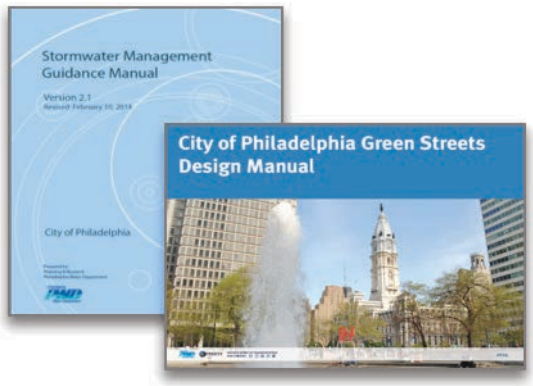
About Green City Clean Waters
Green City Clean Waters Program Summary
www.phillywatersheds.org/doc/GCCW_AmendedJune2011_LOWRES-web.pdf
Implementation and Adaptive Management Plan
http://phillywatersheds.org/doc/GSIMaintenanceManual-1stEdwpreamble_HRes.pdf

---

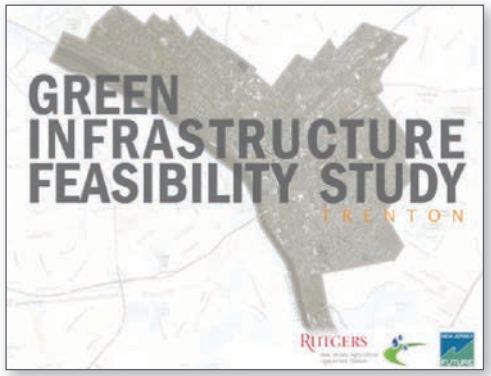
Design Guidelines for PWD Public Projects
http://phillywatersheds.org/gsi_design_resources
Green Stormwater Infrastructure Planning & Design
http://philadelphia water.org/gsi/planning-design/
GSI Standard Details for Public Parks & Recreation Facilities
http://phillywatersheds.org/doc/GSI/GSI_Standard_Details_for_Public_Parks_and_Recreation_Facilities.pdf
GSI Landscape Design Guidebook
http://phillywatersheds.org/doc/Landscape_Manual_2014.pdf
GSI Maintenance Manual
http://phillywatersheds.org/doc/GSIMaintenanceManual-1stEdwpreamble_HRes.pdf

---

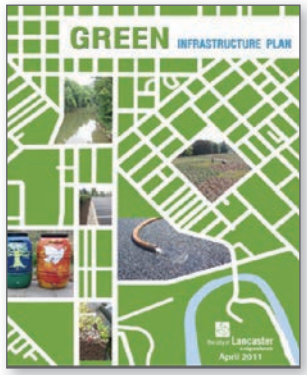
Design Resources for Development Projects
Philadelphia Stormwater Management Guidance Manual
www.pwdplanreview.org/WICLibrary/Full%20Manual.pdf
Green Streets Design Manual
www.phillywatersheds.org/img/GSDM/GSDM_FINAL_20140211.pdf
www.phillywatersheds.org/img/GSDM/GSDM_Appendix_20141014.pdf
Green Streets Design Manual Details in CAD and PDF
www.phillywatersheds.org/img/GSDM/Green_Streets_Details.zip
www.phillywatersheds.org/img/GSDM/Design_Components.zip



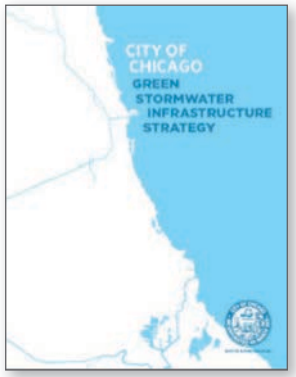
Example City GSI Plans



Trenton, NJ
Prepared by Rutgers New Jersey Agricultural Experiment Station and New Jersey Future
www.njfuture.org/wp-content/uploads/2015/01/2014-11-18_Trenton-Green-Infrastructure-Feasibility-Study.compressed.pdf



Lancaster, PA
Prepared by CH2M Hill
http://cityoflancasterpa.com/sites/default/files/documents/cityoflancaster_giplan_fullreport_april2011_final_0.pdf



Chicago, IL
Prepared by the City of Chicago
www.cityofchicago.org/content/dam/city/progs/env/ChicagoGreenStormwaterInfrastructureStrategy.pdf

Environmental Protection Agency

A guide on Enhancing Sustainable Communities With Green Infrastructure
www.epa.gov/smartgrowth/enhancing-sustainable-communities-green-infrastructure

GIWiz, provides access to tools and resources that can support and promote water management and community planning decisions.
Green Infrastructure Wizard
www.epa.gov/sustainability/giwiz

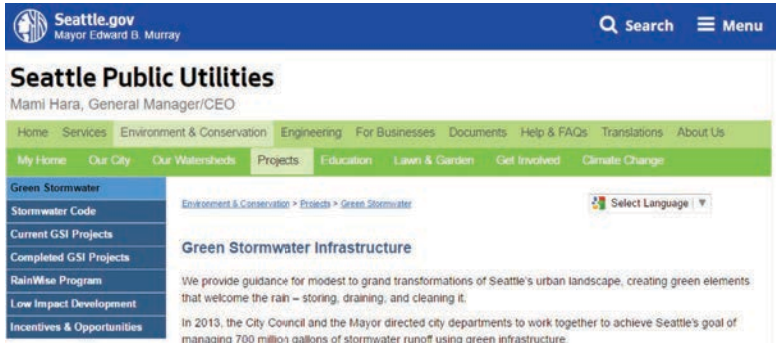
EPA National Stormwater Calculator
This amazing new application created by the EPA allows the user to calculate the amount of precipitation and runoff experienced by a particular location.
www.epa.gov/water-research/national-stormwater-calculator

Additional Web Resources

What is Green Stormwater Infrastructure?
Authored by American Rivers
An illustrated website with details and examples of what green stormwater infrastructure is and why it is so important for every community to develop and implement GSI.
www.americanrivers.org/initiatives/pollution/green-infrastructure/what-is-green-infrastructure/

Wiki Watershed
Authored by the Stroud Water Research Center
Wiki Watershed is a web toolkit for advancing knowledge and stewardship of fresh water. This national and local online mapping and scenario building website is appropriate for educational and planning purposes.
http://wikiwatershed.org

Green Infrastructure Toolkit
Developed by Georgetown University Climate Center
The purpose of this toolkit is to analyze common trends in the approaches various cities are taking to planning, implementing, and funding green infrastructure to manage stormwater. The toolkit is intended to aid local governments nationwide in comparing best practices across cities, drawing lessons from different approaches, and crafting similar policies for their own jurisdictions.
www.georgetownclimate.org/adaptation/toolkits/green-infrastructure-toolkit/introduction.html



Seattle Green Stormwater Infrastructure
Prepared by Seattle Public Utilities; Tracy Tackett (Green Infrastructure Program Manager) & Ray Hoffman (Director)
www.seattle.gov/util/EnvironmentConservation/Projects/GreenStormwaterInfrastructure/index.htm

Accelerating Cost-Effective Green Stormwater Infrastructure: Learning from Local Implementation
Authored by Nell Green Nylen and Michael Kiparsky (Wheeler Water Institute of Berkeley Law, University of California). This study looks into the economics and feasibility of green stormwater infrastructure through real life examples from various cities and towns that have implemented their own GSI projects.
www.law.berkeley.edu/files/CLEE/GSI_Report_Full_2015-02-25.pdf

CITY OF CHESTER GREEN STORMWATER
INFRASTRUCTURE PLAN

Publication Number: 15066

Date Published: June 2017

Geographic Area Covered: City of Chester, Pennsylvania, Chester and Ridley creek watersheds

Key Words: Green stormwater infrastructure (GSI), combined sewer overflow (CSO), rain garden, tree trench, stormwater bumpout, infiltration, low impact development, Memorial Park, stormwater, water quality, nonpoint source pollution, City of Chester, Chester Creek, Ridley Creek

Abstract: The City of Chester Green Stormwater Infrastructure Plan was created for city officials, residents, non-profits, and community groups. This plan highlights available green stormwater infrastructure (GSI) technologies, opportunities, and approaches to improve water quality, reduce combined sewer overflows, meet federal clean water requirements, decrease localized flooding, beautify the community, and enhance community and economic opportunities. The plan provides a blueprint for implementing GSI in Chester City, recommendations on how to start pilot projects, guidance on partnering and public outreach, and suggestions for how to track program impact.

Staff Contact:
Chris Linn
Manager, Office of Environmental Planning
(215) 238-2873 | clinn@dvrpc.org

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

190 N. Independence Mall West, 8th Floor
Philadelphia, PA 19106-1520
Phone: (215) 592-1800 | Fax: (215) 592-9125
www.dvrpc.org

Chris Linn
clinn@dvrpc.org

Peter Rykard
prykard@chestercity.com

Ann Faulds
amf12@psu.edu

Karen Holm
holmk@co.delaware.pa.us