The authors propose that the Philadelphia Water Department consider the use of a pay-for-performance structure to finance, construct, operate, maintain, and monitor projects undertaken to meet its greened acres obligations. The structure would take the form of a public-private partnership (PPP), which at its core is a contractual agreement between a public agency and a private-sector entity that delivers infrastructure projects and services.

Public-private partnerships have been used extensively by governments across the nation and around the world as a means to meet the growing demand for infrastructure construction and maintenance. In an environment of constrained federal and state budgets, PPPs are seen as a way to engage the private sector more deeply in funding infrastructure projects to meet public service needs. PPPs are in theory a means to reduce project costs, accelerate implementation, access new sources of higher risk/reward-seeking capital, and shift risk of performance from the public sector to the private sector.

There is enormous capital capacity to fund infrastructure in the U.S. and beyond. More than $31 billion in 2010 and $17 billion in 2011 was raised for funds targeting infrastructure investments. Some 224 transactions were executed in the most recent full calendar year. PPPs are attractive to investors because they can provide a high level of transparency and generally offer investment premiums in comparison with municipal bonds for similar risks. A PPP arrangement for green infrastructure could allow PWD to leverage private capital to fund an innovative solution to stormwater mitigation, defer its up-front costs, and provide a compelling opportunity to investors, offering good value to the department on a relative basis.

### 5.1. THE GLOBAL AND U.S. PUBLIC-PRIVATE-PARTNERSHIP INFRASTRUCTURE MARKETS

PPP structures vary significantly from sector to sector and from country to country, depending on the nature of the infrastructure projects in question and differences in the respective legislative frameworks that govern the contracting processes. While some PPPs engage private-sector partners to implement individual operations such as design, paving, or metering, others involve the private ownership and operation of infrastructure facilities providing services to municipalities and states that are subject to specific regulatory standards and constraints.

PPPs are used as a means of achieving the optimal distribution of risks and value between the public and private sector.85 PPPs have the potential to deliver an array of benefits to public agencies, including lower construction and maintenance costs for infrastructure projects, access to new sources of funding, and shifting of performance risk away from taxpayers and toward private investors and companies.

---

**Figure 5.1: Benefits of PPPs**

<table>
<thead>
<tr>
<th>Potential Benefit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Construction and Maintenance Costs</td>
<td>Private-sector entities may be able to deliver lower-cost projects through more efficient implementation and operation. Where projects are constructed and maintained by the same private-sector entity, there is greater incentive at the point of construction to take steps to lower future operations and maintenance costs. Efficiencies may also be gained through economies of scale by contracting for multiple projects and services bound together in a single procurement at a single point in time, rather than individual procurements over time.</td>
</tr>
<tr>
<td>Access to New Sources of Funding</td>
<td>PPPs can be financed using off-balance-sheet funding mechanisms that can reduce the impacts on a public agency’s balance sheet, depending on the type of liabilities embedded in the PPP contract. In addition, PPPs’ higher financing risk has a ready demand from investors willing to absorb the risk in exchange for investment premiums relative to typical municipal bond spreads.</td>
</tr>
<tr>
<td>Shifting of Performance Risk to Private Investors and Companies</td>
<td>PPP contracts can be structured with a range of features to reduce risks to the public agency involved, including caps on payment for construction, payment only upon completion of projects according to specifications and time lines, payments over time only upon ongoing performance, and compliance of the project with specific standards and other metrics.</td>
</tr>
</tbody>
</table>
The U.S. has been slower than Europe and Asia to pursue PPPs. Between 1985 and 2011, there were 377 PPP infrastructure projects funded in the U.S., or 9 percent of total PPP projects worldwide. Europe leads the infrastructure PPP market, with 45 percent of nominal value of all PPPs, and increased PPP funding sixfold between 1990 and 2005/6. More complex versions of PPPs in which the private-sector partner designs, builds, finances, operates, and maintains the project accounted for 12 percent of the projects implemented in the U.S. and 24 percent of contracted dollars. Seven of the 12 complex PPP projects were implemented between 2008 and 2010. PPPs globally have been utilized for projects in defense, environmental protection, government buildings, hospitals, information technology, municipal services, prisons, recreation, schools, solid waste, transport, tourism, and water. PPPs have been implemented in the U.S. across an array of project types, most significantly in the transportation sector.

While some public agencies or municipalities, such as Philadelphia, are able to implement PPP structures without enabling legislation at the state level, high-quality PPP legislation can mitigate many of the challenges of PPP execution. Twenty-two states have PPP legislation to allow eligible public authorities to engage with the private sector on infrastructure projects. Fifteen states provide PPP authority for lower-level public entities. Key features of enabling legislation include:

- Permission for unsolicited proposals;
- Combination of government funds with private funds;
- Wider array of procurements allowed for project delivery;
- Long-term franchisee leases or concessions;
- Ability for public-sector agency to hire its own technical consultants; and
- Public-sector outsourcing for O&M and other asset management duties.
To date, no PPP has been implemented with a focus on green infrastructure. While PPPs have not been used extensively for water-related infrastructure more broadly, it may be helpful to provide an overview of two PPPs utilized for CSO-related gray infrastructure, in Indianapolis in 2008 and in Holyoke, Massachusetts, in 2010. The figure below provides context for the terms of those PPPs as a benchmark for designing a PPP structure to fund and manage green stormwater infrastructure in Philadelphia.

PWD or its advisers could contact municipal authorities utilizing PPPs for water-related infrastructure to explore best practices with respect to contract terms and performance standards, and to identify potential process pitfalls.

**Figure 5.3: Existing Transportation PPP Authority by State**

| States with Significant Transportation PPP Authority |

**Figure 5.4: PPP Case Studies**

<table>
<thead>
<tr>
<th>Key Features</th>
<th>Holyoke, MA</th>
<th>Indianapolis, IN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public-Sector Partner</td>
<td>City of Holyoke, MA</td>
<td>City of Indianapolis, IN</td>
</tr>
<tr>
<td>Private-Sector Partner</td>
<td>United Water</td>
<td>United Water</td>
</tr>
<tr>
<td>Project Summary</td>
<td>Under an EPA consent order, Holyoke was required to reduce untreated overflows into the Connecticut River. Holyoke issued an RFP for a company to design and build a CSO facility and upgrade others for 20 years.</td>
<td>Extension of contract executed in 1994 for operation, maintenance, and long-term planning for city’s water and wastewater treatment systems.</td>
</tr>
<tr>
<td>Implementation Environment</td>
<td>MA general laws provide a framework conducive to implementing public-private partnerships.</td>
<td>Indiana state statute allows public entities to contract with private entities for the development, financing, and operation of projects through PPP entities.</td>
</tr>
<tr>
<td>Benefits</td>
<td>$10 million in cost savings (relative to projected public management costs). Completed 1 year ahead of schedule.</td>
<td>PPP is believed to have saved Indianapolis $189 million in first 15 years of contract term (relative to public management costs).</td>
</tr>
<tr>
<td>Contract Provisions</td>
<td>20-year contract for design, construction, and operation of 103-million-gallon-per-day wastewater treatment facility and for upgrading and operating the current wastewater infrastructure.</td>
<td>10 year-contract extension; fixed payment plus CPI adjustment factor.</td>
</tr>
<tr>
<td>Implementation Metrics</td>
<td>92 percent reduction in untreated discharges.</td>
<td>Unknown at time of publication.</td>
</tr>
</tbody>
</table>
5.2. PHILADELPHIA’S EXPERIENCE WITH PPPs

Pennsylvania has not historically had PPP-enabling legislation in place. In 2008, then-Governor Ed Rendell failed in a controversial attempt to pass legislation enabling a PPP structure to be used to lease the Pennsylvania Turnpike. However, in June 2012, Pennsylvania lawmakers approved a public-private partnership measure to give state and local governments more flexibility in using firms to design, build, finance, and manage roads throughout the state. Projects must be approved by a seven-member state panel, and a 20-day period is provided in which the legislature can in turn overrule a project. Though the measure is limited to road infrastructure, its passage may set an important precedent and holds promise for the use of PPPs with other types of public infrastructure.

<table>
<thead>
<tr>
<th>Figure 5.5: Example PPPs in Philadelphia</th>
<th>Biogas Cogeneration Facility</th>
<th>Biosolids Recycling Center</th>
<th>Automatic Metering Reading Services Contract</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Counterparty</td>
<td>Philadelphia Municipal Authority (PMA)</td>
<td>Philadelphia Municipal Authority (PMA)</td>
<td>Philadelphia Municipal Authority (PMA)</td>
</tr>
<tr>
<td>Private Partner(s)</td>
<td>Ameresco for design and construction of a cogeneration facility; Bal Green Biogas, which finances and owns the facility and leases the use of the facility to PWD/PMA</td>
<td>Philadelphia Biosolids Services, LLC, a joint venture of Synagro Technologies, McKissock &amp; McKissock, and Len Parker and Associates</td>
<td>Itron, Inc.</td>
</tr>
<tr>
<td>Total Term</td>
<td>16 years commencing after completion of construction</td>
<td>Interim period with maximum of 5 years, plus a Class-A period with a 20-year term, with one 5-year renewal option</td>
<td>18 years with two 1-year extension options</td>
</tr>
<tr>
<td>Scope</td>
<td>Develop and operate $35 million facility to cogenerate electricity and heat using biogas from the city’s Water Pollution Control Plant.</td>
<td>Design, finance, build, own, operate, and maintain certain new facilities for the processing of the city’s biosolids (solid waste removed from sewage during treatment)</td>
<td>Deliver and install ERT meters and maintain them over time; collect and deliver meter data to PWD</td>
</tr>
<tr>
<td>Ownership of Assets</td>
<td>Private partner owns and leases the facility to the city</td>
<td>PWD and PMA retain ownership of the existing BRC facility and the new facilities site with a buy-out option on the other assets; private partner owns improvements to existing BRC facility and the new facilities</td>
<td>Upon installation, PMA becomes owner of all meter equipment and has the right to purchase any additional equipment upon termination of contract with Itron.</td>
</tr>
</tbody>
</table>
| Terms of Compensation                    | • Lease payments commence upon completion of construction and receipt of certifications  
• Lease payment consists of a basic rent subject to various adjustments including preservation of a net return to the lessor that provides for basic rent increases to cover certain cost escalations | Payments for service as follows:  
• Service fee in FY 2007 of approximately $20 million  
• Subsequent years adjusted by CPI and a transportation cost index  
• Class-A period with estimated fee of $19 million plus $5 million in energy costs | • Fixed payments made upon completion of installations with incentives for timely performance; fixed payments per month according to data delivery completion |
| Potential Penalties for Performance Failures | • Penalties of 10K/day and a $2 million flat fee for late completion of construction  
• Penalties of liquidated damages on a $300–$600 per kW-e and BTU/kW-e basis | • No payment required in the event the private partner fails to perform  
• PWD/PMA can earn nonperformance credits for performance that does not hit specified targets | • Financial penalties for failure to meet performance standards; ban from future contract awards; contract termination paired with default payments to PMA |
| PPP Financing                             | Unknown at time of publication | $65 million to fund new facilities construction financed through the PA Economic Development Financing Agency | RFP for the project contemplated use of PWD’s tax-exempt financing status |
Even without enabling PPP legislation in place in the past, as illustrated in Figure 5.5, PWD has implemented three such structures since 1995 that are widely thought to be successful projects. Most recently, in 2011, PWD awarded a contract to finance, install, maintain, and own a new $35 million 5.6 MW cogeneration plant. The plant will be powered by biogas derived from waste sludge at the city’s wastewater treatment facility. When completed, the biogas plant is expected to provide virtually all of the electricity and heat needed to operate the wastewater facility. It is expected to save the city $4 million in energy expenses and provide some 250 jobs to local residents.

Previously, PWD and the Philadelphia Municipal Authority (PMA) executed contracts with a consortium of private partners to design, finance, build, own, operate, and maintain new facilities for processing the city’s biosolids and to operate the city’s existing Biosolids Recycling Center.91 PWD utilized the PPP structure in this case because it did not believe it could provide biosolids services in as efficient a manner as could be done through the PPP contract. The PPP contract is estimated to have saved the city approximately $5 million per year (20 percent of its projected operating costs absent the partnership), placed the risk of performance on PWD’s/PMA’s subcontractors, and helped conserve PWD capital funds for other needed infrastructure improvements.

In 1997, PWD executed an 18-year contract with Itron, Inc., to collect and deliver water-metering data from more than 450,000 households, which required the installation of water meters and data management systems. The contract reflects PWD’s belief that the utilization of a third party to manage a large portfolio of metering assets offered an array of benefits to the city.

These three examples can be seen as constructive and successful precedents demonstrating the basic viability of the PPP structure in PWD’s experience across an array of infrastructure types, including the use of long-term contracts and performance-based compensation.

5.3 A GREEN STORMWATER INFRASTRUCTURE PPP

5.3.1 Concept Overview

The authors propose that PWD consider use of a PPP structure to finance, design, build, operate, maintain, and monitor compliance for a portfolio of greened acres to assist PWD in meeting its requirements under the EPA-mandated consent order. While the PPP structure has been used extensively internationally and domestically for traditional gray infrastructure, the use of a public-private partnership for green stormwater infrastructure would be groundbreaking, yet it would borrow from related precedents and thereby lower execution risk. The form of PPP most relevant for the purposes of funding green stormwater mitigation in Philadelphia and other municipalities is the so-called availability payment model, whereby a government entity contracts to make a regular, periodic payment to a private-sector entity that delivers and manages greened acres. An availability payment framework is often used for infrastructure where the private partner is not generating revenues directly from consumer usage of the infrastructure; simply stated, such a framework would require PWD to make a quarterly or other regular payment for use of the infrastructure in question. The payment can be subject to performance standards that would allow PWD to reduce its payment amount or eliminate payments altogether in the event that performance is inadequate. PWD would stipulate the performance standards in its request for proposals (RFPs) and contract terms.

Figure 5.6: Sample Elements of a PPP Agreement

<table>
<thead>
<tr>
<th>PWD</th>
<th>PRIVATE STORMWATER OPERATOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Establishes performance criteria</td>
<td>Raises capital for up-front capital construction costs</td>
</tr>
<tr>
<td>Structures a lease with private-sector owners and operators of greened acres</td>
<td>Designs and builds stormwater projects according to PWD financial and performance specifications</td>
</tr>
<tr>
<td>Monitors performance of private-sector partner over time</td>
<td>Maintains greened acres over time</td>
</tr>
<tr>
<td>Makes quarterly payments based on completion of construction to specifications and performance criteria</td>
<td>Provides quarterly performance metrics and reporting to PWD through use of third-party auditor</td>
</tr>
</tbody>
</table>

20-year Contract

Greened Acres
Figure 5.7 below highlights sample PPP terms:

<table>
<thead>
<tr>
<th><strong>Figure 5.7: Sample PPP Contract Terms</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Public-Sector Partner</strong></td>
</tr>
<tr>
<td><strong>Number of Greened Acres Targeted</strong></td>
</tr>
<tr>
<td><strong>Annual Payment Amounts</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Contract Term</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Performance Metrics</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Termination Provisions</strong></td>
</tr>
<tr>
<td><strong>Other Issues</strong></td>
</tr>
</tbody>
</table>

### 5.3.2 Benefits and Risks for PWD

PWD has allocated at least $1.67 billion on an inflation-adjusted basis, over a 25-year period, to green at least 9,564 acres across the city, pursuant to a consent order with the Pennsylvania Department of Environmental Protection. PWD’s compliance strategy relies on achieving the required number of greened acres through a combination of direct investment in capital projects and the application of local regulatory requirements to redevelopment projects, which require such projects to retain runoff on-site. In a bond offering last year, PWD projected that redevelopment projects would yield 3,000 greened acres over 25 years. This suggests PWD is planning for its $1.67 billion budget to cover the remaining 6,564 acres—an estimated $250,000 of funding per greened acre on an undiscounted basis. PWD expects to finance its greened acre program primarily through debt issuance. Although PWD has not published a long-term budget for absorption of the allocated capital over time, the PWD Consent Order and Agreement sets forth the required number of greened acres in five-year increments over the 25 year period, as indicated in Figure 5.8 below:

**Figure 5.8: PWD’s Greened Acre Requirements**
The authors believe that the PPP structure may offer a compelling alternative to PWD's current greened acre plans, with clear benefits to PWD in meeting its clean water obligations. Potential benefits are discussed in the three sections that follow.

5.3.2.1 Lower-Cost Construction and Operations
The authors understand that PWD is currently delivering greened acres at an estimated up-front cost of $250,000 per greened acre, primarily implemented in the public right-of-way, and that PWD expects the cost of greened acres to diminish over time. If PWD were to undertake a PPP to deliver a greened acre portfolio, it might consider establishing a maximum acceptable construction cost per greened acre in any RFP it would issue for a PPP structure. The maximum acceptable construction cost per acre would set a cost ceiling on acceptable acres in a given portfolio, and would be set with the objective of reducing construction costs relative to PWD's expectations of what it could implement on its own.

It has not been within the scope of this study to complete the technical survey that would be necessary to determine the viability of a private sector party's ability to deliver greened acres at a lower cost than what PWD could achieve on its own. Nevertheless, there are reasons to expect that a lower-cost portfolio could be delivered:

- A private partner contracted by PWD can focus on technical designs and property types where it has a competitive advantage and thus deliver greened acres in a cost-effective manner.

- A single partner engaged for the full range of design, construction, and maintenance of greened acres can construct a portfolio so that it delivers the lowest cost over its lifetime, as conflicts between design and maintenance decisions can be optimized and rationalized (as opposed to a design or practice implemented by one party and then maintained by another, where inherent inefficiencies will be embedded in the cost structure).

- An up-front commitment to a partner able to deliver a sizable portfolio of greened acres will enable the partner to achieve economies of scale in the sequencing and organizing of its work, economies not available to greened acres implemented in small increments over the 25-year period currently contemplated under the consent order and agreement.

- A private-sector partner may be able to deploy green infrastructure in a cost-effective manner on property types that PWD would not otherwise have access to, or have access to at reasonable cost.

In order to determine whether a PPP can offer more cost-efficient greened acres to PWD, the authors recommend that a "value for money" analysis be completed whereby the total up-front and ongoing costs of a publicly managed portfolio of greened acres on both public and private properties is compared with the total up-front and ongoing costs of a privately managed portfolio of greened acres. If this analysis suggests clear cost savings in some areas but not in others, PWD can decide not to pursue the PPP, or it can set forth the scope of services to be delivered by the private partner accordingly. For example, if PWD determines that operations and maintenance for a project can be handled most cost-effectively by the department itself, it can engage the private partner to focus only on the design, construction, and financing aspects of a greened acres program.

The consulting firm AKRF was engaged to provide an estimate of costs and the potential supply of greened acres on residential and commercial properties. Notwithstanding the limitations of the cost curve analysis described in Chapter 1, the cost curve suggests that there are numerous opportunities to green acres for less than the $250,000 per acre that PWD is currently estimated to be spending to green acres. As indicated in Chapter 1, the cost curve should not be read as indicating the total supply available, given that simple summing of the AKRF analysis double-counts properties where multiple types of SMPs could be implemented, but rather as an estimate of the total number of SMPs possible within each SMP category type. The figures below summarize the estimated number of potential greened acres and capital requirements for each category of SMP.

A PPP could be structured to invite private partners to submit proposals to green acres on any combination of residential, commercial, and public properties such as schools and hospitals. Utilizing a PPP structure to deliver downspout disconnections might prove challenging, as it assumes implementation of the SMP on over 360,000 residential properties. Significant work would need to be undertaken to evaluate the cost of administering a downspout disconnection program over such a large portfolio of properties. PWD in that case might be better off utilizing a strategy such as the one implemented by the city of Portland, Oregon, which distributed downspout disconnection kits free of charge to residents to self-install in a program that was oversubscribed and deemed highly successful.

A PPP structure might be better suited to engage a private partner to deliver a portfolio of greened acres utilizing swales, porous pavement, rainwater harvest and reuse, and rain garden SMPs. Alternatively, PWD could design the PPP to engage a private partner to focus specifically on a property type such as schools, parking facilities, university campuses, or vacant lots. The scope of projects targeted by PWD in a PPP structure should, in any case, offer opportunities for private partners to deliver greened acres in the most cost-effective manner possible.

5.3.2.2 Access to New Sources of Funding
Because PPP financings tend to price higher than government issued bonds, given their off-balance-sheet structure, they have the ability to attract a different class of investors. For example, many large private-equity infrastructure funds have return hurdles in the range of 10 to 12 percent or higher on a leveraged basis. PWD's tax-exempt bonds trade in the 4 percent range. A PPP capital structure that offers higher-risk and higher-reward opportunities for equity investors can dramatically increase the capital
Figure 5.9: Estimated Potential Supply of Greened Acres and Capital Requirements by SMP

### POTENTIAL SUPPLY OF GREEN ACRES

<table>
<thead>
<tr>
<th>Potential Source</th>
<th>Estimated Potential Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Downspout Disconnection</td>
<td>6,687</td>
</tr>
<tr>
<td>Swales</td>
<td>658</td>
</tr>
<tr>
<td>Infiltration Trench</td>
<td>860</td>
</tr>
<tr>
<td>Rainwater Harvest &amp; Reuse</td>
<td>3,070</td>
</tr>
<tr>
<td>Downspout Disconnection</td>
<td>3,142</td>
</tr>
<tr>
<td>Rain Gardens</td>
<td>233</td>
</tr>
<tr>
<td>Reducing Impervious (Hard) Surface</td>
<td>3,420</td>
</tr>
<tr>
<td>Flow-Through Planters</td>
<td>2,064</td>
</tr>
<tr>
<td>Green Roofs</td>
<td>3,142</td>
</tr>
</tbody>
</table>

### POTENTIAL CAPITAL REQUIREMENTS

<table>
<thead>
<tr>
<th>Potential Source</th>
<th>Total Estimated Capital Required ($ Mil)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Downspout Disconnection</td>
<td>$10</td>
</tr>
<tr>
<td>Swales</td>
<td>$45</td>
</tr>
<tr>
<td>Infiltration Trench</td>
<td>$425</td>
</tr>
<tr>
<td>Rainwater Harvest &amp; Reuse</td>
<td>$439</td>
</tr>
<tr>
<td>Downspout Disconnection</td>
<td>$563</td>
</tr>
<tr>
<td>Rain Gardens</td>
<td>$44</td>
</tr>
<tr>
<td>Reducing Impervious (Hard) Surface</td>
<td>$879</td>
</tr>
<tr>
<td>Flow-Through Planters</td>
<td>$465</td>
</tr>
<tr>
<td>Green Roofs</td>
<td>$1.5Mil</td>
</tr>
</tbody>
</table>
available for funding greened acres construction and operations.

The private partner contracted to finance and deliver greened acres to PWD can consider a variety of capital structures that incorporate nontraditional sources of funding, including philanthropic capital, impact-oriented capital held by those interested in achieving environmental objectives alongside financial ones, and traditional institutional capital sources. Use of creative financing structures could blunt the likely premium required to complete the financing and thereby enable PWD to benefit from the other features of the structure. See Section 5.5, below, for a discussion of investor feedback and factors affecting required returns.

**5.3.2.3 Shifting of Performance Risk to Private Companies and Investors**

Use of a PPP structure gives PWD the opportunity to shift both performance risk and cost management risk to a private-sector partner. Cost management risk is mitigated for PWD in a PPP structure because payments to the private partner would be dependent on achievement of established performance goals. Should the partner fail to achieve the performance goals, PWD would not be obligated to make payment. As a result, the financial risk associated with the PPP strategy is minimal. However, the performance risk cannot be shifted entirely to the private partner.

Unlike other infrastructure expenditures such as transportation projects, PWD will in any case be required to comply with its obligations under the EPA consent order and its Long Term Control Plan. Should PWD rely on a private partner to fulfill a portion of the required number of greened acres and that private partner should fail to perform, PWD will need to identify alternative means of compliance at a potentially higher cost and with insufficient time to enable substitution of acres to take place. Therefore, PWD will need to pinpoint the key drivers of performance risk and manage them accordingly. Figure 5.10 below maps out the life cycle of project implementation and can be used to analyze the specific risk drivers that could impair delivery and performance of a PPP greened acre portfolio. We have grouped those risks in three categories including the pre-construction risk, the construction risk, and the operations and maintenance risks.

Given the heightened sensitivity PWD will have to performance risk, it is important to manage the risks present throughout the life cycle of project implementation. PWD is experienced in assessing and managing construction and operations and maintenance risks, but preconstruction risks could be impactful. In particular, private partners may be unable to provide appropriate performance guarantees to PWD on delivery of greened acres because they may be unable to secure access rights to some properties for project implementation. However, PWD should not engage a private partner without receiving guarantees on delivery of greened acres over the term of a contract that relies on property access.

This risk may be mitigated through the use of a two-stage selection process in which PWD offers a contingent contract to a private partner, subject to that partner’s securing access to properties in a limited time period. For example, private partners could be invited to submit a preliminary proposal that would identify a specific portfolio of greened acres for delivery. PWD could provide the “winner” with a modest budget and a six-month time frame in which to secure access rights to the properties included in the stage-one proposal. At the point of selection of the winner of the first stage, PWD could enter into a contingent contract where the final contract execution is subject to certification of the portfolio assembled by the private partner against specific performance standards during the six-month period. In the event the partner cannot assemble the access rights to the properties, PWD’s contingent commitment would expire at low cost to PWD and with time for the department to implement its own program or identify an alternative partner. In such an arrangement, the private partner can better justify its time investment and opportunity cost of use of resources to solidify the availability of greened acres, while PWD reduces its exposure to the key preconstruction risk in the life cycle of the project.

**Figure 5.10: Lifecycle of PPP Project Implementation**

<table>
<thead>
<tr>
<th>PRECONSTRUCTION</th>
<th>CONSTRUCTION</th>
<th>OPERATIONS AND MAINTENANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Identify specific acres to include in portfolio, including properties and likely SMPs</td>
<td>1. Prep property sites</td>
<td>1. Conduct ongoing maintenance activities</td>
</tr>
<tr>
<td>2. Assemble portfolio by securing access rights to properties for project implementation</td>
<td>2. Construct projects</td>
<td>2. Periodically evaluate technical performance of project</td>
</tr>
<tr>
<td>3. Conduct all design work to refine precise costs and funding required</td>
<td>3. Provide ongoing reporting to PWD</td>
<td>3. Implement necessary capex improvements over time</td>
</tr>
</tbody>
</table>
PWD can mitigate the other, more typical risks in a PPP structure by including in the contract termination provisions such that nonperformance would be addressed by financial guarantees. These would provide capital to PWD to redeploy on alternative projects directly, or allow PWD to substitute the existing partner with a new one, to which any property access rights could be assigned.

### 5.3.3 Procurement Process

The implementation of a PPP structure usually involves three stages, including project appraisal and structuring, contract design, and contract management, as described in the figure below. In particular, PWD can first identify an appropriate cost benchmark and then to establish whether it is possible to deliver a cost-effective portfolio of greened acres, set forth in a value-for-money analysis comparing the costs and benefits of the public versus private-sector options. If the analysis is promising, PWD can consider designing a scope of work and draft contract to issue as part of an RFP process soliciting competitive bids for delivery of a greened acres portfolio.

Use of a PPP structure would likely require PWD to utilize the Philadelphia Municipal Authority, a special-purpose procurement entity that is permitted to engage in long-term contracts. Use of the PMA requires approval by the Philadelphia City Council. The diagram below sets forth the contract structure that PWD could use to engage a private partner.

Figure 5.11: Stages of a PPP Procurement Process

- **APPRAISAL AND STRUCTURING**
  - Establish appraisal criteria including feasibility and economic viability of the project, commercial viability of the project, value for money of the PPP, and fiscal responsibility
  - Identify, assess, prioritize, and allocate the risks of the PPP among the various entities expected to be part of the structure

- **CONTRACT DESIGN**
  - Set performance requirements
  - Establish payment mechanisms including bonuses and penalties
  - Establish payment adjustment mechanisms
  - Set forth termination provisions
  - Determine dispute resolution mechanisms

- **CONTRACT MANAGEMENT**
  - Manage the PPP transaction including procurement strategy, marketing, RFP, and bid process
  - Establish the contract management structures including monitoring over time

Given PWD’s success with the prior PPPs implemented since 1995, the authors are optimistic that the City Council would support a green stormwater PPP. Opposition to PPP structures in the U.S. more generally has centered on several key issues. First, in an effort to achieve cost savings, some private partners develop financial models that intend to use nonunion labor for the construction and operation of the project. Where union jobs are at stake, union opposition can form. Second, some constituents are suspicious of private-sector partners more broadly and consider the use of PPP structures as a privatization of public assets for private-sector profit at the expense of taxpayers. For example, numerous toll road PPPs have been opposed due to private-partner plans to significantly increase toll rates over time, earning profits by passing on higher costs to citizens, which can act like a regressive taxation program. In the case of a green stormwater PPP, these concerns are not particularly relevant.

To ensure that union jobs are not lost in the construction and maintenance of greened acres, PWD could require that union labor be used through the contracting process. As for the rate increase issue, this structure does not presume direct ratepayer compensation to the private partner, and PWD could in theory set in place a fixed payment schedule in advance, with agreed-upon escalations to compensate for inflation, and so on. The authors are optimistic that typical risks related to PPP procurement are minimal or easily mitigated through contract design.
5.3.4 Ownership and Control of Greened Acre Assets

PWD is accustomed to owning the pipes and treatment plants that it operates to provide services in Philadelphia. It is not clear, however, how PWD currently intends to “own” greened acres across the city. Where implementing greened acres in the public right-of-way, PWD would effectively own the greened acre in such a way as to assure its ability to control that parcel over time in meeting its compliance requirements. However, relinquishing the need to own greened acres more broadly could open the door to more cost-effective delivery. For example, a private partner may identify a portfolio of potential greened acres that can be implemented at low cost on residential properties. Its business model could involve making a form of lease payment to the homeowner for use of the property to install a rain barrel or downspout system, but it could obviously not contemplate ownership of that greened acre site in a traditional sense. The authors recommend that PWD consider permitting such flexibility in order to generate the most cost-effective options possible. It may be possible to mitigate control and compliance risk by effectively overgreening (e.g., greening 1.2 acres for every acre of compliance required), which could still be more cost effective than greening only those sites that can be publicly controlled in the strictest sense and at higher cost.

5.4 A PRIVATE PARTNER BUSINESS MODEL

Potential bidders for a PPP focused on green stormwater infrastructure fall into three main categories: traditional engineering and design firms, firms specializing in water-related infrastructure, and firms further specializing in stormwater practice design and implementation. Numerous other players would likely submit qualifying bids for consideration as well. Though the authors have not engaged in dialogue with firms specializing in water-related infrastructure, such as United Water and Veolia, to gauge interest in a greened acre program, both are active in PPPs for traditional water infrastructure. Smaller firms specializing in stormwater practice implementation could also be invited to bid.

Private partners wishing to make proposals in response to a PPP RFP issued by PWD would need to develop a business model that a) delivers and maintains a portfolio of lower-cost greened acre projects; and b) finances that portfolio in such a way as to minimize the costs and avoid impacting PWD’s credit rating and debt ceiling. Further research and development are required to assess whether firms can achieve either of those objectives, although a private partner should be able to capitalize itself in such a way as to offer a compelling financing cost as a component of the all-in payment schedule it could offer PWD based on the PPP financing markets more generally (see Section 5.5 for a discussion of financing premiums).
Assuming the PPP aims to deliver approximately 400 greened acres as described in Figure 5.7 above, with a cost range of $75,000 to $150,000 per greened acre, the capitalization required could range from $30 million to $60 million for design and construction plus an incremental amount of additional capital to fund initiation of operations. A private partner could consider a capital structure with a minimum of 60 percent debt financing. PPP structures tend to achieve higher levels of leverage in the range of 75 to 85 percent. Equity investors would in turn fund some 15 to 30 percent of capital required. Partners in a first-time green infrastructure PPP structure might also contemplate raising grant capital that could help mitigate performance risks associated with untested deployment of green technologies at scale. For example, grant capital could pay for “over-collateralization” of the PPP portfolio assembly to reduce the risk that certain properties will fall out of the portfolio over time. Or it could fund a capital expenditures fund pledged for use in the event of unforeseen maintenance costs. Assuming a grant pool constituted 10 percent of capitalization, a $3 million to $6 million grant fund could support the over-collateralization of an additional 40 greened acres, and potentially double the capital expenditures budget estimated as necessary for ongoing maintenance of the project. As such, the grant capital would reduce uncertainty and risk in the structure that otherwise could inflate the long-term cost of the contract as the private partner and investors attempt to ensure sufficient cash flow to pay for unpredictable maintenance costs without compromising investor returns.

As contemplated, debt returns would be fixed payments with amortization over a 10-year period. AKRF estimates that the useful life of virtually all SMPs is well over 10 years, allowing pay-down of the capital used for design and construction in a timely manner. Equity returns would be driven by potential sources of upside structured into the compensation schedule set forth with PWD; these could include performance bonuses for delivery of completed projects, bonuses for technical and operating performance over time, inflation escalations in annual payments, and potential efficiencies gained by the private partner that generate operating margin improvements over time.

5.5 INVESTOR CAPACITY AND FEEDBACK

Significant capital has been raised in recent years for investments in infrastructure across all categories (including transportation, water, and energy), domestically and around the world. Between 2006 and 2011, private sector infrastructure equity capital committed has effectively quadrupled to $250 billion dollars in equity, implying an infrastructure purchasing power of $625 billion assuming 60% leverage, and growing from 15 to 60 separate funds. As of January 2012, another 144 funds were fundraising, targeting an additional $93.2 billion.

![Figure 5.13: Infrastructure Investors](source: Preqin 2012 Infrastructure Investor Universe)
Several drivers are drawing capital to the infrastructure sector:

- **Demand for new projects:** The Organization for Economic Cooperation and Development (OECD) projects that annual infrastructure investment requirements will average some 3.5 percent of global GDP through 2030. The American Civil Society for Engineers reported in 2009 that U.S. states would need to spend $2.2 trillion over the subsequent five years to fund infrastructure needs, and approximately $286 billion annually through 2025.

- **Public funding shortfalls:** Already present budget constraints have been compounded by macroeconomic stresses in recent years. The Center on Budget and Policy Priorities reports that U.S. state budget shortfalls topped $280 billion for 2010 and 2011 alone.

- **Limited access to traditional financing:** Pressure by rating agencies constrains municipalities and states from issuing more debt. Rating agencies have downgraded government issuers of debt at record pace in recent years as states have struggled to maintain balanced budgets. Moody’s downgraded municipal issuers at the fastest rate in 20 years in 2009. States including California, Arizona, and Illinois experienced downgrades that pushed the amount of downgraded state-backed bonds to $199 billion, the largest amount in 20 years.

- **Risk/return profile of assets and demand for yield:** Investors view infrastructure assets and programs as lower-risk investments with steady, long-term cash flows. Many projects are characterized as mission-critical assets with limited competition. Such assets represent an opportunity to create steady cash yields that also serve as a hedge against future inflation.

  A total of 224 infrastructure investments were completed in 2011, a decrease from the 254 transactions completed in 2010. Unlisted infrastructure fund managers with a total of $174 billion of capital committed had some $68 billion looking for opportunities as of 2011.

  Impact investors represent a new category of investor interest. These investors evaluate opportunities on the basis of financial return and social or environmental impact. Estimates of impact-oriented assets under management vary widely, with Monitor Group citing some $50 billion in current assets under management with the potential to grow to $500 billion over the next decade. It may be possible to identify an investor or group of investors with interest in other types of green infrastructure, such as clean energy or sustainable agriculture, willing to deploy capital to a green stormwater investment opportunity.

  The authors conducted a series of meetings with leading financial institutions including Goldman Sachs, JPMorgan, Morgan Stanley, Deutsche Bank, and Citigroup to gauge institutional investor interest in the PPP structure as a proxy for investor interest and concerns more broadly. Participants in those meetings included a range of commercially oriented professionals involved in infrastructure investing and transaction structuring, corporate sustainability efforts, and corporate foundation grant-making. Feedback from these institutions suggests the following concerns, focused on performance risk, scale, and pricing.

- **Performance Risk:** Performance risk was highlighted as an area of primary concern. If PPP financing relies on a PWD contractual obligation for repayment, an institution’s comfort with the likelihood of performance becomes a critical element of risk assessment. For green stormwater mitigation, there are two types of performance risk: failure to complete construction according to design specifications, and failure to provide ongoing maintenance of infrastructure particularly as related to compliance with environmental regulations and requirements.

  Investors are accustomed to assessing construction risk and would likely price that risk into any PPP structure. Ongoing maintenance risk presents a greater challenge, with three major risk drivers potentially impairing performance and, therefore, triggering the cessation of payment obligations of PWD under a PPP contract. First, it is difficult to evaluate and project the costs of ongoing maintenance operations, which are largely untested at any scale, given that there has been no widespread deployment and maintenance program for greened acres to date. Second, the technology of green stormwater infrastructure may be perceived as relatively new and its future effectiveness uncertain. Some parties interviewed suggested that the efficacy of certain technologies and practices may decrease over time, potentially requiring significant additional capital investment to replace the SMP in order to continue to deliver mitigation benefits and earn the contract performance fee. Third, depending on the specific contract terms, investors expressed concern that the compliance requirements driven by federal regulations could evolve and change over time, making certain greened acres obsolete or increasing the costs of maintenance.

  These performance-related risks stand as the largest impediment to a cost-effective pricing of the strategy and will need to be carefully evaluated and structured around in order to satisfy the needs of PWD and potential investors in green infrastructure. Such concerns do not suggest that investors would not have interest in a green stormwater infrastructure PPP. However, if left unmitigated, these concerns would increase the required return associated with financing the structure and project implementation.

- **Scale:** For most investors, the scale required to attract mainstream institutional capital into a single investment entity is likely at least $20 million, and ideally $50 million or more. We define mainstream institutional capital as pension funds, sovereign wealth funds, foundations/ endowments, family offices, and private banks. Below the $20 million level, there are certain foundations, family and multifamily offices, and impact-oriented investors who are potential sources of capital. Infrastructure funds would need to make at least a $25 million commitment of resources to any potential PPP product. Around $75 million to $100 million would be an ideal amount of capital...
to attempt to raise based on local demand for the capital in terms of project need and potential institutional supply of investment capital. These data are encouraging in that they indicate institutional-scale investors could be approached to finance PPP efforts.

Initial interactions with potential investors, including several of the largest investment banks, confirmed that special consideration might be given to a pilot project with community benefits and green attributes, particularly one with promise of replication in other cities. If additional cities could also be considered in the investment universe, one could consider aggregating capital for a larger green stormwater retrofit fund. Conventional fund-raising and investment allocation limitations suggest a fund of $150 million to $250 million would be ideal for a multicility effort. A fund as small as $75 million to $125 million might be able to achieve desired geographic diversification.

**Pricing:** A PPP structured between PWD and a private-sector partner would have off-balance-sheet financing. Payments made through a contractual obligation do not imply the same liability to PWD as an on-balance-sheet loan obligation or bond issuance. Therefore, the return required by investors will necessarily need to incorporate the lower standard of obligation written into the contract. The weaker the PWD contractual obligation, the higher the return required. The stronger the obligation, the lower the return required. At the same time, the contract terms cannot be so strict as to mimic a traditional bond instrument in terms of PWD’s liabilities therein, or the contract will be perceived by PWD’s rating agencies to be debt-like, possibly resulting in a highly undesired impact on PWD’s credit rating and debt ceiling.

### 5.6 PWD CREDIT RISK

Given that the contemplated PPP structure would involve availability payments made by PWD to the private partner and supported by PWD’s general ratepayer revenue collections, investors would evaluate the credit risk of PWD, and financing premiums would be benchmarked against PWD bonds currently trading in the market. Given this, it is helpful to summarize the ratings and outlooks of recent and outstanding PWD bonds.

The water system serves all of the 1.5 million residents of the city as well as an additional 150,000 people in neighboring Bucks, Montgomery, and Delaware counties. Some 83 percent of water accounts are residential, with the 10 largest users representing 13 percent of total billings. The wastewater system serves a larger catchment area that includes nearly 2.2 million people. Below-average collection rates are a key credit concern. Annual collections currently average 85 percent, and delinquencies are budgeted into total revenue projections. Management is viewed as being highly tenured and capable. Annual rate hikes have averaged 5.5 percent, and revenue projections are thought to be credible and conservative. PWD maintains a Rate Stabilization Fund and a Residual Fund, which fluctuate in size but peaked in 2007 at $187 million and were projected to reach $174 million at the end of fiscal year 2011. Both funds are pledged as security for bondholders and serve as meaningful credit enhancement. Senior lien debt service coverage from net revenues has fluctuated over recent years, going as low as 1.12 times in fiscal 2009 but averaging 1.31 times from fiscal 2006 to fiscal 2010, and rising in 2010 to 1.4 times. Finally, the debt ratio dropped to 72 percent from 84.4 percent in 2010, though it is still more than twice the national median for Moody’s rated combined water and wastewater systems. The figure below summarizes the relatively strong ratings given to PWD’s bonds by Fitch Ratings, Moody’s Investors Service, and Standard & Poor’s Ratings Services.

**Figure 5.14: PWD Bond Ratings**

<table>
<thead>
<tr>
<th>Obligations</th>
<th>Amount</th>
<th>Fitch</th>
<th>Moody’s</th>
<th>S&amp;P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Series 2011A</td>
<td>$135.0m</td>
<td>A+</td>
<td>A1</td>
<td>A</td>
</tr>
<tr>
<td>Series 2011B</td>
<td>$33.6m</td>
<td>A+</td>
<td>A1</td>
<td>A</td>
</tr>
<tr>
<td>Series 2011C</td>
<td>$12.4m</td>
<td>A+</td>
<td>A1</td>
<td>A</td>
</tr>
<tr>
<td>Series 2011D</td>
<td>$18.9m</td>
<td>A+</td>
<td>A1</td>
<td>A</td>
</tr>
<tr>
<td>All Other Outstanding Obligations</td>
<td>$1.6bn</td>
<td>A+</td>
<td>A1</td>
<td>A; AAA/A--; AAA/A-1+</td>
</tr>
</tbody>
</table>

Based on current market conditions in the U.S. infrastructure investing markets, the authors assume that all-in financing costs for a PPP capital structure, including both underlying debt financing and equity investment, might price between 250 basis points and 400 basis points above PWD’s A-rated bonds, currently trading in the 3.8 percent to 4.2 percent range, implying an all-in cost of capital of 6.0 percent to 8.0 percent. Investors will benchmark the all-in cost of financing for the structure relative to the pricing of PWD’s bonds, and will require higher rates of return depending on the embedded loan-to-value, perceived regulatory risk that would impact ratepayer revenues (e.g., new limits to rate increases), the risk of the private partners’ execution capabilities, and the risks associated with PWD’s obligation to pay under the terms of the PPP contract. U.S. PPP transactions tend to price higher than might be necessary given the limited expertise that U.S. municipal authorities have in managing an efficient PPP process. One investor stated that Canadian PPPs price more attractively given Canada’s well-understood PPP process and transparent pipeline. As U.S.-based PPPs become more common, pricing will likely tighten further.

In any event, given that a PPP financing should always price higher than PWD bonds, even if PWD could achieve meaningful construction and O&M cost savings for a PPP-delivered portfolio, it would need to evaluate the all-in costs and benefits of greened acre delivery to see whether the financing premiums required relative to its own financing capacity would be justified, or whether utilizing an off-balance-sheet financing mechanism would offer other benefits that would warrant the additional costs.
5.7 CHAPTER CONCLUSIONS AND RECOMMENDATIONS

Public-private partnership structures offer PWD important potential benefits in the financing and implementation of its green stormwater infrastructure plan. PPPs can lower the costs of construction and maintenance, access new sources of investment capital, preserve balance sheet capacity, and incentivize optimal performance by shifting performance risk to private partners where payments are tied directly to performance.

In order to determine whether a PPP structure is appropriate for green stormwater infrastructure in Philadelphia, the authors recommend the following sequence of steps:

- **Complete a value-for-money analysis.** PWD should complete a value-for-money analysis that examines the costs, benefits, and risks associated with utilizing a PPP for green stormwater infrastructure.

- **Conduct a more comprehensive assessment of greened acre supply and cost estimates.** As discussed in Chapter 1, it would be useful to develop a more refined understanding of potential supply of greened acres with a narrower range of costs for purposes of determining the optimal cost benchmarks and focus for a green stormwater PPP.

- **Establish PPP contract terms.** Pending the conclusions drawn from recommendations 1 and 2, above, PWD should consider developing a draft PPP contract for use in engaging in further dialogue with potential private partners and investors.

- **Issue a request for qualifications or request for proposals.** Pending the conclusions drawn from recommendations 1 and 2, above, PWD may decide to issue an RFI or RFP to solicit specific proposals for consideration.
Endnotes

1 Philadelphia, like hundreds of other municipalities nationwide, is subject to Clean Water Act obligations to reduce raw sewage overflows from combined sanitary and storm sewers, as well as polluted runoff from separate storm sewers.


5 Under Philadelphia’s meter-based billing structure, which is now being phased out through July 2013, nonresidential parcel owners’ monthly stormwater utility fees were based directly on the diameter of a parcel’s potable water pipe; relatively high potable water usage meant a wider pipe and a correspondingly higher stormwater fee. Under that fee structure, owners who utilized large amounts of potable water were charged higher stormwater fees regardless of how much (or how little) stormwater their parcel generated. Owners who had larger paved parcels but who used little or no potable water paid a relatively low stormwater fee, or none at all, despite the fact that they were generating substantial amounts of stormwater for the city to manage.


7 During the phase-in period, the stormwater charge is a hybrid of the meter-based fee and a parcel-based fee.

8 “Impervious area” refers to the total square footage of any plane hard surface area—including the roofs of buildings, paved or hardscaped areas, and compacted dirt and gravel—that either prevents or restricts the absorption of water into the soil and thereby causes water to run off the surface. “Gross area” refers to the total area contained within the legally described boundaries of a property, excluding portions of sidewalk that are in the public right-of-way. See PWD, Frequently Asked Questions: Stormwater Management Service Charge (November 2010). Accessed at www.phila.gov/water/Stormwater/pdfs/Non-Res_FAQ.pdf.

9 The FY14 rates stated here are taken from a joint settlement proposal by PWD and the other parties to the rate proceeding; it is highly likely these rates will be adopted, since they are not being contested.


11 The maximum given credit that a parcel can achieve is 80 percent of the property’s impervious area (IA) and gross area (GA) charges. Per PWD’s proposed FY14 schedule detailed above, the combined annual IA and GA fee per square foot of impervious surface is $0.12. Implementation of an SMP retrofit would allow for a maximum credit of 80 percent of $0.12, equal to 9.7 cents.

12 See Appendix V, Figure 2: SMP Unit Costs Per Square Foot of DCIA.

13 To date, no comprehensive study has been done of SMP costs in Philadelphia. For this report, the authors retained the engineering consulting firm AKRF to develop cost data using a combination of literature values and built projects. Literature costs were used for basins, ponds, wetlands, reduced impervious surface, swales, rainwater harvest and reuse, flow-through planters, and green roofs (national cost survey of built projects provided by the Center for Watershed Protection, 2007); infiltration trenches (EPA, 2004); and porous pavement (Urban Design Tools, 2012). Literature costs were then updated to 2012 dollars and adjusted using a regional construction index factor for Philadelphia (Engineering News Record, 2012). In addition, 20 percent was added for design and engineering, and another 50 percent for site-specific contingency. Rain garden costs were calculated using the AKRF cost curve used to assess residential properties discussed in Chapter 3 of this report. For downsputs disconnections, which apply specifically to residential properties, costs were based on the assumption that the homeowner would redirect the downsput onto adjacent permeable area using simple tools and a plastic elbow attachment costing approximately $50. (As noted elsewhere in this report (see Sec. 3.18.1), PWD might determine that downsput connections require some limited professional oversight to ensure their effectiveness and safety; the costs of any such professional services are not included here.)

14 Conversion from cost per square foot to cost per acre was calculated by multiplying cost per square foot by the number of square feet in an acre (43,560).

Discounted cash flow analysis, or “net present value” (NPV) analysis, is used to take into account the time value of money—that is, the amount of money (on a percentage basis) that the invested capital could earn if it were allocated to an alternative investment. This percentage basis, or discount rate, differs by investor and project type, as investors will have their own “hurdle rate” (i.e., rate of return) they are seeking to meet or exceed given the relative risk and potential return of the project. For stormwater retrofit investments on nonresidential property, the authors have chosen to utilize an 8 percent discount rate. This choice is based on conversations with commercial real estate investors citing a traditional market convention of a 10 percent discount rate, modified by the low interest rates at the time of this writing as well as minimum required returns. The authors also took into account discount rate assumptions cited from the energy efficiency retrofit and solar project market of 5 to 8 percent. See Fuller, Portis, and Kammern, “Toward a Low-Carbon Economy: Municipal Financing for Energy Efficiency and Solar Power,” Environment Magazine (2009); and Gillingham, Newell, and Palmer, “Energy Efficiency Economics and Policy,” NBER Working Paper No. 150311(2009).

16 Though there is scant historical data on stormwater retrofit cost trends, one could also reasonably expect that additional projects will become more economically attractive over time, as economies of scale (achieved through project aggregation and project growth) and greater competition (via entrance of multiple contractors as the green infrastructure market grows) should cause the inflation-adjusted cost of retrofits to decline.

17 For a detailed methodological explanation, including a full explanation of project assumptions, see Appendix I.

18 For more information on the McKinsey cost curve, see “Pathways to a Low-Carbon Economy,” accessed at solutions.mckinsey.com/ClimateDesk/default.aspx.

19 DCIA refers to impervious areas where water flow is continuous to the conveyance system (i.e., streets with curbs, catch basins, storm drains, etc.) and to the basin outlet point (i.e., a retention/detention pond, existing storm sewer/ditch system, natural water body, etc.) without flowing over pervious areas.

20 Certain SMPs that require large amounts of open space (i.e., constructed wetlands, basins, and ponds) were not included in this analysis because of methodological limitations. See Appendix I.

21 For all of the SMPs except downsput disconnection, the acreage estimates include only potential retrofit opportunities on nonresidential parcels; Appendix I provides the methodology for deriving these acreage estimates. For downsput disconnections, the acreage estimates include only potential retrofits on residential parcels; Appendix V provides the methodology.

22 There are two reasons to look at multiple SMP options for each individual property: 1) When assessing which SMP to install on a parcel, property owners will not necessarily use lowest cost as the only decision variable (e.g., while green roofs are cost prohibitive in a credititing scenario, they potentially offer additional benefits such as reduced energy costs or higher perceived real estate value. 2) The model utilized feasibility rather than least cost to derive total acres. Had the model been based solely on
the lowest-cost option feasible at a given property, it would have limited the SMP options to downspout disconnections, swales, and infiltration trenches, thereby creating a graph that had few real points of comparison.

23 973 acres includes all downspout disconnect opportunities (658 acres) in addition to the lower 25 percent cost quartile of swale projects (215 acres). These two project categories are the retrofits that achieve discounted payback based on avoided fees over a 10-year time horizon.

24 As discussed further in Chapter 4, these low costs are based on the assumption that homeowners can reliably install downspout disconnections, to PWD specifications, without the need for professional services that would add to the cost. Further investigation of this premise is recommended.


27 Conversation with staff from engineering and design firm AKRF.

28 Information on the methodology used to generate Figure 1.4 can be found in Appendix III.


30 PWD has allocated $1.67 billion, on an inflation-adjusted basis, over a 25-year period to green at least 9,564 acres across the city, pursuant to a consent order with the Pennsylvania Department of Environmental Protection. In a 2011 bond offering, PWD projected that private redevelopment projects would yield 3,000 greened acres over 25 years. This suggests PWD is planning for its $1.67 billion budget to cover the remaining 6,564 acres—approximately $250,000 of funding per greened acre on an undiscounted basis. See “Green City, Clean Waters Program Summary” (June 2011) and www.phila.gov/water/pdfs/bonds_2011a-b.pdf.

31 For ease of comparison, the authors assumed a 10-year investment period on the part of PWD for SMP installations in the public right-of-way. A more an accurate comparison would require knowing the expected life span of the greened acres in the public right-of-way.

32 For a more detailed explanation of the challenges that private parcel owners are likely to encounter when they seek financing for green infrastructure retrofits, see NRDC, “Financing Stormwater Retrofits in Philadelphia and Beyond,” p. 10 (February 2012). Accessed at www.nrdc.org/energy/on-bill-financing-programs/files/on-bill-financing-IB.pdf.

33 For more detail on PACE, see www.PACENOW.org.


38 For more information, see fund.pfnyc.org/about.html.

39 For more information, see www.nycceec.com/mission/.


45 For more information, see fund.pfnyc.org/about.html.

46 Draft DC regulations § 531.1.

47 Ibid. at § 531.9.

48 Ibid. at § 501.6.

49 Ibid. at § 531.13.

50 Ibid. at § 531.13.

51 Email from Brian Van Wye, District Department of the Environment, to Craig Holland, EKO Asset Management Partners (September 7, 2012), on file with authors.


53 Draft DC regulations § 527.3.

54 Ibid. at § 531.10.

55 Ibid. at § 501.6.

56 Ibid. at § 531.13.

57 Ibid. at § 531.13.

58 Email from Brian Van Wye, District Department of the Environment, to Rebecca Hammer, NRDC (December 8, 2010), on file with authors.

59 Draft DC regulations § 527.3.

60 Ibid. at § 531.10.


62 Draft DC regulations §§ 532.1, 527.11.


64 Philadelphia Water Department, “Philadelphia’s Watershed History,” available at www.phillywatersheds.org/your_watershed/history.


66 U.S. EPA, Water Quality Trading Toolkit for Permit Writers, at p. 39-40. Pennsylvania’s statewide policy for nutrient and sediment...

67 Information on the exchange being set up in Washington, D.C., can be found at http://ddoe.dc.gov/node/224592.

68 PWD Regulations § 600.11(a).
69 Id. at §§ 600.11(b), 600.13(a).
70 Prince George’s County, Md., Code § 32-201.03(f) (2012).
73 Proposed DC regulations § 531.3(e).
75 Beyond making the property more difficult to sell, an easement may also affect the property’s value (easements can sometimes reduce the value of land by half or more).
76 Charlotte Post-Construction Stormwater Ordinance § 18-148; see also “Charlotte Post-Construction Stormwater Ordinance Administrative Manual,” p. 20 (July 2012), available at charmeck.org/stormwater/regulations/Documents/PCCOpercent20Documents/PCCOADminMan0712.pdf (specifying that off-site mitigation BMPs shall be subject to the same maintenance requirements as other BMPs).
77 Draft DC regulations §§ 528.1, 529.1(a).
79 See Section 1.2 for a detailed explanation of the SMSC and its projected escalation over time; the logic behind the selection of an 8 percent discount rate; and how these factors impact the financial viability of stormwater retrofits, both for on-site SMSC credit and for property owners wishing to generate off-site SRCs.
80 www.phillywatersheds.org/whats_in_it_for_you/residents/raincheck.
81 Cost estimate provided by AKRF.
82 The $0.35 per square cost was derived by dividing the cost of the downspout disconnection ($50) by the average project size of 143 square feet. If the project was larger, the cost per square foot would drop.
83 See Section 1.3 for an explanation of how stormwater fees and credits are calculated.
84 The consent order currently states that, for purposes of generating greened acres, “[g]reen stormwater infrastructure designs will be aimed at controlling at least 1 inch of runoff, and up to 1.5 inches of runoff, unless otherwise deemed feasible by engineering design.”