City of Philadelphia Green Streets Design Manual

Philadelphia Water Department | Streets Philadelphia

MAYOR'S OFFICE OF TRANSPORTATION AND UTILITIES

2014

Letter from the Deputy Mayor

The Green Streets Design Manual literally rewrites the book on how Philadelphia will design and construct our streets for decades to come. The Green Streets Design Manual provides design standards and guidance for public and private developers building green stormwater infrastructure within the City right of way.

This publication follows and complements the 2012 release of the Complete Streets Design Handbook. While a complete streets policy benefits the environment by encouraging alternative transportation and reducing the carbon footprints of their users, green streets extends that environmental ethic into the physical design of the street by managing stormwater utilizing porous materials and vegetation. The complete street vision infused with green design standards provides the foundation for a 21st century street network in Philadelphia. This is a great accomplishment for the Philadelphia Water Department and Streets Department that will positively impact the lives of those who live in, work in and visit Philadelphia.

By spearheading the Green City Clean Waters program, the Water Department has become an integral partner to the many City agencies planning and building Philadelphia's streets, greenways, and commercial corridors. Interagency collaboration on the planning and development of streets projects is key to the successful implementation of green infrastructure citywide. No matter what department initiates the project, the Nutter Administration believes it is important that each and every street be considered from a green perspective, and that the design opportunities presented in this manual be maximized.

Together, the Handbook and Manual are the tools we are using to create a safe, attractive, efficient and sustainable urban transportation network, while managing polluted stormwater and achieving a cleaner, greener watershed. I encourage community groups, developers, and City staff to take full advantage of these resources to help our city become a leader in green and complete streets.

Rina Cutler
Philadelphia Deputy Mayor for Transportation and Utilities

Letter from the Water Commissioner

Philadelphia's Green City, Clean Waters program is tackling head-on the pollution and flooding challenges caused by urban stormwater runoff. We are determined to manage 10,000 acres of existing impervious surface over the next 25 years by greening our streets and other legacy assets. We are looking to achieve federal mandates for water quality goals using a sustainable, cost-effective approach that provides significant long-term economic development benefits and a resiliency to our city's infrastructure network.

Philadelphia contains over 2,500 miles of streets that produce large quantities of polluted stormwater runoff. Green stormwater infrastructure projects on streets, or simply "green streets," manage this stormwater to minimize the amount of pollutants that reach our waterways during rain storms. As we witness the effects of climate change causing storms of greater frequency and severity, the green infrastructure we build on our streets is an added safeguard that can help mitigate flash flooding during such events.

Green streets also increase the safety and walkability of our streets and beautify our city. Vegetated bump-outs improve pedestrian and bicycle safety and stormwater tree trenches and planters create lush streetscapes. All of these green street practices improve air quality and minimize the urban heat island effect by reducing pavement and adding greenery. With green streets, we can show how we've taken buried wealth—money that would have been spent on building underground pipes—and brought it to the surface to create dynamic public infrastructure.

The key to the success of green streets is to develop a seamless process whereby stormwater management, street engineering and landscape design come together to produce a functional, attractive and cost-efficient project. This manual provides a toolkit for city agencies, contractors and private partners to achieve that goal.

The Green Streets Design Manual is the product of numerous conversations between the Philadelphia Water Department, the Philadelphia Streets Department, and other stakeholders who work hard to keep our street network safe, efficient and appealing to users of all types. The result is a compilation of finely-tuned design templates that are detailed enough to be informative to design professionals, yet flexible enough to be applied to a variety of urban street conditions.

Ultimately, this manual is one of many tools that will enable the City of Philadelphia to set the national standard for quality and efficiency in green infrastructure design, and to instill each and every one of its public projects with a triple bottom line.

Howard M. Neukrug, P.E., BCEE
Water Commissioner

Acknowledgements

City of Philadelphia

Honorable Michael A. Nutter, *Mayor*
Rina Cutler, *Deputy Mayor for Transportation and Utilities*
Howard Neukrug, *Water Commissioner*

We would like to thank the Philadelphia Green Streets Design Manual Steering Committee participants for their investment of time, energy, and knowledge that helped make this manual a cohesive document, helpful to numerous types of users.

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Southeast Pennsylvania Transit Authority (SEPTA)
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We would also like to thank the members of the Technical Review Committee and technical and graphics consultants for their many hours spent creating, developing, and illustrating every aspect of Philadelphia Green Streets, including both the technical details and the implementation process.

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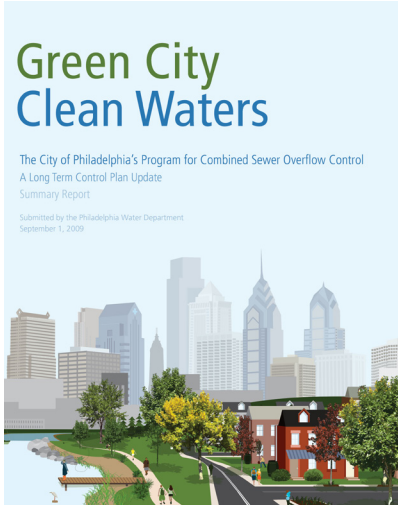


Green City, Clean Waters represents the City of Philadelphia's (City) commitment to the protection and enhancement of our regional watersheds by managing stormwater with innovative green stormwater infrastructure (GSI), while also helping to revitalize the City.

The Philadelphia Water Department (Water Department) developed *Green City, Clean Waters* to provide a clear pathway to a sustainable future while strengthening the utility, broadening its mission, and complying with environmental laws and regulations. As the City agency charged with ensuring compliance with the Federal Clean Water Act, the Water Department developed an infrastructure management program intended to protect and enhance our region's waterways by managing stormwater runoff in a way that significantly reduces reliance on construction of additional underground infrastructure. At the close of the 25 year implementation period, the Water Department will have invested more than $2 billion on the largest green stormwater infrastructure program ever envisioned in the United States. The full *Green City, Clean Waters* plan is available for download at: http://www.phillywatersheds.org/what_were_doing/documents_and_data/cso_long_term_control_plan.

Greened Acres

The Water Department's commitment to achieving the *Green City, Clean Waters* goals is measured in a unit called the Greened Acre. A Greened Acre represents one acre of impervious cover within the combined sewer system drainage area that uses green stormwater infrastructure to manage at least the first inch of stormwater runoff.

Greened Acres

A Greened Acre is an expression of the volume of stormwater in acre-inches, managed by green stormwater infrastructure.

Greened Acres (GA) are calculated using the following equation:

$$GA = IC \times Wd$$

IC is the impervious cover utilizing green stormwater infrastructure (acres). This quantity can include the area of the stormwater management feature itself, as well as the area that drains to it.

Wd is the depth of water over the impervious surface that can be physically managed in the facility (inches). Green stormwater infrastructure designs will aim to control at least 1 inch of runoff, and up to 1.5 inches of runoff, unless otherwise deemed feasible by engineering design.

The Water Department's *Green City, Clean Waters* program includes a 25-year commitment to manage more than one-third of the impervious cover within the sections of the City served by combined sewers, thereby creating at least 9,564 Greened Acres.

Water quality and quantity benefits will also be realized in areas of the City of Philadelphia served by separate sewers as green stormwater infrastructure is implemented.

1.2 What is Green Stormwater Infrastructure?

Urbanization has altered the natural landscape and affected the hydrologic cycle. Where the natural hydrologic cycle maintains a balance of water circulation through evaporation, precipitation, infiltration/groundwater recharge, and absorption and transpiration by plants, urbanization has resulted in an altered hydrologic cycle through construction of impervious surfaces such as buildings, roads and parking lots. The amount of groundwater recharge has been reduced while the volume and rate of runoff has been increased. For decades the philosophy of urban stormwater management was to collect stormwater runoff as quickly as possible, remove it from the surface and either discharge it directly to waterways or transport it for treatment and discharge to the rivers.

Green stormwater infrastructure (GSI) includes a range of soil-water-plant systems that intercept stormwater, infiltrate a portion of it into the ground, evaporate a portion of it into the air, and in some cases, release a portion of the captured stormwater slowly back into the sewer collection system. GSI treats stormwater runoff as a resource to be incorporated into the urban environment instead of as a waste product requiring removal and treatment.

By altering the way stormwater is managed in the City, there are a broad range of benefits for residents, including:

- Small, decentralized green stormwater infrastructure systems introduce vegetated areas back into a paved landscape. These systems provide localized storage to reduce the flows within the existing sewer network.
- Routing stormwater to GSI can slow down the flow, which provides some opportunity for infiltration and evaporation, partially restoring the natural hydrologic cycle.
- Vegetated practices filter runoff, increasing the time it takes for runoff to reach the sewer collection system, improving water quality.
- Infiltrating systems reduce the volume of runoff that enters the sewer collection system for treatment, thereby reducing the operational cost of sewage treatment.
- The use of alternative conveyance practices may reduce the amount of pipe and collection structures needed for a given project.
- Vegetated systems improve air quality, improve habitat, reduce the urban heat island effect, and increase the value of nearby properties.

Implementing Green Stormwater Infrastructure

Integrating GSI into a highly developed area such as the City of Philadelphia requires both a creative and strategic approach to planning and design. The *Green City, Clean Waters* Implementation and Adaptive Management Plan (December 2011) outlined three programmatic components for accruing GAs.

1. Water Department-initiated GSI projects

The Water Department will continue to collaborate with partners to leverage opportunities to maximize GSI investments and proactively embark on a number of strategic planning processes for identifying GSI projects. An initial set of strategies for Water Department-sponsored projects includes:

- Implementing Green Streets
- Implementing GSI on Water Department-owned facilities
- Initiating large-scale planning and implementation of Stormwater Planning Districts (SPDs)
- Coordinating and leveraging opportunities for greening of schools and schoolyards
- Greening of publicly owned parking facilities
- Evaluation of greening opportunities on vacant lands
- Additional strategic initiatives as identified by the Water Department

2. GSI coordinated with "public works" projects

Critical to the City's realization of *Green City, Clean Waters* goals is the creation of standard practices to follow the City's public works investments, including the Water Department's water and sewer replacement projects, Streets Department initiated projects, PennDOT projects, and Philadelphia Parks & Recreation installations of street trees with stormwater management features. The Water Department is calling this collective set of tools the "follow the public works" component of the program due to the opportunity to implement GSI as a standard procedure on public works investments. To this end, the Water Department is committed to incorporating GSI into the planning and design of water and sewer projects by synchronizing the traditional infrastructure design process with the GSI design process. At present, the Water Department replaces roughly 18-20 miles of water mains and 6-8 miles of sewers citywide each year.

This programmatic component will be significantly supported through the development of this Green Streets Design Manual.

3. Private investment

The City of Philadelphia's Stormwater Regulations require onsite stormwater management, including controls to improve the quality of stormwater prior to discharge; controls to reduce the erosive effects of stormwater; and measures to increase groundwater recharge. With a citywide redevelopment rate of .5 to 1% per year, over the 25-year program an estimated 3,000 to 6,000 GAs could be achieved by private development within the combined sewer system drainage area. This manual provides a tool for the private development community to use as they consider the benefits of adding GSI to their project frontages and streetscapes.

1.3 Why a Green Streets Design Manual?

The City of Philadelphia has 2,575 miles of streets comprising approximately 30% of the impervious cover in the City. Consequently, focusing on incorporating GSI into the street environment presents a sizeable opportunity to meet the goals of the *Green City, Clean Waters* program.

Green streets present opportunities to manage stormwater while maintaining the primary function of the street for vehicles and pedestrians. A green street acts as a local stormwater management system, capturing stormwater runoff, allowing it to soak into soil, filtering it and, at the same time, reducing the amount of stormwater that would otherwise make its way into Philadelphia's sewer collection system.

Many Philadelphia City agencies have been engaged in the piloting of green streets. The Water Department continues to partner with the City of Philadelphia Streets Department (Streets), the Pennsylvania Department of Transportation (PennDOT), the Philadelphia Department of Parks & Recreation, the Department of Commerce, utility providers and a number of special service districts throughout the City. The Water Department has focused on demonstrating various GSI stormwater management practices (SMPs) in the streets, including stormwater trees, bump-outs, permeable pavement, and stormwater tree trenches. The aim is to develop a series of standards and specifications, applicable City-wide for green streets implementation.

1.4 An Evolving Manual

This manual provides guidance for the most common GSI designs that can easily be incorporated into the streets within the City. It is recognized that additional GSI technologies and designs may be added or enhanced over time as additional innovative projects are implemented. Users of this manual will note that Section 2, which details stormwater management practices appropriate for installation within the right-of-way, is split into two categories: "SMPs currently in practice by the Water Department" and "SMPS not yet in practice by the Water Department." Over time, the list of SMPs in use by the Water Department is anticipated to increase, and additional details will be standardized and provided within future updates to this manual. As such, this manual will be updated, as needed, to accommodate new information. Additionally, design professionals have the freedom to propose new and alternative stormwater solutions to address the treatment of stormwater within the public right-of-way. As these alternative solutions are approved and implemented, the Water Department will collect and synthesize information for use in future updates.

1.5 How to Use this Manual

This manual provides guidance for public and private entities, specifically design professionals, interested in incorporating GSI within a given right-of-way. It provides users with design standards, guidance on siting, information on elemental flexibility within SMPs, and an implementation process to guide users through the various steps of planning, design and construction of a green street.

This manual explains the design process for a green street and guides the user through the review process. Using the details in this manual will expedite approval of a green street; however, the designer may propose other options for consideration.

The Water Department developed a GSI Design Requirements and Guidelines Packet that provides requirements and guidelines to be used in the design of GSI projects funded and/or maintained by the Water Department, and is available online at: http://www.phillywatersheds.org/GSI_Design_Resources. The technical design guidelines and requirements established in the Green Streets Design Manual were developed in coordination with this Packet. Users of the Green Streets Design Manual should refer to the Packet for the most current technical design guidance. In 2014, the Packet will be consolidated with PWD documentation on the GSI design process and drawing requirements to form a single technical resource document, the GSI Design Manual. Users of the Green Streets Design Manual should continue to refer to the most curent technical design guidance by referring to the GSI Design Manual.

Additionally, Water Department Design Details and Specifications summarize and reference other Water Department sources of information including the current versions of the PWD Green Infrastructure Standard Details, the PWD Green Master Specification, the PWD GSI Design Requirements and Guidelines Packet, and others. These references are available either online at http://www.phillywatersheds.org/GSI_Design_Resources or can be obtained directly from the Water Department. Users of the Green Streets Design Manual should refer to these references directly for the most current information.

The inclusion of green stormwater infrastructure within the right-of-way is an iterative process requiring assessment and reassessment of both stormwater catchment and urban design goals as they relate to physical conditions of the site. The Manual is outlined to serve the designer in navigating the decision process to determine the appropriate GSI treatments for their given project goals and setting. Note that the new development or redevelopment of privately owned sites generally requires projects to undergo Stormwater Plan Review to ensure compliace with the PWD Stormwater Regulations. This process is separate from the implementation of green streets, and is not covered in this manual but may be complementory. For more information on the Stormwater Plan Review process, please visit the PWD Plan Review homepage at www.pwdplanreview.org.

The Green Streets Manual includes the following components:

- Executive Statements from Rina Cutler, Deputy Mayor for the Office of Transportation and Utilities, and Howard Neukrug, Commissioner of the Philadelphia Water Department.
- Chapter 1 contains an introduction to the City of Philadelphia's *Green City, Clean Waters* program and the role of Green Streets in achieving program goals.
- Chapter 2 introduces SMPs appropriate for installation in the right-of-way.
- Chapter 3 provides a context of Philadelphia streets and applicability of green stormwater solutions within various typologies.
- Chapter 4 provides guidance on locating green stormwater infrastructure systems within various street typologies.
- Chapter 5 presents green stormwater infrastructure design requirements and guidelines.
- Chapter 6 introduces design details and specifications for green stormwater infrastructure within the right-of-way.
- Chapter 7 presents green street implementation policies and procedures for non-PWD entities.
- Appendices – Design details, expanded forms and reference materials.

1.6 Relationships with Other Resources and References

In 2009, Mayor Michael Nutter issued an executive order ensuring that the City's streets would accommodate "all users of the transportation system, be they pedestrians, bicyclists, public transit users, or motor vehicle drivers." In doing so he made a promise that all of the City's streets would be designed, built, and maintained as "Complete Streets." As a result of this Executive Order, the Mayor's Office of Transportation and Utilities developed The Philadelphia Complete Streets Design Handbook to be used by City and State agency staff, design professionals, private developers, community groups, and others involved in the planning and design of streets in Philadelphia. The Philadelphia Green Streets Design Manual is intended to serve as companion document to the Philadelphia Complete Streets Design Handbook and has been developed in coordination to avoid duplicative or conflicting guidance.

Typical street design standards apply to green streets. Information pertaining to review of green streets design by the Philadelphia Streets Department, as well as the Water Department, is provided in Chapter 7. For projects along State Routes, the following PennDOT publications may apply:

- Publication 13M (Design Manual Part 2: Highway Design)

- Publication 35 (Bulletin15: PennDOT Approved Construction Materials)

- Publication 72M (Roadway Construction Standards)

- Publication 408 (Construction Specifications)

- Publication 584 (PennDOT Drainage Manual)

SMPs must be designed in accordance with current PWD standards. Current PWD standards can be found online at http://www.phillywatersheds.org/GSI_Design_Resources.

Additionally, the publication of the Green Streets Design Manual follows a number of related resources including guidebooks and manuals that relate to both stormwater management and to the right-of-way at-large in the context of City of Philadelphia Streets. These related guidebooks and manuals should be used by the designer for reference and additional contextual information where cross-referenced from this Manual. Always refer to the most current guidebooks and manuals.

Some of these relevant materials include:

1. **Philadelphia Water Department. 2009. "Green City, Clean Waters: The City of Philadelphia's CSO Long-term Control Plan Update."**

The City of Philadelphia's *Green City, Clean Waters* commitment was originally documented in their CSO Long-term Control Plan Update in 2009, and later amended in 2011 through a Consent Order and Agreement with the PADEP.

Both the CSO Long-term Control Plan Update and the Consent Order and Agreement are available online at the following location: http://www.phillywatersheds.org/what_were_doing/documents_and_data/cso_long_term_control_plan

2. Philadelphia Water Department. 2011. "Green City, Clean Waters Implementation and Adaptive Management Plan: Consent Order & Agreement Deliverable 1."

This regulatory deliverable provides a strategic framework for the Water Department's approach to implementing the *Green City, Clean Waters* plan during the first five years of the program.

This document is available online for download at the following location: http://phillywatersheds.org/ltcpu/IAMP_body.pdf

3. Philadelphia Water Department. 2011. Stormwater Management Guidance Manual.

The Philadelphia Stormwater Management Guidance Manual has been created to assist developers in meeting the requirements of the Philadelphia Stormwater Regulations. The manual is intended to lead developers through the requirements and expectations of the Water Department in terms of stormwater management. The manual provides guidance for the entire site design process, beginning with initial site design considerations, through the post-construction stormwater management plan submittal elements, and ultimately the acquisition of stormwater plan approval. Note: The Stormwater Management Guidance Manual is a tool to guide private development. The Stormwater Managament Gudiance Manual does not cover the design of GSI in the right-of-way, or any GSI that will be owned and maintained by the Water Department..

This document is available online for download at the following location: http://www.scribd.com/doc/13322624/Stormwater-Management-Guidance-Manual-Ver-20

4. Mayor's Office of Transportation and Utilities. 2012. The Philadelphia Complete Streets Design Handbook.

This handbook was developed to support Mayor Michael Nutter's 2009 Executive Order that the City's streets accommodate "all users of the transportation system, be they pedestrians, bicyclists, public transit users, or motor vehicle drivers."

This document is available online for download at the following location: http://philadelphiastreets.com/handbook.aspx

5. Pennsylvania Department of Transportation (PennDOT). 2013. ADA Reference Guide.

The Pennsylvania Department of Transportation, Engineering District 6-0 produced this reference guide to serve as a design tool to guide contractors, engineers and all those involved with the design and construction of Americans with Disabilities (ADA) compliant curb ramps.

This document is available online for download at the following location: ftp://ftp.dot.state.pa.us/public/districts/District6/ADA/D-6_ADA_Policy_and_Guidance.pdf

6. Philadelphia City Planning Commission. 2012. Philadelphia Pedestrian and Bicycle Plan.

This Plan identifies strategies and specific recommendations to increase the number of people walking and bicycling in the City by improving the safety, connectivity, convenience, and attractiveness of the pedestrian and bicycle networks. This plan also established a new street classification that considers the functional roadway classification, land use characteristics, development density and pedestrian activity level of streets.

This document is available online for download at the following location: http://phila2035.org/wp-content/uploads/2012/06/bikePedfinal2.pdf

7. New Jersey Department of Transportation (NJDOT) and Pennsylvania Department of Transportation (PennDOT). 2008. Smart Transportation Guidebook.

The Smart Transportation Guidebook provides guidance on planning and designing highways and streets that support sustainable and livable communities. Its focus is on non-limited access roadways, from local streets through multi-lane state highways, in Pennsylvania and New Jersey. SEPTA design guidelines include guidance on bump-outs.

This document is available online for download at the following location: http://www.state.nj.us/transportation/community/mobility/pdf/smarttransportationguidebook2008.pdf

8. Southeastern Pennsylvania Transportation Authority (SEPTA). 2012. SEPTA Bus Stop Design Guidelines.

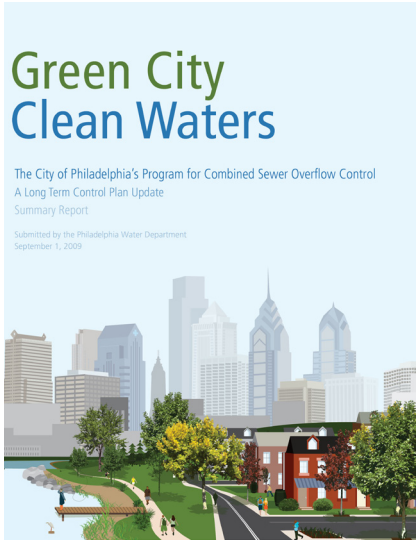
The purpose of this report is to provide municipalities in the SEPTA service area, local developers, and other local partners a consistent set of guidelines for designing surface transit stops. SEPTA design guidelines include guidance on bump-outs.

This document is available online for download at the following location: http://www.dvrpc.org/reports/12025.pdf

9. Pennsylvania Department of Environmental Protection (PADEP). 2005. Pennsylvania Stormwater Best Management Practices Manual.

The Stormwater Best Management Practices Manual provides general guidance from the PADEP on stormwater management for land development processes. The manual is intended to be a tool to achieve a regulatory standard to protect, maintain and improve the Commonwealth's water resources through comprehensive site planning and design guidance.

This document is available online for download at the following location: http://www.elibrary.dep.state.pa.us/dsweb/View/Collection-8305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A Long Term Control Plan Update
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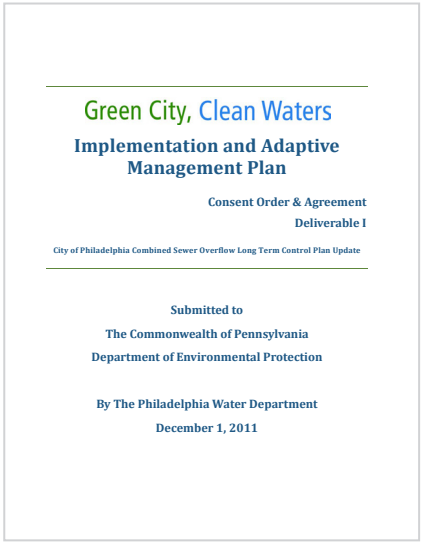
September 1, 2009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The Commonwealth of Pennsylvania
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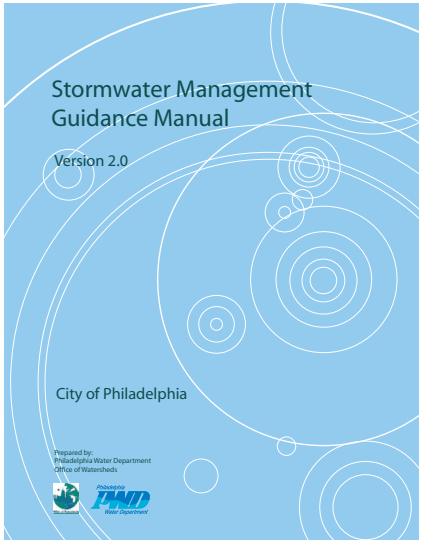
By The Philadelphia Water Department
December 1, 2011


Stormwater Management
Guidance Manual
Version 2.0
City of Philadelphia
Prepared by:
Philadelphia Water Department
Office of Watersheds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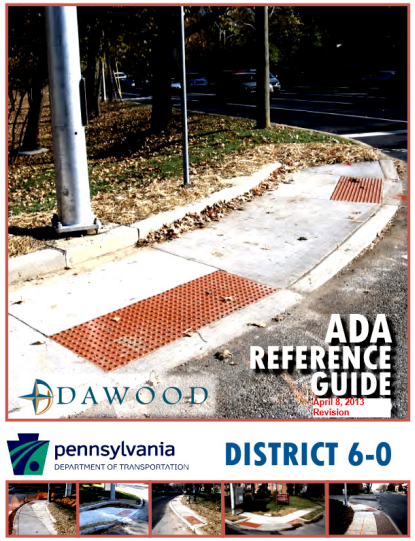
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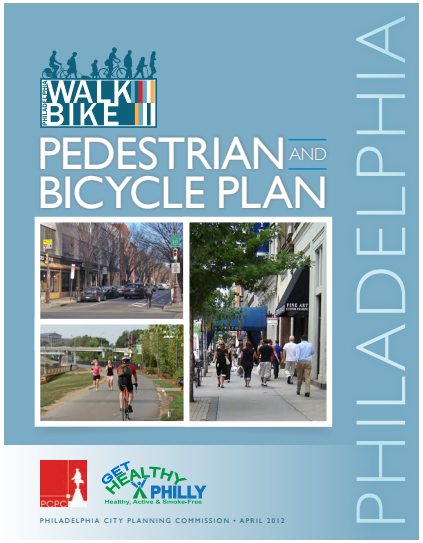
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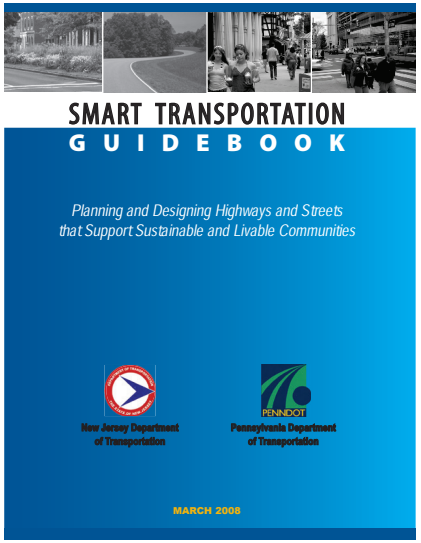
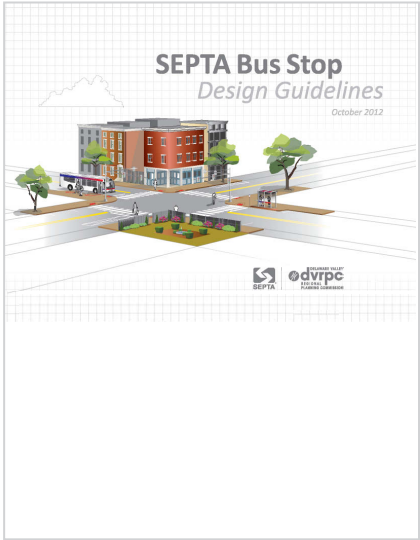

SMART TRANSPORTATION
GUIDEBOOK
Planning and Designing Highways and Streets
that Support Sustainable and Livable Communities
New Jersey Department of Transportation
Pennsylvania Department of Transportation
MARCH 2008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Design Guidelines
October 2012
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Green Street Stormwater Management Practices

chapter 2

2.1 Introduction to Stormwater Management Practices (SMPs) Appropriate for the Right-of-Way

Within this Manual, a variety of designs are presented: Stormwater Planters, Stormwater Bump-outs, Stormwater Trees, Stormwater Tree Trenches, Permeable Pavement. Each of these SMPs is designed to help infiltrate and detain stormwater runoff within the right-of-way.

Any GSI proposed in the right-of-way must consider the effects the SMPs will have on the existing street and all of its users, including motorists, bicyclists, and pedestrians. Well-designed SMPs with rich plantings and quality building materials can be a centerpiece, gateway feature or community enhancement near residences, parks, plazas, bus stops, and in parking areas. Plant material within green stormwater infrastructure facilities can be selected to tolerate salts, drought and temporary inundation, depending on individual site conditions. Additionally, their visibility at the street level provides opportunities for green stormwater infrastructure-related educational and interpretive signage.

Storage and treatment capacity can be increased by connecting green stormwater infrastructure facilities so that they operate as one system along the street. Multiple facilities can treat more runoff, and the total street system must be designed to respond to the many different site conditions that might promote, or negate, the use of certain facilities.

Stormwater management practices are divided into two categories for the purposes of this manual. For those currently in use by the Water Department, typical design and related standards are provided. For those not yet in practice, which will be evaluated through piloting and application in the coming years, standards will be developed and incorporated in a future version of the manual.

2.2 Stormwater Management Practices – Currently Used

Over the past decade, the Water Department has made a significant commitment to the design and construction of GSI demonstration projects throughout the City. By implementing a number of projects aimed at demonstrating the utility of various green stormwater control technologies in highly urbanized areas, the Water Department has helped to raise awareness of GSI among City residents and the regulatory community.

The following practices have been implemented within the City of Philadelphia:

- Stormwater Trees
- Stormwater Tree Trenches
- Stormwater Planters
- Permeable Pavement
- Stormwater Bump-outs (midblock and corner)

2.3 Stormwater Management Practices – Under Development

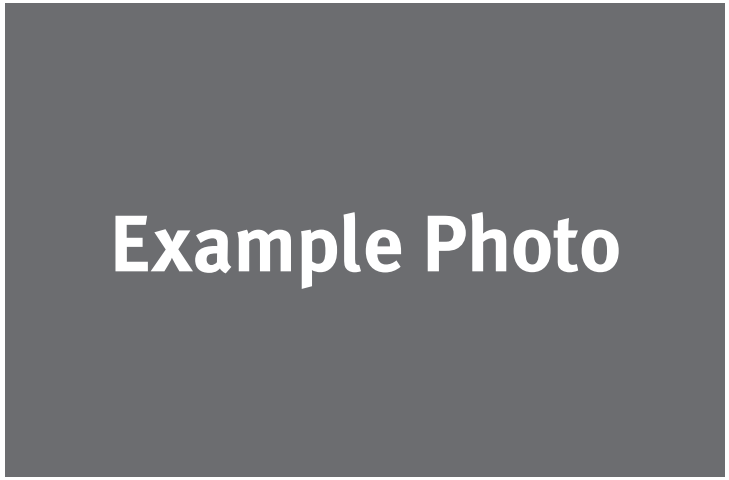
There are a number of stormwater management practices deemed appropriate for use within the right-of-way in other cities, however application of such practices has not yet been piloted within the City of Philadelphia. This section of the manual is intended to be amended as additional stormwater management techniques are identified and proposed for application on Philadelphia streets.

Two such SMPs are currently being piloted, and may become typical SMPs in the future.

- Green Gutters
- Stormwater Drainage Wells

Note that these SMPs are not exhaustive of all types of GSI practices. Other SMPs may be designed and implemented depending on the need or context.

SMP Fact Sheets



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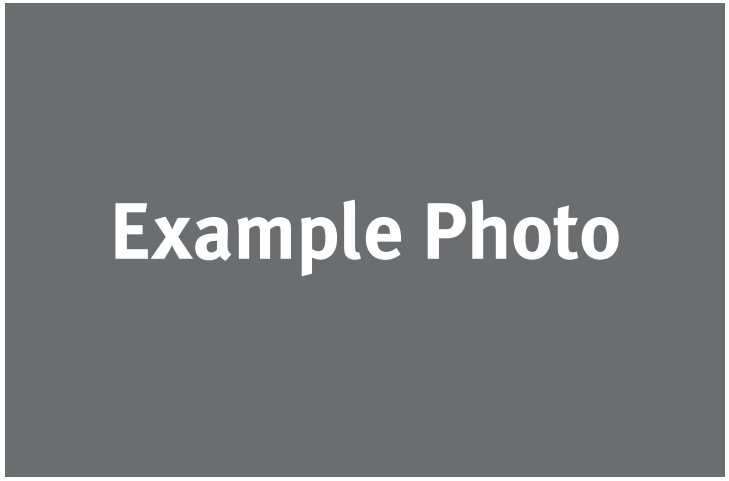


Photo Caption

Overview

A general description of the SMP is provided, including information about its function and aesthetics.

Benefits

- Information regarding benefits associated with the given SMP are listed.

Potential Constraints and Considerations

- Potential constraints and considerations associated with the use of a particular SMP in a given street context are highlighted.

Interaction with Bicyclists and Pedestrians

- Potential for an SMP to have implications on bicyclists and/or pedestrians are highlighted

Urban Design Context

- A description of how this SMP fits in with or complements the urban design context is provided.

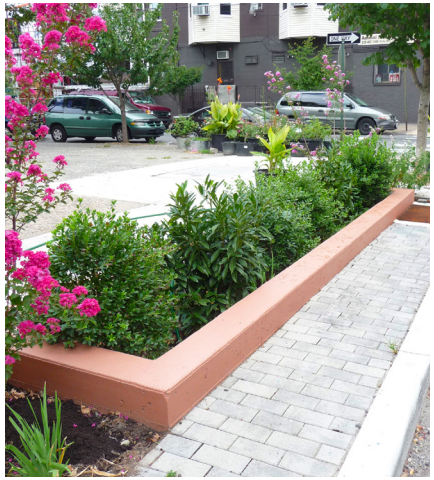
Maintenance

- A general overview of maintenance tasks associated with a given SMP are noted.

Examples

- Examples of projects in Philadelphia where this SMP has been implemented are provided.

Stormwater Planter



Columbus Square

The Philadelphia Navy Yard

Overview

A stormwater planter is a specialized, landscaped planter installed in the sidewalk area and designed to manage stormwater runoff. Runoff is routed to the planter by setting the top of the planting media in the planter lower than the street's gutter elevation and connecting the planter to one or more inlets (types vary), allowing stormwater runoff from the street to flow into the planter. Runoff from the adjacent sidewalk can flow directly into the stormwater planter from the surface. Plantings are incorporated within the facility to provide uptake of water and pollutants. Though stormwater planters can be designed in a variety of shapes and sizes, they are typically rectangular in form with vertical sidewalls on all four sides and an open bottom.

Benefits

- Water filters through the planting soil, improving water quality.
- Provides a physical buffer between pedestrians and the street.
- Creates aesthetic improvements to streetscape.
- Can be sized and placed to fit between existing surface features such as driveways, signs, street furnishings, and street trees.
- Provides an area within the right-of-way for smaller plantings in addition to street trees.

Potential Constraints and Considerations

- Requires adequate sidewalk width to accommodate both the planter and pedestrian circulation; refer to the Complete Streets Design Handbook, Section 4.3.2
- Can sometimes be challenging to limit interior depth of planter depending on surrounding surface grades.
- Must consider step-out areas for on-street parking or vehicle stopping.

Interaction with Bicyclists and Pedestrians

- Provides a separation between pedestrians and moving traffic.
- May intrude into the walking zone a maximum width of two feet, maximum length of 10 feet, and a minimum spacing of 30 feet. Refer to the Complete Streets Design Handbook, Section 4.3.2.

Urban Design Context

- Provides a formal streetscape element.
- Edge treatment may contribute to streetscape design (i.e., a perimeter wall could be designed to function as a seat wall, a perimeter fence could be an aesthetic feature, or the edging may include artistic elements).
- Stormwater Planters are designated as a priority design treatment for all street types by the Complete Streets Design Handbook.

Maintenance

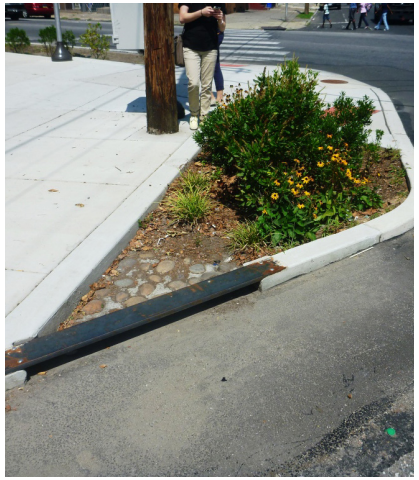
- Routine landscape maintenance needed, such as trimming, watering during droughts, weeding, and litter removal, etc.
- Routine cleaning of inlets and pipes is required.

Examples

- Columbus Square
- The Philadelphia Navy Yard

Figure 2.1: Three-Dimensional View of a Stormwater Planter

Stormwater Bump-out



Shepard Recreation Center Corner Bump-out

Queen Lane Mid-Block Bump-out

Overview

A stormwater bump-out is a landscaped curb extension that extends the existing curb line into the cartway. It is designed to manage stormwater runoff by setting the top of the planting media in the bump-out lower than the street's gutter elevation and connecting the bump-out to one or more inlets (types vary), which allows stormwater runoff from the street to flow into the bump-outs. Runoff from the adjacent sidewalk can flow directly into the stormwater bump-out from the surface. They are designed to capture, slow, and infiltrate stormwater within a planted area or subsurface stone bed. Landscape plantings within the curb extension effectively take up some of the stormwater through their root systems. The remaining stormwater is temporarily stored within the curb extension until it either infiltrates or drains back to the sewer. In mid-block bump-outs, overflow exits through an opening on the downstream side, and flows into a nearby storm drain inlet.

Benefits

- Water filters through the planting soil, improving water quality.
- Provides a physical buffer between pedestrians and the street.
- Does not require encroachment into sidewalk area.
- Encourages slower vehicle speeds by physically and visually narrowing the street.
- Reduces pedestrian crossing distances when used at intersections.
- Provides an area within the right-of-way for smaller plantings in addition to street trees.

Potential Constraints and Considerations

- Must consider existing on-street parking conditions, street width, and vehicle turning radii.
- Alteration of existing curb line will directly impact existing street drainage patterns and bump-out design must ensure existing street drainage is not negatively impacted.
- Vegetation must accommodate adequate sight distances at intersections.

Interaction with Bicyclists and Pedestrians

- Placement should avoid rerouting bicyclists.
- If placed near an intersection, care may be taken to accommodate pedestrian passage through the curb extension, which can limit its stormwater treatment capacity.
- Mid-block bump-outs should not encourage unwanted mid-block pedestrian crossings.

Urban Design Context

- May be integrated with a pedestrian seating area or transit shelter.
- The Complete Streets Design Handbook refers to these practices as Curb Extensions. Curb extensions are designated as a priority design treatment at local / local and local / major street intersections, as well as intersections wth complex geometry, by the Complete Streets Design Handbook.

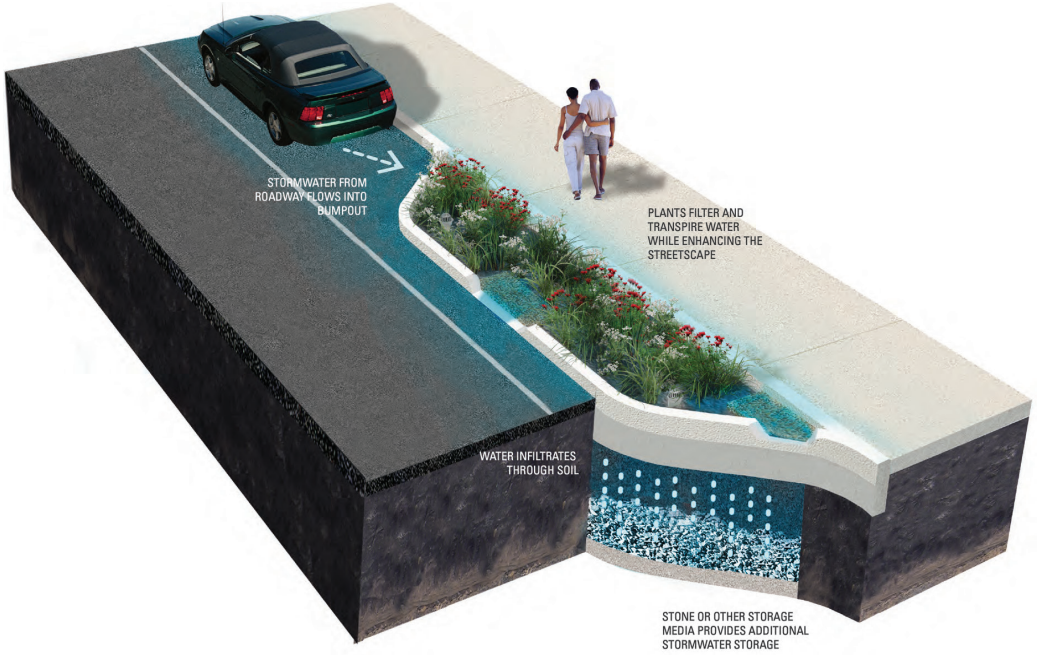
Maintenance

- Routine landscape maintenance, such as trimming, watering during droughts, weed and litter removal, etc.
- Routine cleaning of inlets and pipes is required.

Examples

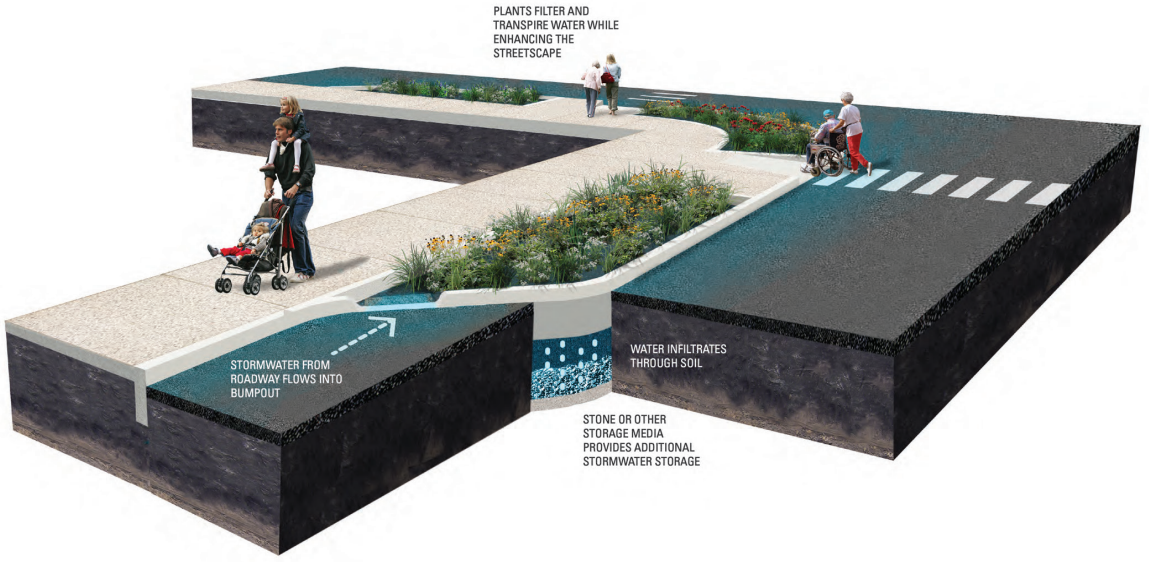
- Midblock Bump-outs: Queen Lane
- Corner Bump-outs: Shepard Rec Center at 56th and Vine; Daroff School at 57th and Haverford; 3rd and Fairmount

Figure 2.2: Three-Dimensional View of a Stormwater Bump-out



Mid-block Stormwater Bump-out

Corner Stormwater Bump-out



Stormwater Tree

Stormwater Tree Precedent

Overview

A stormwater tree is a street tree planted in a specialized tree pit installed in the sidewalk area. It is designed to manage stormwater runoff by placing the top of the planting media in the tree pit lower than the street's gutter elevation and connecting the tree pit to an inlet (types vary), which allows stormwater runoff from the street into the tree pit. Runoff from the adjacent sidewalk can flow directly into the tree pit from the sidewalk surface. Multiple tree pits can be designed in series to maximize the potential for stormwater capture and treatment. Stormwater will either infiltrate or drain to a connection to the storm sewer network. If the stormwater tree is at capacity, runoff can bypass the stormwater tree inlet and enter other downstream SMPs or a downstream storm drain.

Benefits

- Adds street trees to the streetscape.
- Requires only a small footprint and can therefore fit within a constrained site.
- Can accommodate steep topographic changes.
- Can fit between existing street furnishings such as signs, benches, hydrants and lights.

Potential Constraints and Considerations

- Limited stormwater management capacity.
- Recessed elevation of tree pit requires consideration for protecting pedestrians from step down to surface of planting media.

Interaction with Bicyclists and Pedestrians

- Street trees provide the benefit of shade and a vertical separation between pedestrians and moving traffic.
- May intrude into the walking zone a maximum width of two feet, maximum length of five feet, and minimum spacing at 30 feet. Refer to the Complete Streets Design Handbook, Section 4.3.2.

Urban Design Context

- Enhances streetscape with street trees.

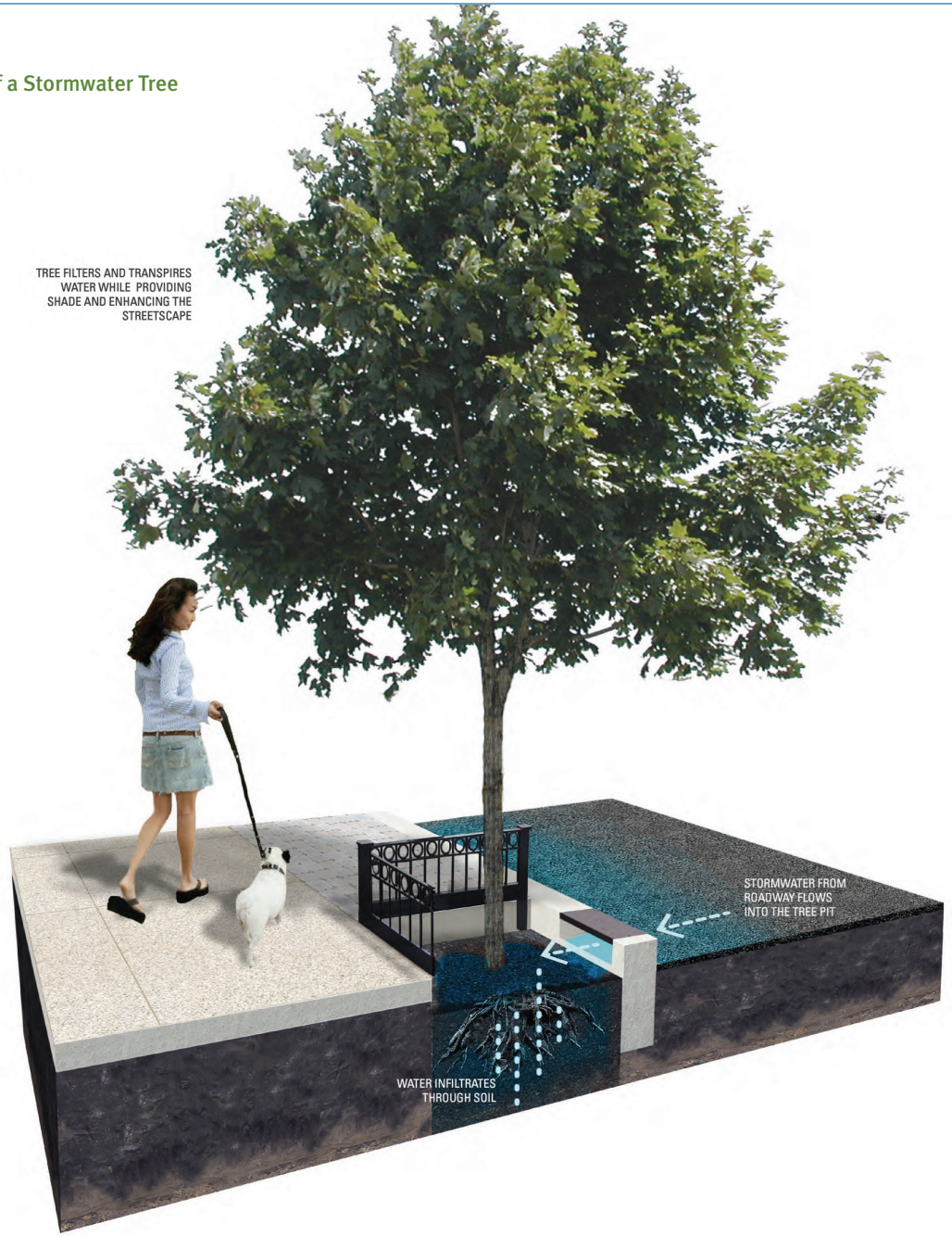
Maintenance

- Routine tree maintenance and litter removal.

Examples:

- Norris Street
- Sepviva Street
- Shissler Recreation Center

Figure 2.3: Three-Dimensional View of a Stormwater Tree



Stormwater Tree Trench

Ben Franklin Parkway

Shissler Recreation Center

Overview

A stormwater tree trench is a subsurface trench installed in the sidewalk area that includes a series of street trees along along a section or the total length of the subsurface trench. It is designed to manage stormwater runoff by connecting the subsurface trench to one or more inlets (types vary), which allows runoff from the street and sidewalk to flow into the subsurface trench. The runoff is stored in the empty spaces between the stones or other storage media in the trench, watering the trees and slowly infiltrating through the trench bottom. If the capacity of the system is exceeded, stormwater runoff can bypass the storm drain entirely and flow into an existing inlet downstream or through an underdrain system connected to the storm drain network. The surface above the trench and surrounding the street trees is restored to the elevation of the surrounding surfaces.

Benefits

- Ability to store a large volume of stormwater
- Adds street trees to the streetscape.
- Impact to existing sidewalk width, use, and surface features is similar to that of typical street tree planting because sidewalk surface is restored to grade.

Potential Constraints and Considerations

- Because flow is directed to the subsurface of the system, special attention should be paid to pretreatment.

Interaction with Bicyclists and Pedestrians

- Does not impede bicycle or pedestrian movement.

Urban Design Context

- Enhances streetscape with some or all of the following: street trees, tree grates, unit pavers.

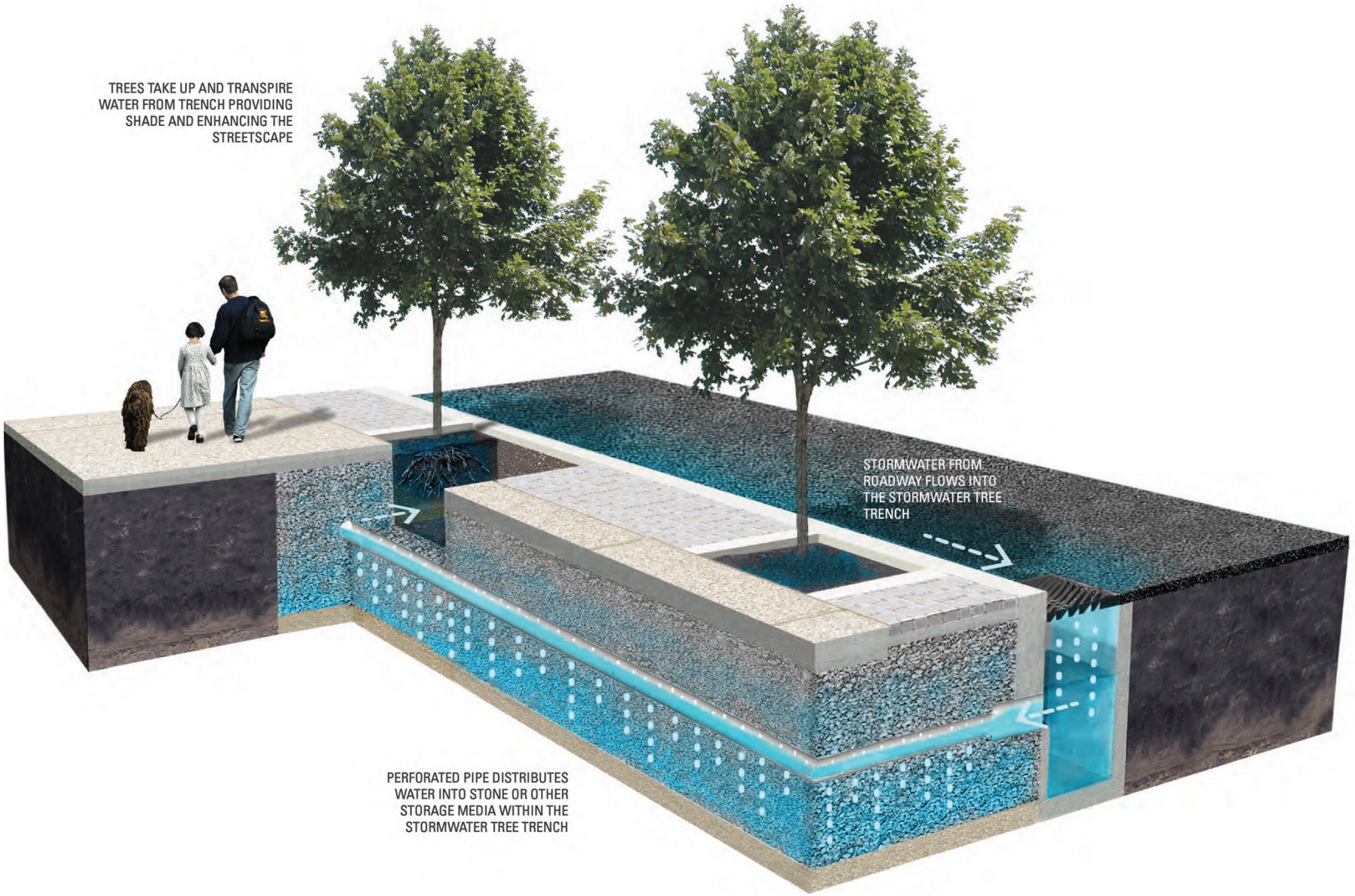
Maintenance

- Routine landscape maintenance of street trees.
- Routine cleaning of inlets and pipes is required.

Examples

- Waterview Recreation Center
- 16th and Snyder
- Ben Franklin Parkway
- Shissler Recreation Center

Figure 2.4: Three-Dimensional View of a Stormwater Tree Trench



Permeable Pavement

Percy Street

Waterview Recreation Center

Overview

Permeable pavement is a hard pavement surface consisting of materials that allow water to pass freely through the surface, thereby eliminating or reducing runoff compared to impervious paving. Permeable pavement surfaces typically include a storage media such as stone beneath the permeable surface that provides the structural support of conventional pavement and also provides temporary storage of stormwater. Permeable pavement, sometimes referred to as pervious or permeable paving/pavement, includes different types of permeable surfaces such as permeable asphalt, permeable concrete, and permeable pavers. While permeable asphalt and permeable concrete materials allow water to pass through the surface of the asphalt or concrete, permeable pavers typically allow water to pass through the joint spacing between the pavers.

Benefits

- Provides stormwater management while maintaining paved and other hardscape surfaces.
- Can be implemented in lieu of traditional pavement replacement projects.

Potential Constraints and Considerations

- Many streets in Philadelphia include an impervious concrete sub-base which would have to be removed for permeable pavement to be effective.
- Design must consider traffic loading and volume conditions.
- Designs may not allow stormwater to drain onto permeable pavements from other areas without approval by the Water Department.

Interaction with Bicyclists and Pedestrians

- Interlocking pavers should not be used in bike lanes.

Urban Design Context

- Alternating permeable paving types can help differentiate surfaces by modal use.

Maintenance

- Periodic clean out or vacuuming of surface is required.
- Ensure that no sediment builds up on the pavement. Remove sources of sediment such as erodible soils in nearby landscaped areas.

Examples:

- Percy Street (Permeable Asphalt)
- Waterview Recreation Center (Permeable Concrete)
- Queen Lane (Permeable Pavers)

Figure 2.5: Three-Dimensional View of Permeable Pavement

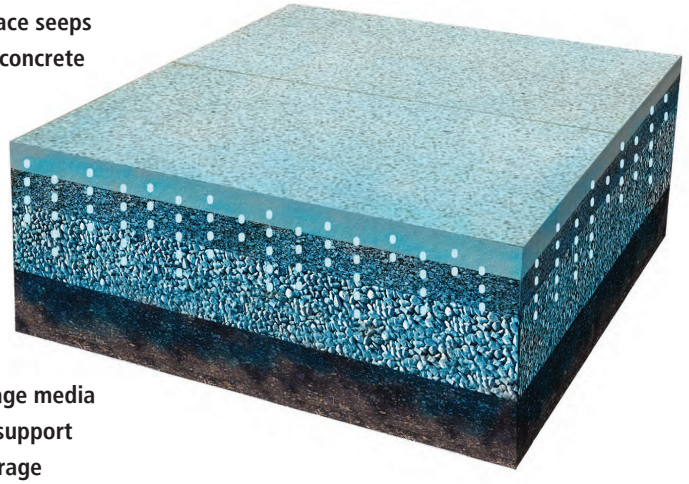
Permeable Asphalt

Stormwater on surface seeps through permeable asphalt

Stone or other storage media provides structural support and stormwater storage

Permeable Concrete

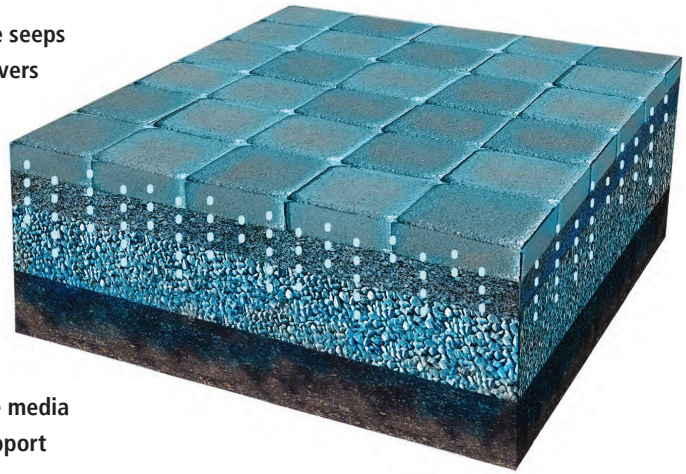
Stormwater on surface seeps through permeable concrete



Stone or other storage media provides structural support and stormwater storage

Permeable Paver

Stormwater on surface seeps through permeable pavers



Stone or other storage media provides structural support and stormwater storage

Green Gutter

Portland, OR precedent

Overview

A green gutter is a narrow and shallow landscaped strip along a street's curb line. It is designed to manage stormwater runoff by placing the top of the planting media in the green gutter lower than the street's gutter elevation allowing stormwater runoff from both the street and sidewalk to flow directly into the green gutter. An elevated curb can be used along the street side of the green gutter with openings along its length to allow runoff to flow into the green gutter. Green gutters can be designed to infiltrate and/or flow to the existing storm sewer. The system attenuates storm-water flows, provides storage and, in some cases, infiltration and evapotranspiration. In flow-through green gutters, overflow runoff can be conveyed to the existing storm drain system, either through an underdrain tied to the existing storm drain system, or as shallow concentrated flow that is conveyed downstream to an existing inlet.

Benefits

- Provides a physical buffer between pedestrians and the street when an elevated street side curb is used.
- Does not require encroachment into sidewalk area.
- Provides an area within the right-of-way for smaller plantings.

Potential Constraints and Considerations

- Must consider existing on-street parking conditions and street width.
- Landscape materials must accommodate direct impact of gutter flow velocity.

Interaction with Bicyclists and Pedestrians

- Edge treatments should prevent pedestrian and bicyclists from stepping into the green gutter area.
- Placement should occur outside of bike lanes.

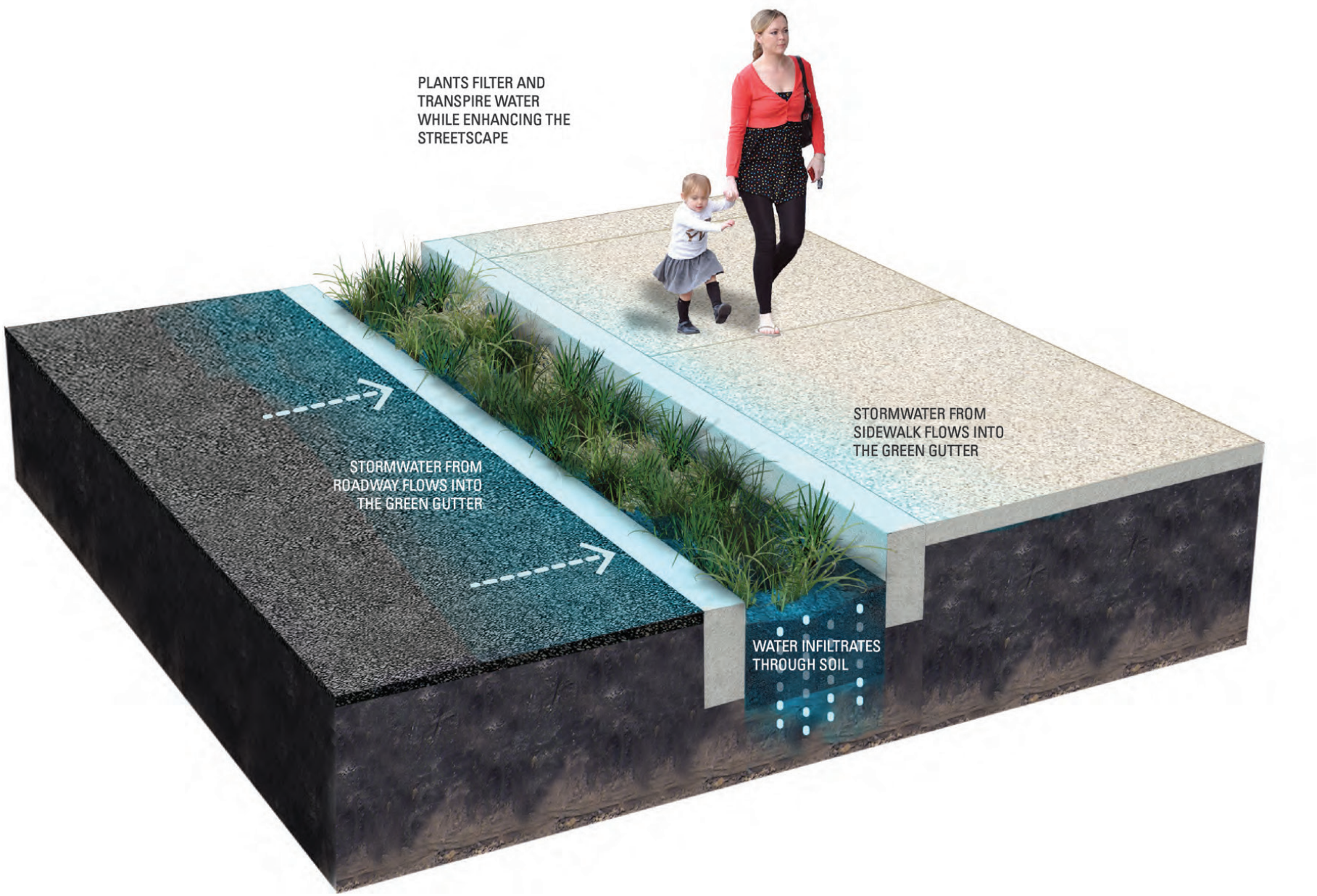
Urban Design Context

- Consider opportunities where there is no on-street parking and/or wide shoulders.
- May not be appropriate in high volume pedestrian areas.

Maintenance

- Routine landscape maintenance.

Figure 2.6: Three-Dimensional View of a Green Gutter



Stormwater Drainage Well

Overview

A stormwater dainage well is designed to manage stormwater runoff by receiving stormwater from upstream collection and pretreatment systems and then discharging the stormwater into the surrounding soils through perforations in the manhole.

Benefits

- Small footprint with potentially large storage volume.
- Potential option where other SMPs are not applicable.

Potential Constraints and Considerations

- The minimum allowable separation between the bottom of the stormwater drainage well and seasonal high ground water is two feet.
- The minimum allowable separation between the bottom of the stormwater drainage well and the top of bedrock is three feet.
- The minimum allowable separation between the stormwater drainage well and building foundations is 20 feet.
- Design sizing may be based on methods other than static storage of the runoff volume. Consult PWD for guidance.

Interaction with Bicyclists and Pedestrians

- Stormwater drainage wells would not impact bicyclists or pedestrians any differently than a normal manhole cover.

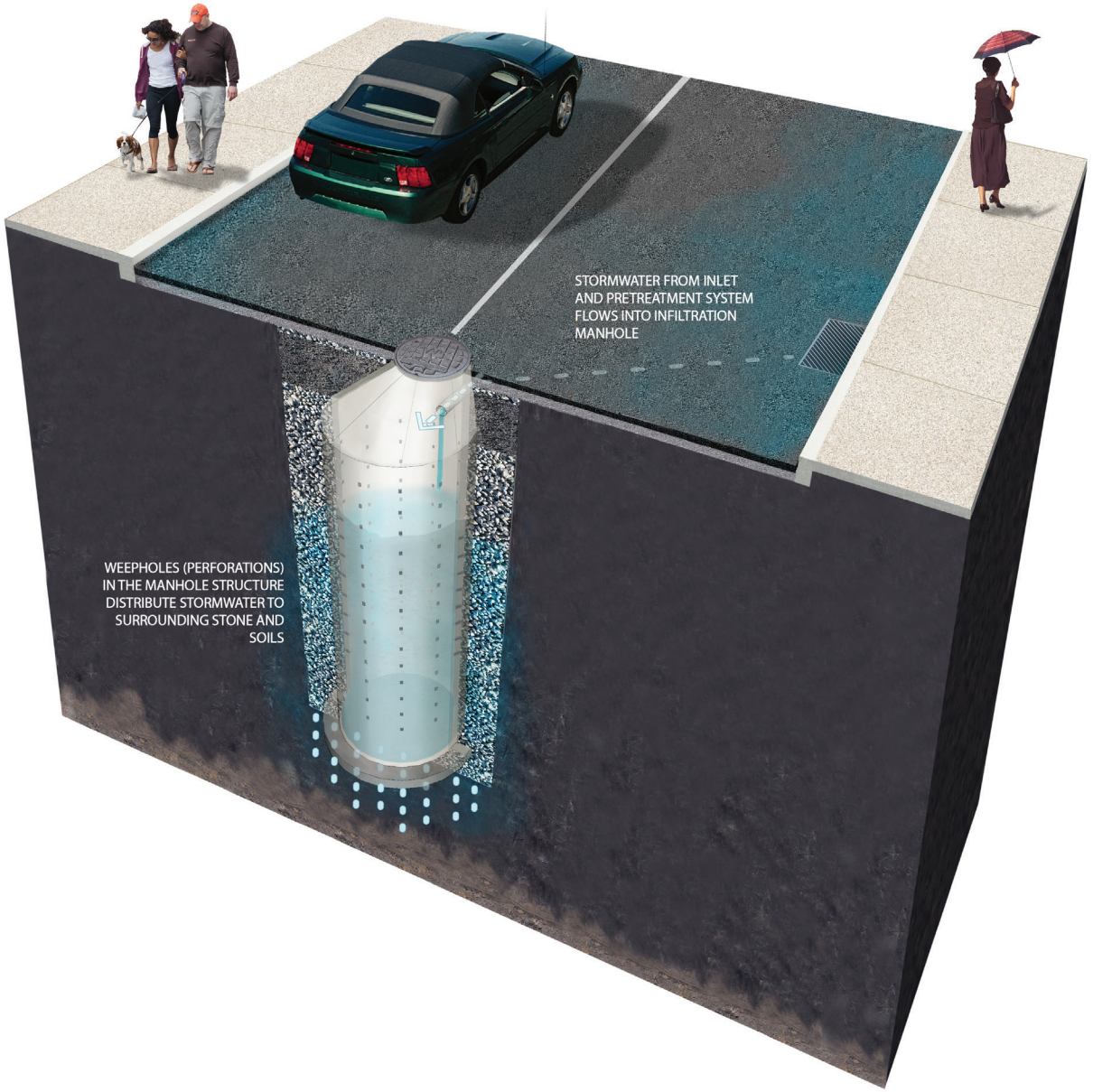
Urban Design Context

- These stormwater management practices are completely below ground with only a manhole cover on the surface; as such, stormwater drainage wells do not impact the urban design context any differently than a normal manhole.
- These SMPs can be used in combination with other SMPs to increase the stormwater management and aesthetic benefits.

Maintenance

- Designed such that stormwater introduced to the stormwater drainage well has already passed through a system that provides a high level of pretreatment, stormwater drainage wells themselves require relatively little maintenance. However, maintenance of the upstream pretreatment system, which varies, will be required.

Figure 2.7: Three-Dimensional View of a Stormwater Drainage Well



Philadelphia Streets

chapter 3

3.1 Philadelphia Streets - History

The City of Philadelphia has a rich history with strong roots in its streets; Philadelphia was one of the first cities in North America to use a rectilinear grid system. This was a part of City founder William Penn's vision to develop a city with orderly design to safeguard against issues such as overcrowding, fire, and disease. Realization of the grid system in Philadelphia included wide streets to efficiently convey traffic and allow for safe evacuation, if needed, and smaller streets for light traffic and pedestrian access to neighborhood destinations.

3.2 Philadelphia Street Typology

In modern day Philadelphia, the rectilinear grid system is still evident, though the scope and scale has changed dramatically. Today, the City has 2,575 miles of streets that come in a diversity of widths and serve a variety of users, purposes, and surrounding land use types. There are a variety of perspectives from which planners, designers, and users view City streets, a few of which will be explored within this section as these diverse perspectives can provide context to the process of evaluating the potential for implementing green stormwater infrastructure on each street segment.

3.2.1 Functional Classification of Roadways

A functional classification of the street network has been defined for the City of Philadelphia using a system similar to the U.S. Federal Highway Administration's functional classification system. A summary of the characteristics of each roadway class (excluding expressways) and the total linear miles by type in Philadelphia is included in Table 3.1. This functional classification of roadways is based primarily on the needs and characteristics of motor vehicle travel.

Table 3.1: City of Philadelphia Functional Classification of Roadways

Functional Classification	Description	Miles of Streets Within this Category
Low-Speed Ramp	On- and off-ramps connecting expressways to street network.	19
Major Arterial	Provides service to through traffic or long trips. Typically a multi-lane road and usually divided. High traffic volumes.	259
Minor Arterial	Provides service for moderate length trips. Medium to high volume traffic.	362
Collector	Provides traffic circulation within neighborhoods and small areas. Connects local roads to arterial system. Lower traffic volumes than arterials.	874
Local	Mainly provides access to abutting properties. Low traffic volumes.	1,103
Non-Travel	Roads that are closed to traffic or cannot be driven on.	35

(Source: Pedestrian and Bicycle Plan 2012)

3.2.2 New Street Types

Public streets are one of the most valuable infrastructure assets a city has. As such, the competition for their use among stakeholders is constant. Recognizing that the City's roadway network has varying demands, many of which are non-vehicular, the Philadelphia City Planning Commission (PCPC) embarked on a bicycle and pedestrian planning process in 2008 that resulted in the City's first pedestrian plan and an update to the City's 2000 bicycle plan. Through this planning process, PCPC re-evaluated the use of the functional classification of streets in this user context and developed a new categorization of street types for the City's roadways to provide a more context-sensitive classification to streets. The new classification considers the functional roadway classification, land-use characteristics, development density, and pedestrian activity level of streets. The new street types are considered supplemental to the functional classification and intended to inform planning decisions when opportunities arise for altering existing or reviewing new streets and sidewalks as part of development projects. Table 3.2 includes the new street type matrix as outlined in the City of Philadelphia's Pedestrian and Bicycle Plan (2012) and the Complete Streets Design Handbook (2012).

Table 3.2: Street Types Defined within the Philadelphia Pedestrian and Bicycle Plan

Type	Description	Miles of Streets Within this Category
High-Volume Pedestrian	• Important pedestrian destinations or connectors in high-density commercial, residential, and mixed use neighborhoods. • Serve more than 1,200 pedestrians per hour during the midday. • Many of these streets also provide important connections for vehicle traffic and serve high vehicle volumes.	5
Civic/Ceremonial Street	• This small group of streets has great symbolic importance, house major ceremonial functions, and play a unique role in the life of the City (i.e., Broad Street, Market Street, and the Parkway). • Sidewalks operate as generous pedestrian promenades. • As major arterials, these streets also have high vehicle significance.	13
Walkable Commercial Corridor	• Active commercial corridors with pedestrian-friendly physical development patterns. • Most buildings meet the street line, and parking lots are not a dominant feature. • Parking and access needs of local businesses often compete for limited right-of-way with pedestrian and bicycle facility needs. • Have lower pedestrian volumes than High-Volume Pedestrian Streets, but are more pedestrian-friendly than Auto-Oriented Commercial areas. • Land use is commercial and mixed use, with some residential and institutional.	37
Urban Arterial	• Major and minor arterials that carry through traffic. • Usually have surface transit routes and must provide adequate pedestrian facilities to allow safe and comfortable access and waiting areas for transit users. • Generally have more travel lanes and vehicles travelling at higher speeds than most other street types. • Land use varies; most often commercial, residential, or institutional.	384
Auto Oriented Commercial/Industrial	• Development pattern is auto-oriented, i.e, with buildings set back significantly from the street, frequent drivewayss, and parking lots in front. • These streets do not provide a pedestrian-friendly environment and are not likely to attract high levels of pedestrian activity other than at transit stops and individual activity centers. • Land use is commercial, auto services, or industrial.	64

Table 3.2: Street Types Defined within the Philadelphia Pedestrian and Bicycle Plan

Park Road	• Minor arterials, collectors, and local roads that provide transportation for vehicles and pedestrians within parks. • Typically have lower speed limits compared to Scenic Drives. • Should include shared-use side paths for pedestrians and bicyclists and/or sidewalks and bike lanes or shared roadway facilities.	21
Scenic Drive	• Major arterials and some minor arterials that provide a scenic view along parks or waterways. • Relatively high volume streets with speeds higher than Park Roads and Local streets. • Land use is typically park land, but may include low density residential with heavy tree canopy. • Should include shared-use side paths for pedestrians and bicyclists and/or sidewalks and bike lanes or shared roadway facilities.	26
City Neighborhood	• Include the majority of the grid streets in older sections of Philadelphia. • Minor arterial and collector streets with commercial mixed use and higher density residential. • The fronts of buildings on these streets typically meet the street line (edge of sidewalk), unlike Low-Density Residential streets where dwellings are set back from the sidewalk.	678
Low-Density Residential	• Collector and local streets provide traffic circulation and access through residential neighborhoods with some commercial, recreational, and institutional uses. • Generally constructed more recently than City Neighborhood Streets and are characterized by dwellings that are set back from the sidewalk.	517
Shared Narrow	• Very narrow local streets, primarily located in older areas of the City. • Sidewalks also tend to be narrow on these streets, but pedestrians and bicyclists can generally walk and ride comfortably in the street. • Right-of-way no more than 30 feet wide; cartway no more than 13 feet wide; no on-street parking.	24
Local	• Smaller streets providing access to properties in residential or non-residential neighborhoods. • Includes service streets and minor residential streets. • Parking is provided on at least one side of the street and sidewalks are usually present.	842

(Source: Pedestrian and Bicycle Plan 2010)

3.3 GSI Suitability and Typology

The factors described within this section help to provide a street-based context for consideration by planners and designers as they evaluate streets for greening opportunities and may help to inform the selection of a site-appropriate system. Aside from the ability to capture, infiltrate and slow stormwater runoff, demands on a street's physical distribution of space, the volumes and provisions made for multiple modes, and the relationship to adjacent land uses may dictate whether or not a site has the space and characteristics to accommodate a given type of green stormwater infrastructure.

The following Suitability Matrix (Figure 3.1) has been developed to provide a snapshot view of green stormwater infrastructure systems that are appropriate to a given roadway type as defined in the Philadelphia Pedestrian and Bicycle Plan. As noted in the Complete Streets Design Handbook, it is not uncommon for a street's type to change from one block to another. Streetscape improvements should be implemented to provide consistent design along routes and smooth transitions from one street type to another, and should include a consistent set of design treatments that are easily understandable to motorists, bicyclists, and pedestrians. These treatments should be carefully selected to accommodate all roadway users, encourage predictable and desirable travel behavior, and account for the different uses and contexts of various street types throughout the City.

Figure 3.1: SMP Suitability Matrix

	High-Volume Pedestrian	Civic / Ceremonial	Walkable Commercial Corridor	Urban Arterial	Auto-Oriented Commercial / Industrial	Park Road	Scenic Drive	City Neighborhood Street	Low Density Residential	Shared Narrow	Local
Stormwater Bump-out											
Midblock	●	●	●	●	●	●	●	●	●	●	●
Corner	●	●	●	●	●	●	●	●	●	●	●
Stormwater Tree Trench	●	●	●	●	●	●	●	●	●	●	●
Stormwater Tree	●	●	●	●	●	●	●	●	●	●	●
Planter	●	●	●	●	●	●	●	●	●	●	●
Permeable Pavement	●	●*	●*	●*	●*	●	●	●	●	●	●
Green Gutter	●	●	●	●	●	●	●	●	●	●	●
Stormwater Drainage Well	●	●	●	●	●	●	●	●	●	●	●

**Treatment is appropriate for use within pedestrian, bicycle, parking, and shoulder areas only*

● Recommended

● Possible, but there is probably a better choice

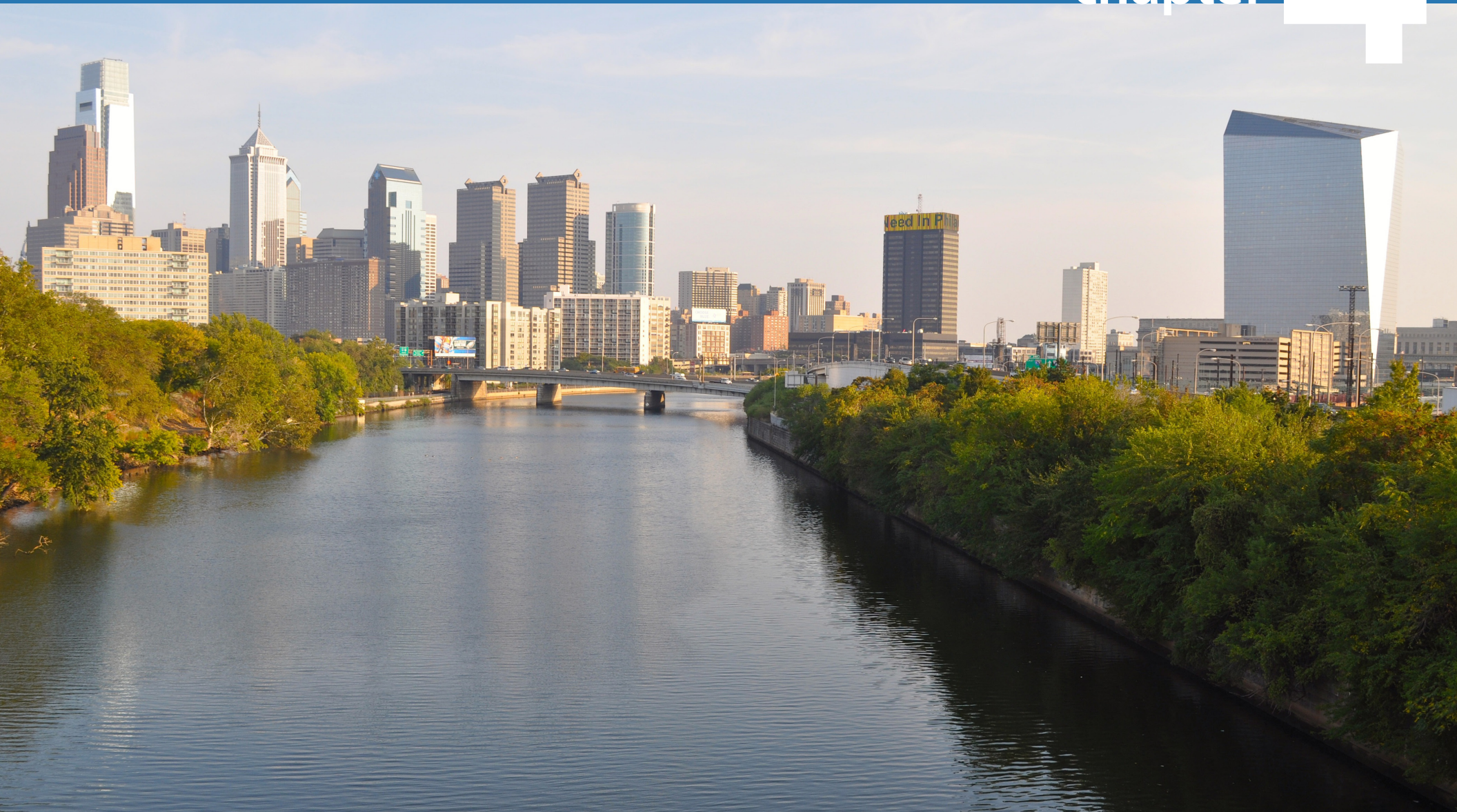
● Not recommended

Note: For installations along State Routes, coordinate with PennDOT to identify appropriate recommended treatments.

Note: The criteria by which an SMP is determined to be recommended, possible, or not recommended for a given street are explored further in Chapter 4.

Siting Green Stormwater Infrastructure Systems

chapter 4



4.1 Green Stormwater Infrastructure Locations within the Right-of-Way

Street rights-of-way comprise approximately 38 percent of the total impervious area within the combined sewer area in Philadelphia. Impervious areas within the rights-of-way contain zones dedicated to certain uses. These zones, or "components," fully described in the Philadelphia Complete Streets Design Handbook, include the following:

- Vehicle/Cartway – Area used for travel by motorized vehicles and bicycles.
- Curbside – Areas adjacent to the cartway that provide buffers between the cartway and other zones. Curbside uses include road shoulders and on-street parking.
- Furnishing – Area between the curb and the pedestrian zone that incorporates design elements such as trees, signage, lighting, and streetscape furnishings.
- Pedestrian – Area used for pedestrian travel.

Refer to Figure 4.1 for an illustration of typical complete street components within the right-of-way. Refer to the Complete Streets Design Handbook for more information on the characteristics of these components.

GSI systems can not only be appropriately incorporated into streets, but can also help define these zones. A GSI SMP refers to a specific practice, such as a stormwater planter or stormwater tree trench. The term system refers to multiple SMPs that are hydraulically connected, or to a single SMP that is hydraulically connected to another stormwater storage system. GSI SMPs and systems can organize the physical environment, orienting users by providing design elements to support appropriate uses within certain zones and neighborhood contexts.

As previously noted in Chapter 2, this Manual presents the following five (5) SMPs that may be typically incorporated into street rights-of-way in Philadelphia:

- Stormwater Bump-outs
- Stormwater Trees
- Stormwater Tree Trenches
- Stormwater Planters
- Permeable Pavement

Additionally, the following two (2) SMPs are currently being piloted, and may become typical SMPs in the future:

- Green Gutters
- Stormwater Drainage Wells

Refer to Figure 4.2 for a plan view diagram showing a typical layout of SMPs within the street right-of-way.

Note that these SMPs are not exhaustive of all types of GSI practices. Other practices may be designed and implemented depending on the need and context. Other practices not included in this Manual may include practices such as rain gardens and vegetated swales.

Figure 4.1: Complete Street Components

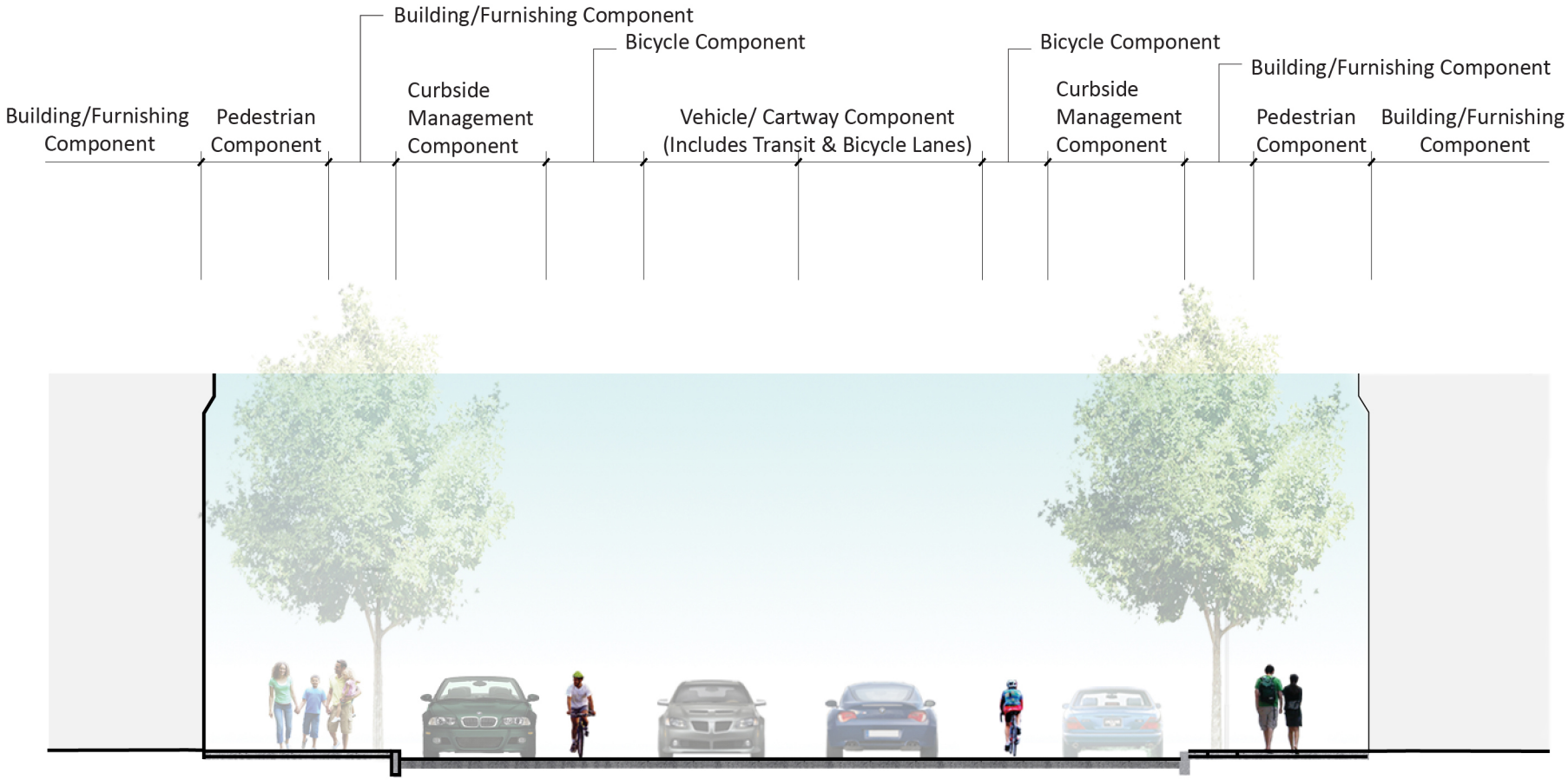
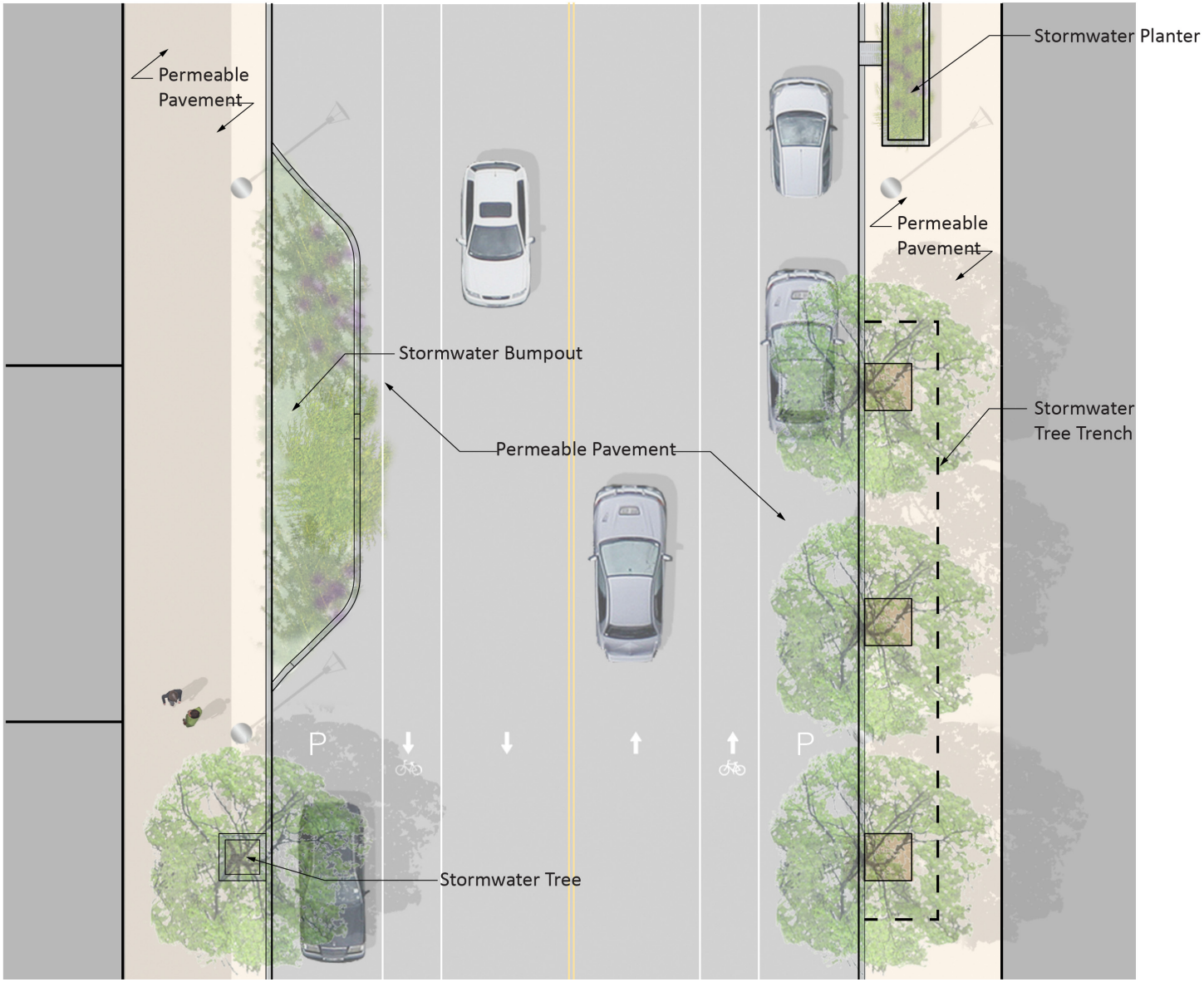


Figure 4.2: Plan View of typical SMP layout within street right-of-way



4.2 Siting Strategies for Green Street Applications

The following procedure should be used to evaluate potential GSI SMPs and systems and to select the most appropriate alternative:

1. Identify potential streets where GSI can be implemented based on existing conditions.

- Obtain pertinent site information to:
  - Determine longitudinal gradient and cross-slope of street
  - Locate the system to maximize the drainage area
  - Recognize and avoid conflicts such as underground utilities and overhead wires.
  - Consider the preliminary sizing for proposed SMPs. Refer to Chapter 5 for design criteria.

2. Identify the street's typology.

- Use site survey, GIS, aerial photography, and site photography, and refer to the Philadelphia Complete Streets Design Handbook to:
  - Identify the street type (Complete Streets Design Handbook Chapter 3)
  - Identify the street pedestrian component (Complete Streets Design Handbook Chapter 4.3)
  - Identify the building and furnishing component (Complete Streets Design Handbook Chapter 4.4)
  - Identify the bicycle component (Complete Streets Design Handbook Chapter 4.5)
  - Identify the curbside management component (Complete Streets Design Handbook Chapter 4.6)
  - Identify the vehicle/cartway component (Complete Streets Design Handbook Chapter 4.7)

1

2

3

3. Consider potential GSI SMPs and systems.

- Use this Manual, including the Suitability Matrix (Figure 3.1) together with the considerations outlined in Section 4.3, the example siting scenarios outlined in Section 4.4, and other relevant factors to identify potential GSI SMPs and systems.

4

4. Choose the most appropriate GSI SMPs and systems.

- Use this Manual, including the considerations outlined in Section 4.3, the example siting scenarios outlined in Section 4.4, and other relevant factors, to choose the most appropriate GSI SMPs and systems.
- As design proceeds, return to the list of potential GSI SMPs and systems to consider alternatives if unforeseen problems make those selections infeasible.

Section 7.1 of this Manual outlines the requirements for entities proposing to construct GSI within the right-of-way. Approvals by appropriate City agencies will be issued at each phase of the project. Refer to Section 7.1 for detailed information on proposing and designing GSI in the right-of-way, and submitting GSI in the right-of-way for permits.

4.3 Technical Design Considerations

When siting GSI SMPs and systems within the right-of-way, all applicable technical design considerations must be evaluated. Each consideration may affect the choice of the most appropriate SMP or siting location. Technical design considerations include, but are not limited to, the following steps:

- Use the strategy outlined in Section 4.2 to choose the most appropriate GSI SMPs or systems for the given location.
- Identify open space available for GSI installation while maximizing drainage area capture potential.
- Using site mapping and survey information, delineate the specific drainage area that can be captured by each individual SMP within the chosen GSI system.
- Perform infiltration testing in accordance with the GSI Design Requirements and Guidelines packet.
- Consider the maximum impervious area loading ratio in determining the required footprint of each SMP or system.
- Compute the required storage volume needed in each SMP or system to manage one inch or more of runoff from the impervious area draining to each SMP or system.
- Provide the required storage volume above the ground surface (ponded).
- Where it is not possible to provide all or part of the required storage volume as surface level and/or ponded storage, provide the remaining volume as subsurface storage.
- Design inlets, as described in Section 5.3, to be able to fully capture the required storage volume.
- Place systems with underdrains in locations where underdrains can easily be tied-in to a proposed structure and back to the existing sewer.

4.3.1 Soil Conditions

In designing GSI SMPs and systems, the designer may encounter soil conditions where the soils drain too slowly for infiltration or, conversely, too rapidly. In addition, environmental contamination, high water table, bedrock, or obstructions may make infilitration infeasible. Soil investigations will be discussed further in Section 5.3.

4.3.2 Steep Topography

Steep slopes, in excess of approximately 5 percent grade, create several challenges to incorporating GSI SMPs and systems within street rights-of-way:

- The bottoms of GSI SMPs designed for infiltration should be level. Creating SMPs with level bottoms on slopes may increase the required space and material needed to construct a proposed SMP to manage a given volume of stormwater runoff.
  - Terracing with check dams or berms within the SMP is a key design strategy. This keeps the SMP bottom flat while minimizing the space and material for stormwater management.
- High velocities of runoff entering GSI SMPs or systems can create erosive entrance conditions within systems.
  - The engineer must design SMP entrance points to prevent erosive conditions and dissipate energy. Entrance points may be stabilized with various energy dissipation design components and methods. Refer to Appendix 6.2, Section ED, Energy Dissipation.
- High velocities of runoff flowing along a street may have a greater potential to bypass entrances to GSI SMPs or systems.
  - The engineer must design SMP or system entrance points to capture the required runoff volume. Techniques to ensure the runoff is captured include providing sufficiently sized stormwater entrances and adding shallow depressions in front of the entrances such as curb cuts, within the gutter, where appropriate. Refer to Appendix 6.2, Section SE, Stormwater Entrance and Entrance Related.

4.3.3 Designing around Utilities

Utilities will almost certainly be located near proposed GSI SMPs within street rights-of-way.

The designer should request PA One Call information for all potential GSI locations before proceeding with design. PA One Call can be reached by dialing 811 or calling 1-800-242-1776.

Please refer to Appendix 7.2 for utility contact information.

Overhead wires may interfere with trees selected for GSI SMPs. Appropriate trees should be selected for GSI SMPs, based on anticipated mature tree height and overhead wire locations.

The designer is cautioned that drawings and field mark outs provided by utilities may not be accurate. During construction, the actual utility locations and dimensions must be confirmed, and field changes to the proposed GSI SMP or system may be required in coordination with affected utilities. The construction drawings should provide notification that the Contractor should stop work and contact the appropriate parties when unanticipated utility locations or conditions are encountered.

Stormwater Infiltration Impacts to Utilities

The following considerations should be made when designing GSI SMPs in the vicinity of other utilities:

- Where other utilities are adjacent to proposed GSI SMPs, a horizontal setback of at least two feet, or as required by the affected utility, is recommended. Setbacks apply to existing lighting and utility poles as well as underground utilities.
- Where other utilities are located below proposed GSI SMPs, infiltrated stormwater may tend to move along preferential flow paths within utility bedding material rather than infiltrate into the existing soil subgrade as intended. An impermeable liner such as a geomembrane placed on the bottom of the GSI SMP along the length of the utility and to a certain width on either side of it is an option to reduce this potential impact.
- Where other utilities cross through a proposed GSI SMP, setbacks of undisturbed excavation area around utilities that cross through an SMP should be determined based on input from the utility owner. The utility may elect to concrete-encase, replace, move, or request setbacks from excavation and infiltration. Where utilities are allowed to cross through an SMP, a utility sleeve must be placed around the utility. Impervious waterstops, such as anti-seep collars, must be used where the utility enters and exits the SMP.
- The placement of a GSI SMP may limit future access to a buried utility that is within or below the SMP. If future replacement or repair is needed, the repair could involve disturbance of the SMP, adding to project costs and potentially damaging the GSI SMP or system. For this reason, all GSI SMPs and systems should be designed to avoid placement above or across utilities to the greatest extent possible. The designer should coordinate with the Water Department and the affected utility to define the specific project requirements.

The designer should be aware that each utility may have different or stricter requirements than discussed above.

4.3.4 Future Maintenance

The designer should consider long-term maintenance requirements when designing GSI systems. The designer should specifically consider access to inlets and flow control devices, placement of observation wells, and potential locations of maintenance equipment access within the street right-of-way.

4.4 Example Siting Scenarios

The following are five (5) example GSI system siting scenarios: Local Street; City Neighborhood Street; Low Density Residential Street, and two examples of Urban Arterial Streets. Note that these examples do not necessarily represent a required or optimal GSI design for all comparable street types and widths. These examples are shown here for illustration purposes.

4.4.1 Narrow, Local Street

Figure 4.3 – Local Street — Existing Conditions

When evaluating this street segment, the following characteristics are highlighted:

- Narrow street in residential neighborhood
- Single-lane cartway with one lane of parking and sidewalks
- Moderate to high demand for street parking
- Uniform sidewalk cross slope toward street; street crowned in middle
- Existing inlets at corners
- Some street trees on right side of street; no vegetation or shade on left side of street
- Stoops and steps in front of houses appropriate for neighborhood setting
- Light vehicle and pedestrian traffic

Local, from Figure 3.1

Stormwater Bump-out	
Midblock	●
Corner	●
Stormwater Tree Trench	●
Stormwater Tree	●
Planter	●
Permeable Pavement	●
Green Gutter	●
Stormwater Drainage Well	●

● Recommended

● Possible, but there is probably a better choice

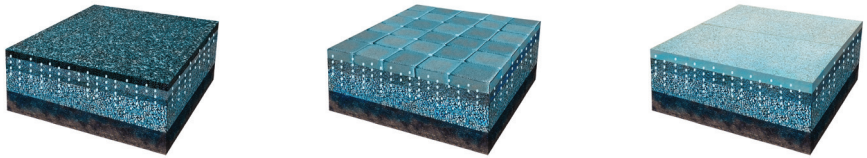
● Not recommended

Figure 4.4 – Local Street — Rendered Visualization of Selected GSI System

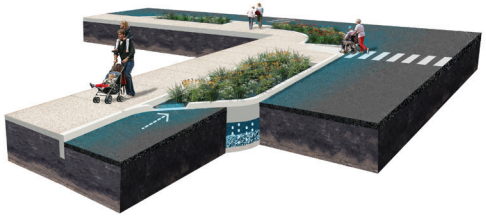
Imagining this street retrofitted with green stormwater infrastructure, the Water Department highlights the following points:

- Ideal location for permeable pavements
- Bump-outs may be used at corners if turning radii allow, but typically would not be recommended mid-block because of street width and parking demand. Refer to the Complete Streets Design Handbook, Section 4.7.1.
- Tree trenches, stormwater trees, and planters may not be feasible due to narrow sidewalks. Consider creative methods of narrowing the typical planting width in order to maintain required pedestrian zones. Refer to the Complete Streets Design Handbook, Section 4.3.2.

Permeable Pavements



Corner Bump-out



4.4.2 City Neighborhood Street

Figure 4.5 – City Neighborhood Street — Existing Conditions

When evaluating this street segment, the following characteristics are highlighted:

- City Neighborhood Street in a mixed residential and commercial neighborhood
- Single-lane cartway with two lanes of parking and sidewalks
- High demand for street parking
- Uniform sidewalk cross slope toward street; street crowned in middle
- Existing inlets at corners
- No shade or vegetation on either side of street
- Light to moderate vehicle and pedestrian traffic

City Neighborhood Street, from Figure 3.1

Stormwater Bump-out	
Midblock	●
Corner	●
Stormwater Tree Trench	●
Stormwater Tree	●
Planter	●
Permeable Pavement	●
Green Gutter	●
Stormwater Drainage Well	●

● Recommended

● Possible, but there is probably a better choice

● Not recommended

Figure 4.6 – City Neighborhood Street — Rendered Visualization of Selected GSI System

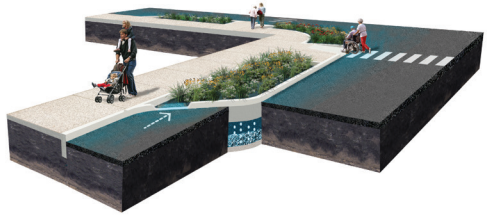
Imagining this street retrofitted with green stormwater infrastructure, the Water Department highlights the following points:

- Bump-outs should be used at corners if turning radii allow, but may not be recommended mid-block due to street width and parking demand. Refer to the Complete Streets Design Handbook, Section 4.7.1.
- Tree trenches may be used if utility conflicts are limited.
- Stormwater trees may be best for neighborhoods with many utility laterals.
- Planters can be considered if a more decorated streetscape is desired. Refer to the Complete Streets Design Handbook, Section 4.3.2.
- Permeable pavements can be considered. On this type of street, permeable pavements may be most appropriate in the parking lane and on the sidewalk.

Stormwater Tree

Stormwater Tree Trench

Corner Bump-out



4.4.3 Low Density Residential Street

Figure 4.7 – Low Density Residential Street — Existing Conditions

Low Density Residential, from Figure 3.1

Stormwater Bump-out	
Midblock	●
Corner	●
Stormwater Tree Trench	●
Stormwater Tree	●
Planter	●
Permeable Pavement	●
Green Gutter	●
Stormwater Drainage Well	●

● Recommended

● Possible, but there is probably a better choice

● Not recommended

When evaluating this street segment, the following characteristics are highlighted:

- Low Density Residential street in a residential neighborhood
- Single-lane cartway with two lanes of parking and sidewalks
- Moderate to high demand for street parking
- Uniform sidewalk cross slope toward street; street crowned in middle
- Existing inlets at corners
- Large trees on both sides of street
- Houses set back from right-of-way; no streetscape furnishings
- Potential moderate vehicle traffic; light pedestrian traffic

Figure 4.8 – Low Density Residential Street — Rendered Visualization of Selected GSI System

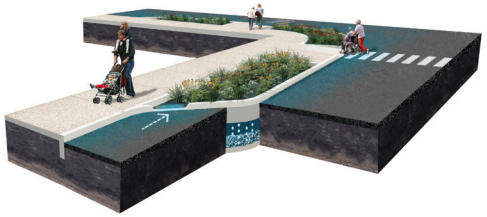
Imagining this street retrofitted with green stormwater infrastructure, the Water Department highlights the following points:

- Bump-outs should be used at corners if turning radii allow. Mid-block bump-outs can be considered if parking demand allows. Street may be wide enough to accommodate bump-outs without exceptions to the Complete Streets Design Handbook, Section 4.7.1.
- Tree trenches may be located where space allows.
- Stormwater trees may be considered if existing trees or utility conflicts make large tree trenches infeasible.
- Sidewalks may be wide enough to accommodate SMPs without exceptions to the Complete Streets Design Handbook, Section 4.3.2.
- Permeable pavements may be considered. Permeable pavers in the parking lane or sidewalk may be appropriate and may beneficially deliver water to existing trees' root systems.

Stormwater Tree

Stormwater Tree Trench

Corner Bump-out



4.4.4 Urban Arterial Street

Figure 4.9 – Urban Arterial Street — Existing Conditions

When evaluating this street segment, the following characteristics are highlighted:

- Urban Arterial street in a mixed residential and commercial neighborhood
- Two-lane cartway with two lanes of parking, two bike lanes, and sidewalks
- High demand for street parking
- Uniform sidewalk cross slope toward street; street crowned in middle
- Existing inlets at corners
- Some street trees on right side of street; no vegetation or shade on left side of street
- Minimal streetscape furnishings, even at bus stop locations
- Potential moderate to heavy vehicle and pedestrian traffic

Urban Arterial, from Figure 3.1

Stormwater Bump-out	
Midblock	●
Corner	●
Stormwater Tree Trench	●
Stormwater Tree	●
Planter	●
Permeable Pavement	●*
Green Gutter	●
Stormwater Drainage Well	●

**Treatment is appropriate for use within pedestrian, bicycle, parking, and shoulder areas only*

● Recommended

● Possible, but there is probably a better choice

● Not recommended

Figure 4.10 – Urban Arterial Street — Rendered Visualization of Selected GSI System

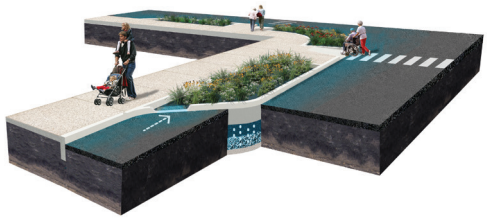
Imagining this street retrofitted with green stormwater infrastructure, the Water Department highlights the following points:

- This street type may be an ideal setting for corner bump-outs, as turning radii are often easier to accomodate on wide streets. Corner bump-outs may also improve the pedestrian experience and make street crossings safer. Mid-block bump-outs can be considered if street width and parking demand allows. Refer to the Complete Streets Design Handbook, Section 4.7.1.
- Tree trenches can be used if utility conflicts are limited.
- Stormwater trees may be considered in neighborhoods where many utility laterals make tree trenches infeasible.
- Planters can be considered if a more decorated streetscape is desired.
- Sidewalks may be wide enough to accommodate SMPs without exceptions to the Complete Streets Design Handbook, Section 4.3.2.
- Permeable pavements should only be considered in bike or parking lanes, or in sidewalks.

Stormwater Tree

Stormwater Tree Trench

Corner Bump-out



4.4.5 Urban Arterial Street

Figure 4.11 – Urban Arterial Street — Existing Conditions

When evaluating this street segment, the following characteristics are highlighted:

- Urban Arterial street in a mixed residential, commercial, and industrial neighborhood
- Five-lane cartway with two lanes of parking, two bike lanes, and sidewalks
- High demand for street parking
- Uniform sidewalk cross slope toward street; street crowned in middle
- Existing inlets at corners
- Some street trees on left side of street; no vegetation or shade on right side of street
- Minimal streetscape furnishings
- Potential moderate to heavy vehicle traffic; moderate pedestrian traffic

Urban Arterial, from Figure 3.1

Stormwater Bump-out	
Midblock	●
Corner	●
Stormwater Tree Trench	●
Stormwater Tree	●
Planter	●
Permeable Pavement	●*
Green Gutter	●
Stormwater Drainage Well	●

**Treatment is appropriate for use within pedestrian, bicycle, parking, and shoulder areas only*

● Recommended

● Possible, but there is probably a better choice

● Not recommended

Figure 4.12 – Urban Arterial Street — Rendered Visualization of Selected GSI System

Imagining this street retrofitted with green stormwater infrastructure, the Water Department highlights the following points:

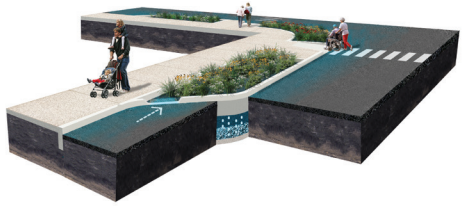
- This street type may be an ideal setting for corner bump-outs, as turning radii are often easier to accommodate on wide streets. A corner bump-out may also improve the pedestrian experience and make street crossings safer. Streets may be wide enoughto accommodate bump-outs without exceptions to the Complete Streets Design Handbook, Section 4.7.1
- Tree trenches can be used if utility conflicts are limited.
- Stormwater trees may be considered in neighborhoods where many utility laterals make tree trenches unfeasible.
- Planters can be considered if a more decorated streetscape is desired.
- Sidewalks may be wide enough to accommodate SMPs without exceptions to the Complete Streets Design Handbook, Section 4.3.2.
- Permeable pavements should only be considered in bike or parking lanes, or in sidewalks.
- Given the width of the street, increasing the size of systems such as bump-outs and planters beyond typical sizing called for in this manual can be considered.

Stormwater Tree

Stormwater Tree Trench

Stormwater Planter

Corner Bump-out



Mid-Block Bump-out

Green Stormwater Infrastructure Design Requirements and Guidelines

chapter 5

5.1 Overview of Design Requirements

This chapter includes information on the design of GSI SMPs and systems. The term SMP refers to a specific practice, such as a stormwater planter or stormwater tree trench. The term system refers to multiple SMPs that are hydraulically connected.

This chapter discusses requirements, which must be followed, and guidelines, which should generally be followed but may contain exceptions. Requirements use the words must and will, while guidelines use words such as can and should. All GSI in the right-of-way is publicly owned. The requirements ensure standard construction of SMP components, so that the Water Department will be able to provide adequate maintenance. Therefore, requirements must always be met, and justification is required for not meeting guidelines.

Appropriate sizing of SMPs and systems and design of inlets to convey runoff into the SMPs and systems are discussed.

5.2 Purposes of GSI Design Requirements

GSI manages stormwater using source control processes of infiltration, evaporation, transpiration, disconnection from sewers, and detention, among others. Systems are generally composed of some combination of vegetation, surface storage, and subsurface storage.

The primary goal of implementing GSI is stormwater volume reduction. Volume reduction provides ancillary benefits including water quality improvement, channel protection, and flood control. Systems are to be sized to manage, at a minimum, the first one inch of stormwater runoff. Inlets are to be designed to convey this volume into the SMP.

Where infiltration is not feasible, stormwater runoff may be detained and slowly released in accordance with the requirements and guidelines provided in this chapter.

5.3 Soil Testing & Requirements

Infiltration is required, unless the designer determines that infiltration is not feasible due to poor infiltration rates, geotechnical considerations, or environmental contamination. If infiltration is not feasible, the storage volume must be drained using a detention and slow release control.

Low Infiltration Rates

Where infiltration rates less than 0.25 inches per hour are measured at the proposed bottom depth of the SMP and the soil below the proposed SMP exhibits an acceptable infiltration rate, the following design options should be considered:

- Lower the proposed bottom of the SMP so that water captured within the SMP can infiltrate through the better draining soil.
- Excavate the poorly draining soil and replace it with an amended or imported soil having an acceptable infiltration rate. However, the engineer must still confirm that the infiltration rate of the soil below the newly introduced amended or imported soil is greater than or equal to 0.25 inches per hour.

Where infiltration rates are less than 0.25 inches per hour and better draining soils are not found underlying the proposed SMP or system, the SMP or system may be designed as a slow-release detention system. Infiltration requirements and guidelines are further discussed in Section 5.5.

Excessively High Infiltration Rates

The primary concern of a rapid infiltration rate is that such a condition may indicate the tested location is hydraulically connected to an underlying void or fissure which could cause land subsidence or damage to adjacent structures. The design engineer must work with a qualified geotechnical engineer to evaluate these concerns.

Where the geotechnical engineer identifies excessively high infiltration rates, the following design options should be considered:

- Excavate the rapidly draining soil and replace it with an amended or imported soil having an acceptable infiltration rate.
- Where it is not feasible to amend or excavate and replace the existing soil, the SMP may be lined with an impermeable liner, such as a geomembrane, and designed as a slow release detention SMP.

5.4 Sizing Requirements

GSI systems must be sized according to both area and volume.

Area

The Water Department generally recommends a maximum loading ratio of 10:1 for infiltration systems, but the ratio can be higher if runoff drains through a surface system. For systems with surface components, the allowable loading ratio is based on the upper horizontal surface of the SMP, where sediment buildbup is expected to occur. Refer to the GSI Design Requirements and Guidelines Packet for more information.

When a system of hydraulically connected SMPs is used to manage runoff from a single drainage area, larger footprint downstream SMPs may be used to account for undersized upstream SMPs. The reverse is not true: oversized upstream SMPs may not be used to account for undersized downstream SMPs.

Volume

GSI SMPs or systems must be sized to capture and manage the required storage volume (V), equal to a minimum of one inch of runoff from the contributing impervious drainage area. Apply Equation 5.1 to compute the required storage volume:

$V = A \times P/12$ (Eq. 5.1)

Where, V = required storage volume (cu. ft.)

A = impervious drainage area (sq. ft.)

P = precipitation = 1 in. or more

When a system of hydraulically connected SMPs is used to manage runoff from a single drainage area, larger volume downstream SMPs may be used to capture overflow from undersized upstream SMPs. The reverse is not true: oversized upstream SMPs may not be used to account for undersized downstream SMPs.

The following values should be used when calculating storage provided by an SMP:

- Open graded, crushed stone aggregate has a porosity of 40 percent.
- Soil in a surface system has a porosity of 20 percent.

Storage provided above the elevation of the overflow control device cannot be counted toward the required storage volume.

The bottom elevation of the SMP must be a minimum of two feet above any infiltration-limiting layer, such as bedrock or seasonal high ground water.

5.5 Additional Requirements

System Drainage

Green stormwater infrastructure systems must completely drain within 72 hours; drain down within 24 hours is recommended.

Soil infiltration testing must be completed prior to design, as noted in the GSI Design Requirements and Guidelines Packet.

Underdrains must be placed in all systems with subsurface storage components. The minimum underdrain pipe length is 20 feet. Any underdrain pipe should have cleanouts every 75 feet, at a minimum as well as at the end of the pipe. Additionally, cleanouts should be located upstream of bends and evenly spaced during straight pipe runs.

Infiltration is preferable to other hydrologic operations. Wherever possible, SMPs or systems should be designed to infiltrate stormwater. As discussed in Section 5.3, if tested infiltration rates are found to be greater than or equal to 0.25 inches per hour and the SMP or system is able to drain completely in 72 hours or less, the SMP or system should be designed for infiltration, and the underdrain should be capped.

Infiltration Next to Buildings or Structures

Adequate separation from adjacent buildings or structures must be maintained to avoid potential basement flooding or damage to buildings.

As a general rule, at least ten (10) feet of separation between infiltrating GSI systems and buildings or structures should be maintained. However, the designer should always evaluate potential structural concerns resulting from proposed GSI systems.

Where potential wet basements are a concern, the depth of the nearby basement should be considered. Assuming a 1 to 1 down spread, the SMP should be placed so that the basement is outside the zone of influence of the infiltration.

Where there are other structural concerns resulting from potential infiltration, the design engineer must work with a qualified geotechnical engineer to evaluate those concerns. The consulting engineer must provide a letter signed and sealed by the geotechnical engineer providing support for the proposed design. The consulting engineer should make this evaluation in any case where there may be structural concerns, even when a proposed SMP is more than ten (10) feet away from adjacent structures. The design engineer is responsible for identifying these concerns and addressing them.

Design Considerations for Detention/Slow Release Systems

The maximum release rate for GSI detention SMPs or systems is 0.05 cubic feet per second (cfs) per acre of impervious drainage area managed. The minimum orifice control diameter that may be used in a GSI SMP or system designed for detention is 0.5 inches.

The following is the design process for extended detention GSI SMPs or systems:

- Determine the orifice control diameter needed to control the discharge to less than or equal to 0.05 cfs per acre of contributing drainage area.
- Evaluate the stage versus discharge relationship of the controlling orifice, based on system geometry.
- Round the required orifice diameter down to the nearest eighth of an inch.
- Ensure 72-hour drain down time.

Inlet Selection and Placement

Stormwater runoff typically enters GSI SMPs or systems through various stormwater entry points such as standard storm inlets with pretreatment (referred to as green inlets), trench drains, or curb openings. Occasionally, stormwater enters the system via sheet flow. In the following discussion, the term stormwater entrance refers to any method of runoff entry into GSI SMPs or systems, including green inlets, trench drains, and curb openings.

Where possible, stormwater entrances should be located directly upstream of existing stormwater inlets to maximize runoff capture from the right-of-way and minimize the length of flow for stormwater runoff bypass. If a stormwater entrance will be placed in a sump condition (where roadway area on all sides of the stormwater entrance is pitched toward it) or will impact existing street drainage, the overflow pathway for runoff that does not enter the stormwater entrance must not cause flooding in the cartway or pedestrian zones or otherwise pose a safety concern.

Inlets must be sized to convey the one-year storm peak runoff rate to the GSI SMP or system; refer to the GSI Design Requirements and Guidelines Packet for more information. PennDOT Standard Inlets may be required on State Routes. PWD Standard inlets are to be used where PennDOT inlets are not required. Refer to Appendix 6.2, functional system FS-2, Stormwater Entrance and Entrance Related for more information.

Clean Washed Stone Aggregate

All subsurface systems must use uniformly graded, clean, washed stone aggregate; refer to Appendix 6.2, design component 7.1.1, Stone for more information.

Erosion and Sediment Controls

Projects must comply with the Erosion and Sediment Controls requirements noted in PA Code, Chapter 102. The implementation and maintenance of erosion and sediment control practices are required to minimize the potential for accelerated erosion and sedimentation, including those areas that disturb less than 5,000 square feet of area. Where proposed eath disturbance is greather than or equal to 5,000 square feet, a written erosion and sediment control plan must be prepared.

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Design Details and Specifications

chapter 6

6.1 Design Details

Design details for the Green Street SMPs discussed in Chapter 2 are presented in Appendix 6.1 and include the following drawings:

Drawing	Name
G-01	Cover
G-02	Introduction to the Design Details
G-03	General Rules
SP-01	Stormwater Planter Placement Diagram
SP-02	Stormwater Planter
TT-01	Stormwater Tree Trench
ST-01	Stormwater Tree
SB-01	Stormwater Bump-out Placement Diagram
SB-02	Stormwater Bump-out (Mid-block)
SB-03	Stormwater Bump-out (Corner)
SB-04	Stormwater Bump-out (Bus Stop)
PP-01	Permeable Pavement
GG-01	Green Gutter
DW-01	Stormwater Drainage Well

Refer to Appendix 6.1 for the Design Details and Appendix 6.2 for Design Components Specifications. Please be sure to review drawing G-02 of the Design Details for an introduction, which provides important information that explains the use and application of the Design Details, including how the various Design Components are cross-referenced.

The Design Details included in Appendix 6.1 are not templates to be used directly as final design details. They are intended to illustrate green street SMPs currently being used or piloted by the City of Philadelphia and provide designers with a combination of general rules, guidelines, requirements, and information to help them apply and modify them to their specific project and site conditions.

If, in the future, completely prescriptive sizing, geometry, and layout requirements are established for each Green Street SMP, the Design Details will be updated accordingly. It should be noted that designs or design elements that deviate from or are not addressed by information included in this manual are not specifically disallowed and the City is open to evaluating new ideas and options. However, this may require additional review and coordination by the Water Department and other City agencies.

Note that the green gutter shown on GG-01 and the stormwater drainage well shown on DW-01 are all labeled as Pilot to signify that those are SMPs that the City of Philadelphia has not installed at this time.

6.2 Functional System / Design Component Approach

In order to summarize the many individual components that make up Philadelphia's Green Street SMPs, an approach was developed to group and divide these components into twelve Functional Systems. Each component, known as a Design Component, is a physical feature of the SMP that achieves the functional purpose of its corresponding Functional System. For this approach, the following twelve Functional Systems were established:

FS-1 Area Protection (AP)

FS-2 Energy Dissipation (ED)

FS-3 Stormwater Entrance (SE)

FS-4 Storage Media (SM)

FS-5 Media Separation (MS)

FS-6 Planting Media (PM)

FS-7 Landscaping (L)

FS-8 Impermeable Barriers (IB)

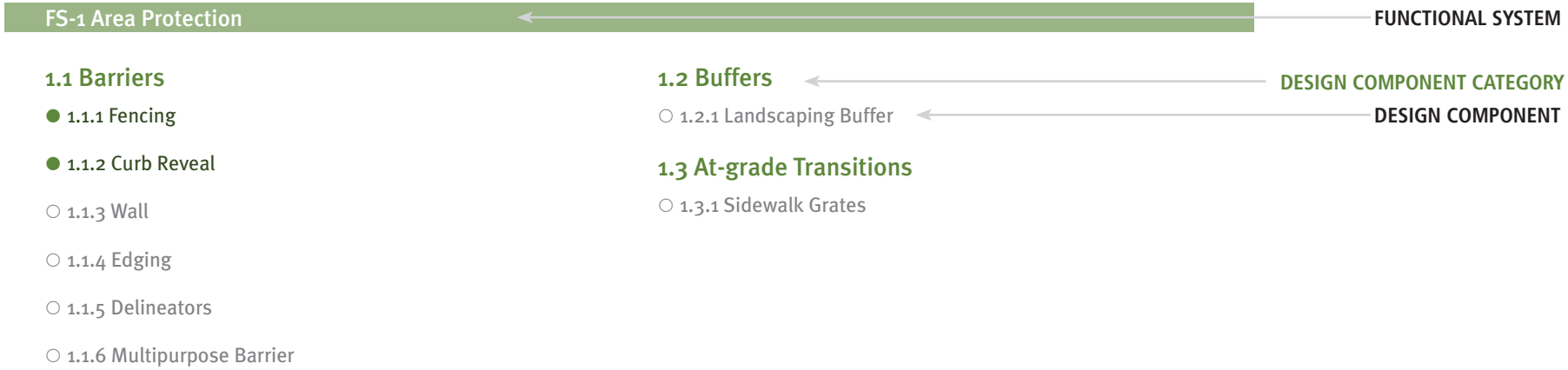
FS-9 Piping (P)

FS-10 Pretreatment (PR)

FS-11 Subsurface Stabilization (SS)

FS-12 Identification and Education (IE)

The twelve Functional Systems and their corresponding Design Components have been arranged according to a hierarchy, format, and numbering system shown on the following example subset of Design Components:



Design Components shown in black represent Design Components for which specifications have been developed at this time. Design Components shown in gray are intended for potential future development and for which specifications have not been developed at this time. The complete list of Functional Systems and Design Components in Table 6.1 is provided on the following pages.

Table 6.1 Functional System and Design Components

FS-1 Area Protection

1.1 Barriers

- ● 1.1.1 Fencing
- ● 1.1.2 Curb Reveal
- ○ 1.1.3 Wall
- ○ 1.1.4 Edging
- ○ 1.1.5 Delineators
- ○ 1.1.6 Multipurpose Barrier

1.2 Buffers

- ○ 1.2.1 Landscaping Buffer

1.3 At-grade Transitions

- ○ 1.3.1 Sidewalk Grates

FS-2 Stormwater Entrance

2.1 At-Grade Inlets

- ● 2.1.1 Curb Cut
- ● 2.1.2 Depressed Curb
- ○ 2.1.3 Lay-by Inlet
- ● 2.1.4 Trench Drain

2.2 Inlet Structures

- ● 2.2.1 Green Inlet
- ○ 2.2.2 Shallow Inlet
- ○ 2.2.3 Dual Connection Inlet
- ○ 2.2.4 Upflow through Domed Riser

2.3 Permeable Surfaces

- ● 2.3.1 Permeable Asphalt
- ● 2.3.2 Permeable Concrete
- ● 2.3.3 Permeable Pavers

2.4 Other Inlet Types

- ○ 2.4.1 Curb Insert (e.g. scupper, curb-o-let)
- ○ 2.4.2 Formed Opening Through Curb
- ○ 2.4.3 Hollow Curb
- ○ 2.4.4 Curb Core

2.5 Entrance Related

- ● 2.5.1 Wheel Guard
- ● 2.5.2 Gutter Apron

Table 6.1 Continued

FS-3 Pretreatment

3.1 Inlet Inserts

- ● 3.1.1 Filter Insert

3.2 Inlet Barriers

- ○ 3.2.1 Opening Covers (e.g. grate plate)

FS-4 Energy Dissipation

4.1 Formed Materials

- ● 4.1.1 Splash Pad

4.2 Loosely Placed Materials

- ○ 4.2.1 Level Spreader

4.3 Grade Changes

- ● 4.3.1 Surface Sump

4.4 Vertical Obstacles

- ○ 4.4.1 Baffles

FS-5 Landscaping

5.1 E&S / Final Stabilization

- ● 5.1.1 Erosion Control Blanket
- ○ 5.1.2 Temporary Seeding

5.2 Vegetation

- ● 5.2.1 Trees
- ● 5.2.2 Plants, Grasses and Shrubs
- ○ 5.2.3 Seeding
- ○ 5.2.4 Vines and Trellises

5.3 Top Dressings

- ● 5.3.1 Mulch
- ○ 5.3.2 Stone

Table 6.1 Continued

FS-6 Planting Media

6.1 Soils

- ● 6.1.1 Engineered Soil
- ○ 6.1.2 Amended Soil
- ○ 6.1.3 Native Soil
- ○ 6.1.4 Structural Soil

FS-7 Storage Media

7.1 Aggregate Materials

- ● 7.1.1 Stone

7.2 Prefabricated Materials

- ● 7.2.1 Modular Storage Systems
- ○ 7.2.2 Arch Systems
- ○ 7.2.3 Pipe Systems

FS-8 Media Separation

8.1 Fabric Materials

- ● 8.1.1 Geotextile

8.2 Aggregate Materials

- ● 8.2.1 Sand Filter
- ○ 8.2.2 Pea Gravel Filter

Table 6.1 Continued

FS-9 Piping

9.1 Conveyance

- ● 9.1.1 Underdrain
- ● 9.1.2 Distribution Pipe
- ● 9.1.3 Domed Riser
- ○ 9.1.4 Consolidation Pipe / Fittings

9.2 Protection on / around Piping

- ● 9.2.1 Utility Sleeve
- ● 9.2.2 Anti-seep Collar

9.3 Access to Piping

- ● 9.3.1 Cleanout

9.4 Monitoring

- ● 9.4.1 Observation Well
- ○ 9.4.2 Piezometer Well

9.5 Unpiped / Other Conveyance Items

- ○ 9.5.1 Runnels
- ○ 9.5.2 Swales
- ○ 9.5.3 End Walls

FS-10 Impermeable Barriers

10.1 Liners

- ● 10.1.1 Geomembrane Sheets

10.2 Check Dams

- ○ 10.2.1 Surface Check Dams
- ○ 10.2.2 Subsurface Check Dams

10.3 Coatings

- ○ 10.3.1 Epoxy / Tar

Table 6.1 Continued

FS-11 Subsurface Stabilization

11.1 Grid Systems

- 11.1.1 Geogrid

11.2 Construction Techniques

- 11.2.1 Over-excavation

FS-12 Identification and Education

12.1 Signage

- 12.1.1 Permanent Signs
- 12.1.2 Temporary Signs

12.2 Ornamental

- 12.2.1 Medallions

12.3 Decorative

- 12.3.1 Stenciling
- 12.3.2 Muraling

6.3 Specifications

Design Components shown in black in Table 6.1 are included in Appendix 6.2 and represent Design Components for which specifications have been developed at this time. For each Design Component included in Appendix 6.2, information is presented in a standard template that describes the Design Component and where applicable, provides specifications, additional considerations/options, applicability, submittal requirements, references, attachments such as supplemental details, and examples. The template is a packaged snapshot of Water Department specifications and standard details and is not necessarily inclusive of all Water Department specifications. For complete information, the references listed for each Design Component can be requested from the Water Department.

Projects along State Routes must conform with PennDOT Publication 408: Highway Specifications, current edition.

6.4 Updates and Future Development of Design Components

The Design Components shown in gray in Table 6.1 are intended for potential future development and a brief description and examples for some of these, particularly ones that offer some level of innovation or design interest, are provided in Appendix 6.3. For these Design Components as well as those that currently have less defined specifications, the specification templates can be created and updated as more specific standards are developed by the City over time.

It is important to note that the list of Design Components shown above is not exhaustive and does not represent the only Design Components allowed for Green Street SMPs. It is likely that the quantity and types of Design Components will change in the future depending upon many factors including the evolution of SMP design standards, manufacturer products, and implementation of the Green Streets program within Philadelphia. In fact, the framework of Functional Systems and Design Components was established in part so that as additional Design Components are proposed and developed, either by the City or by third parties, they can be added to the framework and specifications can be developed for them.

Green Street Implementation Policies and Procedures

chapter 7

7.1 Design Review & Approvals Process

This section outlines the requirements for entities proposing to design and construct GSI within the right-of-way (a green street) with SMPs to be accepted by the Water Department as GSI assets upon completion.

GSI and SMP projects that impact the right-of-way may trigger reviews to ensure compliance with Philadelphia's Complete Streets Policy. Projects that trigger Civic Design Review or Plan of Development Review must submit an appropriate copy of a Complete Streets Checklist to the Planning Commission. Projects that change the curb line such that a lay-by-lane is added, a traffic signal is affected, or a traffic study is required must submit an appropriate copy of a Complete Streets Checklist to the Streets Department. Complete Streets Checklists for Planning Commission review and for Streets Department review are available on the Streets Department's website.

While not all projects will trigger reviews for compliance with the Complete Streets Policy, they will all require approvals by the appropriate City agencies at each phase of project review. At each level of review, agencies will provide comments on the design that must then be addressed and resubmitted in subsequent review phases. Applicants are expected to copy the Water Department on all submissions, clearance letters, permits, and correspondence with City and state agencies, utilities and community organizations regarding the project.

The five phases of the design review and approval process are:

Phase One: Proposal and Location Approval

Phase Two: Concept Design & Approval

Phase Three: Preliminary Design (Optional)

Phase Four: Final Design

Phase Five: Permitting Process

7.1.1 Phase One: Proposal and Location Approval

The first step in the Green Street Design Review and Approval process is obtaining location approval from the City. The following summary documents the process for obtaining green street siting approval from the City.

Green Streets Project Proposal Form

To initiate the green street design review and approval process, applicants must submit Section A of the online Green Street Project Proposal Form to the Water Department. This proposal form will be used to evaluate the eligibility of a green street project within the proposed location. Section A of the form should be utilized to discuss the scope of the project and any related details of the proposed plan. Applicants will have the opportunity to utilize Section B as a checklist to track their submittals and review throughout the design review and approval process. The entire proposal form must be completed and submitted to the Water Department during the final design phase in order to gain approval for the project.

The Water Department's *Green Street Project Proposal* is available at: http://www.phillywatersheds.org/gsdm. Please see Appendix (7.1) for an example of the document. Note, however, the proposal must be completed and uploaded to the web site. Visit the web site for additional instructions.

Although project proposals will be evaluated and approved jointly by the Water Department and Streets Department, only one project submittal is required at this stage. If the proposed location is deemed infeasible, the Water Department will provide feedback regarding why the location did not meet siting criteria.

Survey and Infiltration Tests

Upon notification of project location approval, it is recommended that applicants order all surveys and infiltration tests necessary for the Water Department's review.

7.1.2 Phase Two: Conceptual Design and Approval

The second phase in the Green Street Design Review and Approval process involves the submittal of conceptual designs for Water Department approval.

Concept Design Submittal

All applicants are required to prepare and submit a concept design for review and approval by the Water Department and Streets Department. Conceptual designs must be developed in accordance with the requirements and guidelines found in Section 5 of this manual.

The conceptual design submittal must include, at minimum, the following information:

1. Base plan for all project areas. Refer to the PWD GSI Drawing Requirements Packet for detailed drafting standards

2. Creation of conceptual design drawings based on base plan information
3. SMP concepts, including preliminary layout of stormwater features in plan view (a detailed design is not required at this time)
4. Identification of existing ADA ramps impacted by the project
5. Results of infiltration testing and other relevant geotechnical information. Infiltration tests must be performed in accordance with procedures described within the GSI Design Requirements and Guidelines Packet.
6. Any additional relevant drawings and documents (the Streets Department may require additional plans and/or studies as warranted by the project, including but not limited to: turning plans, parking analysis, pedestrian and traffic studies)
7. Design calculations
8. Drainage area maps
9. Engineer's estimate of probable construction costs (conceptual-level)

Though the Water Department and the Streets Department will jointly provide comments on the concept designs, only one project submittal is required at this stage. Should a conflict arise in the feedback provided by City agencies, it is the responsibility of the applicant to communicate the issue to the Water Department and resolve any discrepancies. Upon concept design acceptance, the Water Department will issue a City Work Number for the project that must be utilized on all plans and materials submitted for City agency review.

Projects along state routes must submit to PennDOT for review of the approved design. These projects will require a Highway Occupancy Permit, so early coordination with PennDOT is essential.

Concept Design submissions and resubmissions must be submitted electronically to the Water Department GSIIP Manager:

Philadelphia Water Department
Office of Watersheds
Green Stormwater Infrastructure Implementation Program (GSIIP)
Jessica Brooks, Manager
1101 Market Street, 4th Floor | Philadelphia, PA 19107
215.685.6213 I Jessica.K.Brooks@phila.gov

Pre-Design Meeting

The applicant has the option to request a pre-design meeting with the Water Department. The pre-design meeting will provide the applicant with the opportunity to review concept designs, project schedule, and all required documents and approvals.

Developer Services Meeting

If requested by the Streets Department, applicants must attend a developer services meeting. Developer services meetings are offered by the Streets Department to provide guidance to developers in the early stages of design of projects that will incur significant work in the right-of-way. If attending a developer services meeting, applicants must provide the Streets Department with concept designs at least one week prior to the meeting.

City Plan Action, Requirements and Procedure

Proposed designs that impact or change the City curb line (e.g. bump-outs) may warrant a City Plan Action. The Streets Department or the Water Department will notify the applicant if a City Plan Action is required. The application for City Plan Action is available through the Streets Department (http://www.philadelphiastreets.com/pdf/City_Plan_Applicatio.pdf).

Please contact the Streets Department for further requirements:

Frank Morelli, PLS
Survey Bureau Manager
215-686-5540

City Plan

City Plan is the legal description of the streets, on which the curb lines are regulated. A City Plan Action is a change to the official City Plan. The Actions that incur a change to the City Plan are as follows:

- Place a new street on the City Plan
- Strike an existing street from the City Plan
- Revise the lines and/or grades of an existing street
- Permanently relocate curblines and change roadway widths
- Place or strike a City utility right-of-way on/from the City Plan
- Any combination of the above

7.1.3 Phase Three: Preliminary Design Meeting (Optional)

The third phase in the Green Street Design Review and Approval process involves an optional meeting between the applicant and the Water Department and Streets Department prior to submitting a final design. At this meeting, applicants have the opportunity to meet with the Water Department to review preliminary designs with the intent of garnering feedback to improve the overall design and potentially streamline submissions as the project moves to the final design phase. Each submittal of preliminary designs must address all comments from previous submissions.

Plans submitted for preliminary design review must include, but are not limited to the following information:

1. Draft plan set
    a. All comments on the base plan have been adequately addressed
    b. All design features included and identified
    c. Plan view layout complete with all necessary call-outs
    d. Profile complete with all necessary call-outs
    e. Section, as needed, complete with all necessary call-outs
    f. All needed inverts and dimensions specified
    g. All needed details included
2. Design calculations in Excel spreadsheet format. Sufficient calculations should be provided to confirm designs.
    a. At minimum, calculations should include the following: contributing drainage area, storage volume, loading ratio, calculations of release rates for slow-release systems, and storm size managed
3. Tree and/or landscaping plan
4. Drainage area maps
5. Cost estimate, if requested
6. All engineering and environmental work that has been developed to date for the project

7.1.4 Phase Four: Final Design

The fourth phase in the Green Street Design Review and Approval process includes final reviews, production and submission requirements for final designs.

Design Review

Prior to submitting final plans, applicants must submit a site and tree planting plan to Philadelphia Parks & Recreation (PPR) for review and approval of tree locations and species selection (if applicable).

Applicants must also submit final plans to any other agency that has facilities in proximity to the project area, including, but not limited to: Verizon, PECO, PGW, SEPTA and Comcast. Applicants must make all revisions required by those agencies prior to making final submission to the Water Department, Streets, and PennDOT (required for a project located on a state road). Please see Appendix 7.2 for design review contacts.

Final Design Submittal

All applicants are required to submit a final design package for review and approval by the Water Department and Streets Department. All plans must be in accordance with the standards described within the Water Department's GSI Design Requirements and Guidelines Packet and the Water and Sewer Design Manual. Multiple submissions may be necessary if submissions are incomplete, inaccurate, or not acceptable for technical reasons. Each subsequent submittal must address all outstanding comments from previous submissions.

During final design, applicants will be required to meet with the Water Department to develop a maintenance agreement for the installed SMPs. The Water Department requires applicants to maintain the project site during construction activities, and may require applicants to maintain surface vegetation for an initial period of time following installation. The Water Department may also require certain functional components of the SMPs to be guaranteed for a period of time post-construction. These specific time periods as well as the details of the maintenance requirements for each SMP may vary, and will be outlined in the agreement provided by the Water Department.

Final design package submissions and resubmissions must go directly to the following Water Department and Streets Department addresses:

Philadelphia Water Department
Office of Watersheds
Green Stormwater Infrastructure Implementation Program (GSIIP)

Jessica Brooks, Manager
1101 Market Street, 4th Floor | Philadelphia, PA 19107
215.685.6213 I Jessica.K.Brooks@phila.gov

Philadelphia Streets Department
The Division of Surveys, Design and Construction
Attention: Project Design Engineer
Municipal Services Building-Room 830
1401 JFK Blvd.
Philadelphia, PA 19102
215.868.5578

Plans submitted for final design approval must include, at minimum, the following information:

1. Electronic copies of Parks and Recreation,Streets Department, PGW, and any other necessary utility approval letters (1 copy)
2. Electronic copy of the maintenance agreement, if applicable (1 copy)
3. Materially complete plan set (3 copies)
   a. All design features included and identified
   b. Layout complete with all necessary call-outs
   c. Profile view(s) complete with all necessary call-outs
   d. Section view(s), as needed, complete with all necessary call-outs
   e. All needed inverts and dimensions specified
   f. All needed details included
4. The Water Department's final design report (refer to the GSI Design Requirements and Guidelines Packet, Section X), including:
   a. Written Report
   b. GreenIT data entry application metrics report
   c. Supporting calculations and modeling
   d. Drainage area maps
5. Soil and geotechnical information
6. Draft specifications and bid tabulation
7. Engineer's estimate of construction costs
8. Green Street Project Proposal Form (Complete Section B)

Streets Department Approval

The Streets Department will review and return final plans with comments enclosed. Upon approval, the Streets Department will return plans with approval stamps. Depending on the nature of the project, additional comment or approval letters may be issued separately for specific design elements, such as pavement restoration or lighting.

Philadelphia Water Department Approval

Once Streets Department approval is given, the Water Department will review the project. Upon approval, the Water Department will issue a final design approval letter requesting a final submission of the design package.

Submission of Approved Plans

Upon Water Department and Streets Department final design approval, applicants are required to submit one set of signed and sealed mylar drawings by a professional engineer registered in the Commonwealth of Pennsylvania, construction documents, and a final design report in electronic form to the following Water Department address:

Philadelphia Water Department
Office of Watersheds
Green Stormwater Infrastructure Implementation Program (GSIIP)
Jessica Brooks, Manager
1101 Market Street, 4th Floor | Philadelphia, PA 19107
215.685.6213 I Jessica.K.Brooks@phila.gov

After reviewing and approving final submissions, the Water Department will issue a developer agreement, with a copy of the authorized final mylars to the applicant. If a bond is required, it will be detailed within the agreement.

Upon completion and return of the developer agreement, the Water Department will issue a Construction Approval Letter, as notice to proceed, with a copy of the fully executed agreement.

The applicant must submit electronic copies of approved plans as AutoCAD and PDF files. Electronic files can be submitted via CD-R to the same Water Department address stated above.

Plans submitted for final submission must include the following information:

1. Hardcopies
    1. Memo from project manager approving final package
    2. 1 set of mylar drawings, (signed and stamped)
    3. 2 sets of prints (complete with drainage area maps)
    4. 1 copy of Philadelphia Streets Department approval letter
    5. 1 copy of PGW approval letter

2. Electronic Copies
    1. Half size design drawings in pdf format
    2. Full size design drawings in pdf format
    3. Design drawings in AutoCAD or Micro-Station format
    4. Specifications in Microsoft Word format
    5. Engineer's estimate of construction cost in Microsoft Excel format
    6. Drainage area maps in pdf and AutoCAD or Micro-Station format
    7. Water Department final design report (as per requirements)
    8. Design calculations in Microsoft excel format
    9. 1 copy of each utility/agency response letter in pdf format

7.1.5 Phase Five: Permitting Process

The fifth phase in the Green Streets Design Review and Approval process includes the securing of necessary permits. The Water Department and Streets approval process for the proposed SMP does not take the place of any other permit or approval that the project may require. At a minimum the following permits are typically required when working in the Philadelphia right-of-way.

City Permits

Permits must be acquired prior to initiating pre-construction conference and construction work. All projects that propose any impact to the right-of-way will require a street opening/street closure permit. This permit ensures compliance with all current state, city and federal government regulations for right-of-way construction. Once the applicant has received the permit, it is valid for three years or until construction is complete.

Upon issuing the final approval letter, the Streets Department will clarify what additional permits, if any, must be obtained by the applicant. Permitting fees may apply to the permitting process and will be identified within the final approval letter.

If a new connection to a City sewer is proposed as a part of the project, the Water Department must approve construction. Sewer Connection Requirements are available online at: http://www.pwdplanreview.org/WICLibrary/Sewer Connection Requirements.pdf

PennDOT Highway Occupancy Permit

If the project impacts a state-owned street, a Highway Occupancy Permit (HOP) must be acquired from PennDOT prior to the start of construction. HOPs are filed through PennDOT's ePermitting System (https://www.dot14.state.pa.us/EPS/home/home.jsp).

HOPs are only valid for one year from the date of issuance. PennDOT requires that HOPs be submitted at least 60 days before the start of construction, and recommends at least 120 days. Due to PennDOT regulations, applicants are also advised to avoid placing subsurface stormwater elements under the cart way on PennDOT owned roads. PennDOT can answer additional inquiries on this matter.

For further information and permit submissions, please contact PennDOT:

Pennsylvania Department of Transportation
Engineering District 6-0
Attention: District Traffic Services Manager
7000 Geerdes Boulevard
King of Prussia, PA 17406-1525
610-205-6560

Section 7.2 Construction and Inspection

This section outlines the requirements for applicants initiating construction of a green streets project. Described herein are the submissions necessary upon completion of the project, as well as guidance on coordination with the Water Department's construction and inspection process, submitting required As-Built drawings and photo documentation.

Approvals by City agencies will be issued upon final inspection.

7.2.1 Pre-Construction

Pre-Construction Meeting

All partners must schedule a pre-construction meeting with the Water Department Construction Branch. A minimum of two weeks advance notification of the project pre-construction meeting must be given. Contact Mr. Robert Britt, Chief, PWD Construction Branch at Robert.Britt@phila.gov, to schedule the project pre-construction meeting. Copy Mr. Robert Rotermund, Assistant Manager, PWD Construction Branch at Robert.Rotermund@phila.gov, on all correspondence.

Prior to pre-construction meeting, a Water Department construction engineer and inspector will be assigned to the project to review and approve all material submissions, installations, and payment items.

If special maintenance is needed beyond typical Water Department maintenance protocols, applicants must meet with the Water Department to create a maintenance agreement for the project.

The following documents must be submitted to the Water Department Construction Unit prior to or at the pre-construction meeting:

1) Anticipated construction schedule or phasing plan

2) Anticipated dates for procurement of materials and equipment

3) Any construction documents

4) A list of all subcontractors and contact information

5) A list of all materials, suppliers, and a materials storage plan

6) Construction submittals

- E.g. shop drawings for specialized designs must match specifications within this manual (cast iron materials, geotextile fabric, etc.)

7) Questionnaire and Financial Statement for Qualifying Bidders form

The following contact information for contractor personnel should be provided at the meeting:

1) Project Manager: (Name/Phone/Cell/Fax/email)

2) Construction Superintendent: (Name/Phone/Cell/Fax/email)

3) After hours/emergency contact the following individual(s): (Name/Phone/Cell/Fax/email)

4) Subcontractors: (Name/Phone/Cell/Fax/email)

7.2.2 Public Notification

Applicants may want to consider promoting this project as a Green City Clean Waters opportunity that increases visibility of green partnerships. Please contact PWD Public Affairs to discuss collaborative opportunities and resources such as GSI educational materials and special events:

Philadelphia Water Department
Public Affairs
Attention: John DiGiulio
1101 Market Street, 3rd Floor
Philadelphia, PA 19107
215.685.6019 I John.DiGiulio@phila.gov

7.2.3 Construction and Inspection Administration

Construction Initiation

Upon completion of the project pre-construction meeting, applicants may begin scheduling construction, mobilizing field operations, and placing orders for materials and equipment. Prior to construction, applicants must submit complete shop drawings for each element of the GSI work for review by the PWD Construction Branch or Design Branch, as applicable. Refer to the project specifications for shop drawing requirements. All materials and a list of suppliers must also be submitted to the Construction Branch for approval.

All shop drawing submissions or questions about shop drawings should be directed to:

Philadelphia Water Department
Construction Branch
Attention: Robert Britt
1101 Market Street, 2nd Floor
Philadelphia, PA 19107
215.685.6341 I Robert.Britt@phila.gov

Inspection

A Water Department inspector and engineer will be assigned to the project to ensure that all construction work is performed in accordance with standards.

Applicants must provide office space for use by the Water Department inspector during construction of GSI. If applicants choose to work during premium time, such as weekends, holidays, or extended workdays resulting in over 40 hours in one week, the Water Department Construction staff reserves the right to charge for this inspection time.

Photographic and Video Documentation

Applicants must maintain construction records and photographic progress for all components of the project. Applicants are required to photograph the site frequently to sufficiently convey existing conditions. Photographs should include, but are not limited to: temporary inlet protection during construction, clean inlets post-construction, and critical construction phases throughout the project. Photographs are to be time and date stamped in accordance with Appendix 7.3. Prior to the start of construction, applicants must document pre-construction conditions of all areas to be disturbed or accessed by the contractor. Applicants must notify the Water Department project engineer at least two days before taking any photographs. The project engineer will communicate any special requests or instructions for photo-documentation prior to each visit.

Following the completion of construction, SMPs should remain off-line, i.e., not able to receive runoff, (via plugged inlets, blocked curb cuts, etc.) until the Water Department accepts ownership of the GSI asset. Applicants are also required to take CCTV footage (in .mp4 format) of all sub-surface pipe features upon completion of construction. This footage should be sufficient to document that the entire extent of sub-surface pipe features are clear of debris and sediment and properly installed.

Punchlist

A punchlist is a list of tasks, in response to unaddressed issues in the projects construction, which are required to be completed to comply with the terms of a construction contract.

Generally, punchlists are generated during the final inspection phases of construction.

7.2.4 Construction Completion and Final Inspection

Once construction is substantially completed, the Water Department will perform a walk through and give the applicant a punchlist of items to be addressed. Once the punchlist items and all requirements are addressed and a final inspection is completed, the Water Department will issue a Completion Notice Letter, signifying the completion of construction.

7.2.5 Requirements for the Water Department to Assume GSI Asset Ownership

The Water Department will assume ownership for GSI assets that have been designed and constructed following the review process outlined within this manual and will furnish a completion notice. Any projects that deviate from the standards prescribed within this manual may require additional review and/or modifications prior to the transfer of ownership.

The Water Department reserves the right to perform detailed inspections prior to assuming ownership of an SMP. Should an SMP fail to pass inspection, the Water Department reserves the right to refuse ownership of the SMP and require that it either be removed or rebuilt to working specifications. Any projects that deviate from the standards prescribed in the technical design portion of this manual may require additional review by the Water Department prior to the transfer of ownership.

The following submissions are requirements for the Water Department to assume ownership of the constructed infrastructure:

Warranties

The GSI project is to be fully warrantied by the applicant for a period as defined in the maintenance agreement from the date of approval of as-built drawings and acceptance by the Water Department.

As-Built Documents

An as-built survey must be provided to the Water Department by the applicant's construction contractor per the project specifications. As-builts must be signed by the contractor and submitted to the Water Department inspector, as AutoCAD and PDF files, after final inspection and approval of the project. Refer to the project specifications for as-built requirements.

Any change to or deviation from the final approved design plans during construction must be approved by the assigned Water Department project engineer and indicated on the as-built drawings.

If as-builts are not provided, the Water Department reserves the right to refuse ownership of the project and require that it either be removed or rebuilt to working specifications.

Photographic and Video Documentation Submission

Photo-documentation and CCTV footage, as described above in Section 7.2.3, must also be completed prior to construction, during and post-construction. Upon completion of this documentation, applicants must submit materials prior to the Water Department assuming ownership of the GSI assets. For further information on the requirements and submittals for project photo-documentation, please refer to Appendix 7.3

Note: Photographic and video copyrights are equally shared and unrestricted between the photographer, the Water Department and/or contractor.

Section 7.3 Maintenance

7.3.1 Maintenance Responsibilities During and After Construction

The Water Department requires applicants to maintain the project site during construction activities, including proper erosion and sediment controls such as protection of inlets and subsurface elements. Once construction of the SMP is complete, the Water Department may require applicants to maintain surface vegetation for a period of time post-construction. During this time, plantings must be watered, mulched, weeded, pruned, fertilized, and otherwise maintained and protected as necessary. This time period will be defined in the maintenance agreement between the Water Department and the applicant (see Section 7.3.3). The Water Department will assume maintenance of subsurface elements upon approval of clean and properly constructed subsurface elements.

The Water Department reserves the right to refuse ownership and/or future maintenance responsibilities if the SMP is not properly maintained and protected in accordance with the maintenance agreement. The Water Department reserves the right to refuse ownership of the SMP and require that it either be removed or rebuilt to working specifications. For more information regarding standard maintenance practices for specific SMP types, please refer to the Water Department's Maintenance Manual (to be completed in June 2014).

7.3.2 Water Department Asset Maintenance

The Water Department is responsible for maintenance of the majority of drainage infrastructure located within the public right-of-way, including SMPs. Exceptions to this rule include the maintenance of roadway components in State Highways, medians in City Streets and State Highways, street trees, and private drainage laterals. All stormwater management practices that become Water Department assets are maintained for stormwater management functionality to ensure that they continue to perform as designed. All applicants are currently required to meet with the Water Department to develop a maintenance agreement for installed SMPs during the final design stage.

Additional areas that may be affected by, created, or modified due to the installation of SMPs for which the Water Department will not assume maintenance responsibilities include: sidewalk areas, ADA ramps, street paving, and streetscape elements outside the SMP system. Generally, routine maintenance of SMPs includes surface level maintenance (pruning, watering, invasive and non-target vegetation control), cleaning actions (trash, sediment removal), erosion control and subsurface maintenance (pipe flushing, inlet cleaning, etc.), and other minor structural and functional repairs. It should be noted that salt should not be applied to porous concrete areas for at least one year following their installation (as is the recommendation for standard concrete), as this may lead to failure of the concrete.

Applicants desiring additional maintenance of the above-ground elements for aesthetic purposes may assume such additional maintenance responsibilities, formalized through a written agreement between the applicant and the Water Department. Additionally, applicants may wish to include aesthetic features not standard to the Water Department's guidelines, such as ornamental plantings or decorative curbing or fencing. In these circumstances, the applicant would be required to maintain and replace (as needed) the additional features. Green Street components that deviate from Water Department standards will not be maintained by the Water Department. A signed Memorandum of Understanding (MOU) for maintenance and replacement will be required prior to the approval and installation of such additional features. The Water Department retains the right to inspect and require changes to all SMPs that are maintained by others at their discretion.

7.3.3 Maintenance and Replacement Responsibilities of Others

Certain components indirectly associated with SMPs have maintenance responsibilities assumed by entities other than the Water Department. These components can include street trees that are maintained by the Philadelphia Department of Parks and Recreation; street surfaces that are maintained by the Streets Department or PennDOT; and sidewalk maintenance and snow removal that is the responsibility of adjacent property owners. Additionally, while the Water Department maintains the majority of the City's stormwater inlets, stormwater inlets whose function is to drain the road surface of State Highways are owned by PennDOT, but maintained by the Water Department.

Any party that damages or removes a constructed Water Department asset is required to replace that asset as depicted in the As-Built drawings. Once the Water Department assumes ownership of a stormwater management practice, it becomes an asset to the City of Philadelphia.

Section 7.4 Funding

7.4.1 Potential Funding Collaboration Opportunities from the Water Department

This section examines existing, potential, and new sources of capital funding and describes a range of tools and strategies to extend, enhance, and leverage available funding for green street projects. Taken together, these funding programs, agreements, and strategies offer the best mechanisms to support the construction of SMPs on Philadelphia's streets by private or non-municipal entities. The success of the green streets program overall will require the participation, cooperation, and joint collaboration of diverse stakeholders throughout the City.

In certain cases, the Water Department may be able to coordinate partial funding for green streets projects constructed by other entities and agencies. Such projects will be required to follow the design and review requirements set forth in this manual. The Water Department is also developing other innovative funding ideas for projects within the public right-of-way, and may have the ability in the future to fund the design and construction portion of eligible green street projects. All parties interested in collaborating with the Water Department for green street projects should indicate so on their applications, and will be contacted should an appropriate funding mechanism be available.

Any funding provided by the Water Department is not eligible for use on non-SMP project costs such as: replacing sidewalk that is not disturbed as part of the SMP installation, ADA ramps that are not immediately connected to the SMP, street paving, signage, and signalization costs. Eligible costs may include: the design of the SMP, subsurface storage elements, excavation required for subsurface storage, and all landscaping, plantings, and media within the SMP. The Water Department reserves the right to make the final determination of which elements within a green street project would be eligible for funding.

7.4.2 Additional Funding Opportunities

Additional funding sources and grant programs may support green street projects. State, federal, and institutional funding programs with the potential application to green street design and construction are summarized in Table 7.1.

Table 7.1 Potential Green Street Funding Programs

FEDERAL GRANT PROGRAMS				
Grant Name	**Sponsoring Agency**	**Link to Further Information**	**Description**	**Eligibility Requirements or Funding Restrictions**
Targeted Watersheds Grant Program	EPA: Office of Water	http://water.epa.gov/grants_funding/twg/initiative_index.cfm	The targeted watersheds grant program through EPA encourages successfully community based approaches to protect and restore the nation's waterways. Grant funds can be used to support activities relating to the prevention, reduction, and elimination of water pollution. Projects cannot be activities required or regulated under the Clean Water Act.	None
Community Development Block Grants	Funding provided by U.S. Department of Housing & Urban Development (HUD); administered by the Philadelphia Office of Housing & Community Development (OHCD)	http://www.phila.gov/ohcd/hud.htm	GSI elements for green streets could be eligible for Transportation Enhancement (TE) funds. One of the categories eligible for these funds includes "mitigation of water pollution due to highway runoff." DVRPC solicits, reviews, and approves TE projects in the Philadelphia region	Municipality, county, state agency, or not-for-profit agency.
Highway Safety Improvement Program	Funding provided by USDOT, Federal Highway Administration; administered by PennDOT	http://safety.fhwa.dot.gov/hsip/	Types of projects funded include the rehabilitation and new development of parks and recreation facilities; acquisition of land for active or passive park and conservation purposes; and planning for feasibility studies, trails studies, conservation plans, site development planning, and comprehensive recreation, greenway and open space.	Municipalities and authorized non-profit organizations.
EPA Urban Waters Small Grants	EPA's Urban Waters Program	http://www.epa.gov/urbanwaters/funding/index.html	Eligible projects are those which involve the acquisition of land, easements or rights-of-way and the construction, improvement, expansion, extension, repair or rehabilitation of either a system for the supply, treatment, storage or distribution of water not used solely for residential purposes, or a system for the collection, treatment or disposal of wastewater (including industrial waste and the separation of sanitary sewers and storm sewers) not used solely for residential purposes. Grants are provided at a $5 million maximum or 75% of total eligible project costs, whichever is less. Loans are also available at a $5 million maximum per project with a 2% interest rate and repayment terms up to 20 years.	Municipalities; Industrial Development Corporations; Municipal Authorities; Investor-owned water or wastewater enterprise

Grant Name	Sponsoring Agency	Link to Further Information	Description	Eligibility Requirements or Funding Restrictions
TIGER Grants	United States Department of Transportation	http://www.dot.gov/tiger	Funds work designed to transform systems so that environmental problems are not created in the first place; supports efforts to reduce the damage currently being done by unsustainable practices; looks for programs and initiatives that help repair the damage caused by unsustainable practices; looks for places where capital investment are not available to correct an environmental problem.	Must be a 501(c)(3) non-profit organization to qualify. Individuals and for-profit organizations are not eligible.
Clean Water State Revolving Fund (CWSRF)	Funding provided by EPA; administered by PADEP	http://www.portal.state.pa.us/portal/server.pt/community/pennvest/9242	Project must be within one of the five issue areas: global health, climate & environment, basic survival safeguards, urbanization, and social & economic security; for climate & environment it needs to be related to sustainable growth and resilience to climate change.	Must be a 501(c)(3) non-profit organization to qualify. Individuals and for-profit organizations are not eligible.
PENNSYLVANIA STATE GRANT PROGRAMS				
Growing Greener	PADEP; Growing Greener grants are also available through PennVEST	http://www.depweb.state.pa.us/portal/server.pt/community/growing_greener/13958	Projects qualifying for grants under Surdna's Sustainable Environments program include those focused on improving transportation systems and encouraging smart growth. One of their funding priorities in this area is "supporting state and city leaders in the development and implementation of innovative solutions and the transfer of best practices that create environmental, economic and social benefits.	Must be a 501(c)(3) non-profit organization to qualify. Individuals and for-profit organizations are not eligible.
Community Conservation & Recreation Grant	PA Department of Conservation & Natural Resources (PADCNR)	https://www.grants.dcnr.state.pa.us/LearnMore.aspx?GrantProgramId=51	Types of projects funded include the rehabilitation and new development of parks and recreation facilities; acquisition of land for active or passive park and conservation purposes; and planning for feasibility studies, trails studies, conservation plans, site development planning, and comprehensive recreation, greenway and open space.	Municipalities and authorized non-profit organizations.

Grant Name	Sponsoring Agency	Link to Further Information	Description	Eligibility Requirements or Funding Restrictions
Water Supply and Wastewater Infrastructure Program (PennWorks	PA Department of Community and Economic Development	http://www.newpa.com/find-and-apply-for-funding/funding-and-program-finder/water-supply-and-wastewater-infrastructure-program-pennworks	Eligible projects are those which involve the acquisition of land, easements or rights-of-way and the construction, improvement, expansion, extension, repair or rehabilitation of either a system for the supply, treatment, storage or distribution of water not used solely for residential purposes, or a system for the collection, treatment or disposal of wastewater (including industrial waste and the separation of sanitary sewers and storm sewers) not used solely for residential purposes. Grants are provided at a $5 million maximum or 75% of total eligible project costs, whichever is less. Loans are also available at a $5 million maximum per project with a 2% interest rate and repayment terms up to 20 years.	Municipalities; Industrial Development Corporations; Municipal Authorities; Investor-owned water or wastewater enterprise
NATIONAL PRIVATE FOUNDATION GRANT PROGRAMS				
The Heinz Endowments	Howard Heinz Endowment	http://www.heinz.org/grants_apply.aspx	Funds work designed to transform systems so that environmental problems are not created in the first place; supports efforts to reduce the damage currently being done by unsustainable practices; looks for programs and initiatives that help repair the damage caused by unsustainable practices; looks for places where capital investment are not available to correct an environmental problem.	Must be a 501(c)(3) non-profit organization to qualify. Individuals and for-profit organizations are not eligible.
Rockefeller Foundation Funding	The Rockefeller Foundation	http://www.rockefellerfoundation.org/grants	Project must be within one of the five issue areas: global health, climate & environment, basic survival safeguards, urbanization, and social & economic security; for climate & environment it needs to be related to sustainable growth and resilience to climate change.	Must be a 501(c)(3) non-profit organization to qualify. Individuals and for-profit organizations are not eligible.

Grant Name	Sponsoring Agency	Link to Further Information	Description	Eligibility Requirements or Funding Restrictions
Surdna Foundation Grant	Surdna Foundation	http://www.surdna.org/grants/grants-overview.html	Projects qualifying for grants under Surdna's Sustainable Environments program include those focused on improving transportation systems and encouraging smart growth. One of their funding priorities in this area is "supporting state and city leaders in the development and implementation of innovative solutions and the transfer of best practices that create environmental, economic and social benefits.	Must be a 501(c)(3) non-profit organization to qualify. Individuals and for-profit organizations are not eligible.
Environmental & Cultural Preservation Grants	The Tiffany & Co. Foundation	http://www.tiffanyandcofoundation.org/apply.aspx	To improve the urban parks experience by supporting infrastructure improvements and beautification efforts in existing parks and by supporting the creation of additional green spaces. **They were a major funder for the High Line Park project in NYC, which includes sustainable storm-water management features.	Must be a 501(c)(3) non-profit organization to qualify. Individuals and for-profit organizations are not eligible.
REGIONAL AND LOCAL GRANT PROGRAMS				
Watershed Protection Grants	William Penn Foundation	http://www.williampennfoundation.org/WatershedProtection.aspx	Projects must be in the Delaware or Susquehanna watersheds. Priorities include: to protect and restore places of ecological significance; support watershed-wide research, policy, and practice; and empower communities to act.	Applicant must be a 501(c)(3) organization
	The Pew Charitable Trusts	http://www.pewtrusts.org/program_investments_procedure.aspx	Although stormwater is not listed as a specific program priority there is evidence of past successful grants (i.e. Race Street Pier and the Delaware River Waterfront Corporation in 2010) that have stormwater management benefits. There is a strong argument for civic initiatives and climate change benefits to the green infrastructure approach to stormwater management that will help the Water Department receive grants through these other priorities.	The majority of grants are given to public charities (501 (c)(3) organizations)

Grant Name	Sponsoring Agency	Link to Further Information	Description	Eligibility Requirements or Funding Restrictions
Schuylkill River Restoration Fund Grant	Works with the Water Department, Exelon, Schuylkill River National and State Heritage Area, Pennsylvania Department of Conservation & Natural Resources	http://www.schuylkillriver.org/Grant_Information.aspx	Funding will be given to projects that mitigate water quality and quantity problems in the Schuylkill River watershed resulting from acid mine drainage, agricultural runoff, and stormwater issues. Funds may be used for implementation: includes labor, materials, signage, site preparation, permit fees, and any other "hard costs"; project management (up to 10%). A portion of the available funds will be set aside for projects that are able to demonstrate direct protection of the Philadelphia drinking water supply.	
	The Albert M. Greenfield Foundation	http://thealbertmgreenfieldfoundation.org/grants/howtoapply	The foundation has a wide range of projects that it funds including science. Past projects funded by the Greenfield Foundation include PHS's "Share the Harvest," a memorial garden with the Urban Tree Connection, and the "Greening Greenfield" project at the Albert M. Greenfield School. This track record shows an interest in funding urban greening and landscaping projects, especially if they serve children and/or underserved sections of the City. The Foundation prioritizes projects and organizations that find innovative solutions to entrenched problems.	
Stormwater Management Incentives Program Grant	Philadelphia Water Department	http://www.phillywatersheds.org/what_were_doing/SMIP_Grant	The Stormwater Management Incentives Program (SMIP) grant provides assistance to non-residential Water Department customers. Use of funds is restricted to projects that support the design and construction of stormwater mitigation measures. These may include, but are not limited to: detention and retention basins, tree trenches, green roofs, porous paving, and rain gardens.	Only non-residential properties are eligible. Applicants must be owners of the property or have permission from the property owner(s).