4.1 INTRODUCTION

Philadelphia’s parcel-based stormwater fee and credit program (hereinafter “stormwater management service charge” or SMSC) allows nonresidential customers to reduce their stormwater fee through the construction of approved stormwater management practices (SMPs). However, many property owners may lack cost-effective on-site options for mitigation given the constraints of their property. One potential alternative to provide flexibility for these property owners could be an off-site stormwater mitigation crediting program, whereby constrained property owners could purchase credits instead of building on-site SMPs or paying the stormwater fee. This chapter examines the feasibility and structure of an off-site program and explores the potential for supply under such a program. An off-site mitigation program would allow property owners to benefit from retrofits even when those retrofits do not generate credits for their own stormwater fees. For instance, residential owners who are not eligible for credits against their stormwater fee, and commercial owners who oversize their retrofits to manage more than an inch of runoff, could install retrofits and earn stormwater credits that could be sold to other property owners who lack financially attractive options for on-site investment.

Adding an off-site mitigation program to the existing stormwater fee structure could deliver several important benefits, including:

- Greater flexibility for constrained property owners by providing a lower-cost SMP retrofit option than may be available on their own parcels.
- System-wide cost savings by leveraging the market to find least-cost SMPs.
- An increase in private sector participation by incentivizing property owners not currently covered by the parcel-based stormwater fee structure (i.e., residential properties) to invest in mitigation.
- Maximization of retrofits on commercial properties by incentivizing property owners to retrofit beyond what is required to receive stormwater fee reductions.
- Establishing a market price to reveal low-cost mitigation opportunities, thereby attracting private capital to the most cost-effective retrofits.
- Creation of transparency and a market price for SMP retrofits.

Establishing an off-site mitigation program would also create new administrative burdens for PWD, such as certifying credits on credit-generating properties, maintaining a public credit registry (along with serial numbers for individual credits), and setting up a system to ensure that credit-generating sites continue to be maintained post-certification. And such a program would have to be carefully designed to ensure that it yields greened acres that can be counted toward PWD’s compliance with its Clean Water Act obligations. These issues are also explored below.

4.2 SUPPLY AND DEMAND

To analyze the potential off-site mitigation market, the dynamics of credit supply and demand must be examined. By definition, an off-site retrofit would have to capture runoff in a location, or in an amount, that would not earn credit against the stormwater fee of the property where the retrofit is installed. We have identified three distinct types of properties that have the potential to meet this criterion:

i. residential properties,
ii. development and redevelopment projects, and
iii. non-site-constrained commercial properties.

Each of these properties has unique characteristics and regulatory requirements that allow them to be sources of supply. Residential properties are not currently eligible for credit under PWD’s parcel-based stormwater fee structure; therefore, any stormwater mitigation they perform is additive and should receive credit. Development and redevelopment projects (which are required to manage the first inch of runoff) and already-developed commercial properties that voluntarily undertake retrofits to reduce their own fees could elect to manage more than one inch of on-site runoff or to manage additional runoff from an adjacent public right-of-way. The surplus management volume could generate an off-site stormwater mitigation credit.

Demand for off-site mitigation credits would come from property owners under the stormwater fee structure who, because of site constraints, could not retrofit their own properties. Authors’ analysis suggests that there may be relatively few off-site credit and on-site mitigation opportunities. Therefore, authors assume that there would be sufficient demand for mitigation credits as long as the cost of these credits is less than the cost of the stormwater fee.
Box 4.1: Potential for an Off-site Mitigation Program within PWDs Regulatory Authority

PWD maintains authority to implement a market for parcel-based stormwater fee credits under 351 Pa. Code § 5.5-801, which allows the Department to “fix and regulate rates and charges for supplying water...and for supplying sewage disposal services.” PWD currently operates a stormwater management services credit system under section 304.5 of the Philadelphia Water Department Regulations. However, substantial opportunity exists to establish an expanded credit system for the parcel-based stormwater fee program that would allow for creation of off-site stormwater mitigation credits through implementation of green-infrastructure-based SMPs. Such a program could greatly increase the use of green infrastructure in the Philadelphia area, resulting in reductions in stormwater runoff, stormwater pollutant load, and CSO events.

4.3 MARKET STRUCTURE: OFF-SITE MITIGATION TRADING

To understand how an off-site mitigation program could work, this section explores three possible models for off-site mitigation trading: bilateral, citywide, and public aggregation. Each of these frameworks has advantages, but it is important to note that these models are not mutually exclusive and, indeed, could coexist and support one another.

4.3.1 Bilateral Trading

The most basic off-site mitigation trade entails a bilateral transaction between a buyer and a seller. In this scenario, property owner #1 (the buyer) enters into an agreement with property owner #2 (the seller) to invest in an SMP on the seller’s property. In exchange for this investment, the buyer receives the associated benefits (i.e., cost savings) related to the stormwater fee reduction, which the buyer can then use to offset his own stormwater fee.

Of course, the off-site benefits transferred via the bilateral transaction would need to be recognized by PWD in order for the buyer to use the credit against his stormwater fee. PWD could simply recognize the SMP and credit the buyer’s account, or preferably PWD could issue a tradable instrument, an off-site credit. In this latter scenario, the seller would register the retrofit with PWD for approval. Once it was approved, PWD would issue a credit to the seller, who would then transfer the credit to the buyer. The buyer would then be able to use this credit to offset his stormwater fee. This concept of a tradable instrument or credit is relevant in each of these models and would facilitate the operations of an off-site mitigation program.

In a bilateral trading scenario there are several ways a buyer and seller could interact, depending on the requirements of each party. If the seller is capital constrained or requires technical assistance, the buyer and seller could work together at all stages of SMP development. In this instance the buyer could provide the investment capital as well as design and engineering assistance. Alternatively, if the seller has sufficient capital and access to design expertise, the buyer and seller could operate independently. The seller, or a third party working with the seller, could develop the project independently and then sell the final credits to the buyer.

Typically, a bilateral agreement between a buyer and seller would be negotiated for a fixed term and a fixed fee, meaning that a fixed supply of credits would be transferred to the buyer. All transaction and credit costs would be

Figure 4.1: Bilateral trading (shared savings)
directly negotiated between the two parties; however, as in many markets, standardized contracts can be created. As the market matures, third-party project developers could emerge who would work with potential sellers to finance and develop projects, as well as brokers who would facilitate transparency and connection between buyers and sellers.

For off-site mitigation and bilateral trading to work, the seller must be able to provide mitigation on a per-unit basis for less than the stormwater fee. Further, the buyer must be able to use the credits generated from the SMP to reduce his stormwater fee. Therefore, PWD must provide a clear pathway for the certification and registration of SMP credits so they can be used against the stormwater fee. One possibility would be to use PWD’s existing process for registering and validating on-site fee credits.47

There are some benefits to a bilateral transaction, primarily in its potential for simplicity and ease of deployment. From PWD’s perspective, a bilateral transaction may require minimum intervention and investment in market infrastructure since it simply requires the recognition by PWD of the credits generated by the seller for use against the stormwater fee. Further, a seller may be able to use a bilateral agreement as a basis from which to seek financing for SMP construction.

While there are benefits, there are also significant drawbacks when compared with a program that allows broader, citywide trading. The price and other details of a bilateral trade are typically kept confidential and therefore fail to develop a transparent market price that other property owners could use to guide their retrofit decision-making process. Additionally, a bilateral trading program does not take full advantage of the market mechanism to find efficiencies and least-cost mitigation. Rather than a robust market with a transparent value for credits and bids and offers, in a bilateral program buyers and sellers will have to seek each other out on a one-on-one basis. If a relationship is not already established between the two parties, there is little to no infrastructure available to facilitate a new relationship based on trading. In addition, buyers and sellers will have to invest in advertising their needs. This implies a cost and inefficiency.

As a point of comparison, renewable energy credit (REC) markets use bilateral trading. REC markets are predicated on the creation of a renewable portfolio standard (RPS), which mandates that utilities purchase a certain percentage of their power from renewable sources. Under this scenario, a utility may choose to enter into a long-term, bilateral contract with an energy supplier to meet its RPS requirements (or purchase RECs on the spot market, if one exists). Often, the renewable energy supplier will use the bilateral agreement as a means to finance development off-site that will ultimately supply RECs to the utility. Exchanges do exist in REC markets but are not widespread, given the disaggregated nature of REC markets.

### 4.3.2 Citywide Trading

To improve the efficiency of an off-site mitigation program, PWD should consider allowing broader participation incorporating citywide trading or sewershed-specific trading of mitigation credits. (See Section 4.11 for guidance on sewershed-specific trading.) As in bilateral trading, in a citywide trading program a developer of an off-site mitigation project would seek certification from PWD, or a third party

![Figure 4.2: Citywide Trading](image-url)
Figure 4.3: Public Aggregation: Option #1

PWD identifies and develops land; issues credits to a buyer, broker, or exchange.

Buyer may choose to purchase credits directly from PWD, broker, or exchange.

Buyer can opt to pay for credits in advance.

Buyer uses credits against SMSC bill.

- Designated by PWD, and upon successful certification would be issued a tradable instrument that could be held or sold. However, unlike bilateral trading, the seller could sell all or part of the credits he receives to any other party—either citywide or within his geographic boundary. That party, in turn, could choose to use those credits against his own stormwater fee or resell the credits to another buyer. The fact that the credit is now separated from the original seller is a key distinction between bilateral and citywide trading. Critical for this approach to work is the integrity of the certification program (refer to Section 4.8 for more details).

A citywide trading program would best harness the power of the market to incentivize property owners to invest in SMP retrofits, at or above the baseline. Benefits of a citywide approach include:

- Increased liquidity, with more buyers and sellers;
- Greater flexibility, with more options for constrained property owners and more potential buyers for off-site mitigation projects; and
- Increased likelihood of an open market with transparency on credit prices. A transparent market price for a unit of SWM mitigation would allow property owners to make informed investment decisions and would make it more likely that least-cost SMPs are being put into practice.

While these benefits are compelling, a broader program may require a larger administrative burden for PWD to establish the appropriate rules, processes, and market infrastructure to support such a program. This would include PWD regulation, the procedure to certify credits (this will likely be required for a bilateral trading program as well), and the possible establishment of a marketplace or exchange through which credits can be bought and sold. (See Section 4.14 for further discussion.)

4.3.2.1 Public Aggregation

While the two market structures described in the previous section rely on transactions between two private entities, another structure to consider is public aggregation. Under this scenario the city, or an entity designated by the city, would act as an aggregator to develop mitigation projects on private and possibly public land that could be offered in the form of stormwater fee credits to constrained property owners. A constrained property owner would be able to purchase credits from the city once they were created, or pay up-front into a fund that the city would use to develop stormwater retrofit projects. Either way, public aggregation would provide significant flexibility and a single contact for constrained property owners to participate in off-site mitigation. Moreover, purchasers would have the assurance that credits generated by the city would continue to function and not become invalidated, thereby reducing risk to the purchaser. The city in turn would be able to leverage economies of scale by aggregating demand from several property owners and investing in stormwater management interventions at a larger scale and on property that might otherwise not be available to a private developer, such as vacant lands.
It is worth noting that the city might also choose to designate an entity to act on its behalf. For example, PWD could designate an NGO, the Philadelphia Industrial Development Corporation, the Philadelphia Municipal Authority, or another entity to collect on its behalf and then distribute the money directly into a program that facilitates SMP retrofits. This program could be implemented by PWD, by this same entity, or by a private contractor administered by either of the former options.

Revenue generated through public aggregation would result in fewer dollars received by PWD through the stormwater fee. In order to be a viable alternative for constrained property owners, their payments into the fund would have to be less than their SMSC (as would be the case in all off-site credit trading schemes). In this scenario, PWD would receive lower net revenue than would have been generated through the traditional stormwater fee. However, public aggregation may have benefits that could justify its implementation, even when considering reduced revenue. For example, revenue from the sale of city-generated stormwater credits could be allocated to a capital budget rather than an operating budget, which is where stormwater fees reside. This type of budget flexibility could be attractive to PWD because it can use the money—along with its enhanced budget flexibility—to continue its own mitigation efforts. Finally, giving additional flexibility to constrained property owners may help mollify potential opposition to parcel-based billing.

One important consideration is to avoid competition between the public and private sectors for credits where the public aggregating mechanism would underbid the private developers. Therefore PWD should consider limiting the deployment of public aggregation to constrained property owners and consider placing a limited term on the aggregation mechanism that would serve to jump-start the program and offer flexibility to constrained property owners early. If unsuccessful, or if the program reduces PWD revenue beyond an acceptable level, the program could phase out while bilateral or citywide trading continued unabated.

Under any market structure, it is expected that PWD would bear some additional regulatory burden to set up a stormwater retention credit (SRC) market, enact policy, and incrementally improve the marketplace, as necessary. However, if a private marketplace were to evolve out of effective policy and the ability to establish a sufficient credit supply—as would be the aim with a public aggregation strategy—PWD’s regulatory burden should lessen over time. Again, these structures are not mutually exclusive and indeed could be designed to work together. For example, bilateral trades could take place within the framework of a citywide trading program, as could a public aggregation option.
4.3.3 Recommendations

Philadelphia should consider implementing a citywide trading program that introduces a tradable instrument that can be bought, held, or sold through an exchange. Introducing a tradable instrument increases the liquidity of the off-site market because it would attract more buyers and sellers to the marketplace. Further, a transparent market price for a unit of SWM mitigation would allow property owners to make informed investment decisions—making it more likely that least-cost SMPs would be put into practice.

4.4 MARKET MECHANICS

Once the fundamental structure of the off-site credit market has been selected, several issues pertaining to the mechanics of the market must also be considered in order to ensure that the market is robust, transparent, and efficient. PWD must decide on a denomination, or unit, for off-site credits, as well as a life span for those credits. A credit exchange, or other infrastructure to facilitate the buyer-seller relationship, must be established in order for parties to come together and transact. PWD must set eligibility criteria for credit-generating projects, which may require determining whether geographical restrictions should be set for those projects vis-à-vis the sites purchasing the credits. PWD must determine requirements for project maintenance, inspection, and verification. Finally, public participation and transparency should be emphasized through a public comment process and an openly accessible online trading registry.

CASE STUDY: Washington, D.C.

In August 2012, the Washington, D.C., District Department of the Environment (DDOE) proposed new stormwater regulations for the city, pursuant to its recently renewed municipal separate storm sewer system (MS4) permit. These regulations require new development and redevelopment sites to retain on-site the volume of runoff generated by a 1.2-inch storm (the 90th percentile rainfall event in Washington, D.C.).

However, the regulations offer developers the option of retaining some of that volume off-site, as long as they demonstrate that a minimum of 50 percent of the retention requirement is met on-site. When a site selects the off-site compliance option, it may achieve its “off-site retention volume” by purchasing stormwater retention credits (SRCs), each of which corresponds to one gallon of retention for one year, by paying DDOE’s in-lieu fee, or by a combination of the two. The site owner may use SRCs that it has earned elsewhere in the District or purchase them on a private market. Regulated site owners are responsible for their off-site retention volume on an ongoing basis.

Sites may generate SRCs by installing management practices that achieve retention in excess of regulatory requirements, either by achieving any amount of retention on a site that is not subject to the regulations, or by achieving retention above and beyond what is required of that site by the regulations (up to a ceiling of the volume generated by a 1.7-inch, or 95th percentile, storm). After approving an application to certify SRCs for eligible retention capacity, DDOE will certify up to three years’ worth of SRCs for that capacity. After that three-year period, the owner of the retention capacity may apply for more SRCs.

These regulations are still in draft proposal form, and the program is subject to change until the regulations are finalized by DDOE in 2013. While the authors of this paper do not necessarily endorse all aspects of the proposal, it provides one useful illustration of how a tradable permit system could be structured.

CASE STUDY: Charlotte, NC

In 2008, the city of Charlotte, North Carolina, instituted an off-site mitigation program to provide flexibility for site-constrained property owners conducting development or redevelopment efforts downtown and in other targeted areas. The program was designed to reduce cost barriers for redevelopment that supported growth of Charlotte’s light rail system—a priority of elected officials, who are principally concerned with economic revitalization—while protecting the city’s water assets from impairment. In the fall of 2011, the program was expanded to incentivize redevelopment citywide, including suburban areas. The program is administered under Charlotte’s post-construction control ordinance—its permitting system for new development and redevelopment areas.

The ordinance allows property developers to pay a one-time fee if cost or site constraints prevent them from meeting their stormwater retention mandates (85 percent retention of total suspended solids from the first inch of a rainfall event). The city charges the developer $60,000 per impervious acre ($90,000 in the suburbs) so it can perform its own mitigation off-site on city-controlled lands, primarily through easements on private or public property. The fee is based largely on land costs (to the city), construction costs, and 20 years of operations and maintenance. One key drawback of this structure is that after 20 years, the cost of operations and maintenance shifts to the ratepayer, as opposed to the developer. The city, in turn, is able to achieve large economies of scale using this regional approach, and it is now building off-site SMPs for less than $30,000 per acre. A 2010 study from the Nicholas Institute for Environmental Policy Solutions quoted a comment by Daryl Hammock, Charlotte’s stormwater manager, on the cost difference between on-site and off-site mitigation: “On one three-acre urban site, the costs for underground stormwater treatment were estimated to be about $700,000. By allowing [developers] to pay a fee, in this case, $180,000, everyone was happy. The city is able to take $180,000 and treat a much larger area—approximately 18 acres—for the same cost.”

Since July 2008, this program has collected $3,238,405 over 33 projects for an average cost per project (to the developer) of just over $98,000. The money generated is invested in regional pond retrofits that remove total suspended solids and increase stormwater detention. Because the city views the program as a success, and based on interest from local project developers, Charlotte is now exploring the potential for private developments to generate stormwater retention credits (SRCs).

While not a direct analogue to the city aggregation market structure discussed earlier in this report (Charlotte’s off-site program involves a fee in lieu of on-site compliance), its success proves that a city can, in some cases, take on the project developer role more cheaply than private parcel owners.
4.5 CREDIT DENOMINATION

In order for a credit to be traded, it must first have a clearly defined unit of denomination. By analogy, within the carbon offset market a unit is defined as the right to emit 1 metric ton of carbon dioxide (CO₂) or another greenhouse gas set to an equivalent basis (CO₂e). Once a unit is established, it is then packaged into a credit using an offset ratio. The compliance authority under which a credit will be applied determines the offset ratio, which we can think of as units avoided to units emitted. The ratio can be 1:1, 2:1, or something else. Another way to think about this would be to consider how many units an emitter would have to purchase for every metric ton of CO₂e it emits.

Within the stormwater trading context, a parcel owner would purchase a stormwater retention credit (SRC) to offset his stormwater management fee. SRCs are similar in that they need to be set on a standard, unitized basis, with a defined offset ratio. This basis can be one or more of the following: temporal, meaning the length of time an SMP measure will remain a viable mitigation tool (discussed in more detail in Section 4.9, below); spatial, meaning the amount of area needed to manage runoff; or volumetric, meaning the volume of water the measure is able to manage. We recommend using all three parameters and discuss a number of options below.

4.6 SRC OFFSET RATIO

The simplest approach would be to use a 1:1 offset ratio. This means that the retention capacity needed for an on-site retrofit to receive a fee reduction (1 inch of stormwater) can be replaced on a one-to-one basis with an off-site credit purchased by the parcel owner. For example, Washington, D.C.’s proposed SRC regulations call for a 1:1 offset ratio.

While this is appealing for its simplicity, there are at least two scenarios in which an offset ratio other than 1:1 is likely to be necessary, and a third scenario in which such a higher ratio is worthy of consideration. First, if credit is provided for retrofits that manage more than 1 inch of runoff on-site (see discussion below), a different offset ratio is likely necessary. As noted below, there are diminishing environmental returns on greater levels of stormwater capture; therefore, capturing an extra half-inch of runoff beyond the first inch should not generate a full one-half of the value of a 1-inch credit.

Second, if credit is given for retrofits that manage less than 1 inch of runoff, a different offset ratio may be necessary. The value to PWD of capturing only a fraction of an inch on a site is not necessarily directly proportional to the value of capturing a full inch of runoff. As noted below, PWD would need to quantify the value to develop an appropriate offset ratio.

Third, an offset ratio of greater than 1:1 can be a useful way of hedging against the possibility that an SMP will not be well maintained to achieve peak performance at the credit-generating site. This risk also exists, of course, for on-site projects. However, this risk may be substantially increased when a credit purchaser combines credits from many small off-site projects (as opposed to a single on-site project). The risk may also be increased for certain types of projects; this could include SMPs installed on residential properties, which may be more likely to be inadvertently damaged by the actions of homeowners. For these reasons, PWD should consider an offset ratio of greater than 1:1 for any categories of off-site retrofits that are deemed to have a higher risk of failure than typical on-site projects.

4.7 OPTIONS FOR SRC UNIT DENOMINATION

Before presenting options for unit denomination, it is important to distinguish who is eligible to generate credits. If the credit is being generated by a site not subject to the parcel-specific fee (e.g., a residential property, then any retention capacity installed is additive and therefore should generate a credit. On the other hand, credit-eligible sites (e.g., commercial and condominium properties) would need to add retention capacity beyond what would be required to simply reduce their fee (more than 1 inch) (see Option 3, below).

Option 1

1 credit = 1 inch of stormwater managed per square foot

Placing credits on per-square-foot basis reduces land area restrictions that could preclude smaller properties’ participation in the SRC market. (See Section 4.17 for more detail.) It is worth lowering barriers to entry for smaller projects, especially for residential property owners, by providing credit for smaller interventions (such as downspout disconnects). In addition, PWD regulations enable property owners subject to the parcel-based fee to apply for a partial impervious-area credit. This credit is based on 1 inch of stormwater managed by an on-site SMP; where the square footage of the impervious-area credit approved is equivalent to the square footage of IA that is managed.21 Because there is no minimum square-foot limit under current on-site credit regulations, it may be unwise to have an off-site minimum square-foot limit for SRCs (as is the case in Option 2). In addition, buyers will likely want to trade in quantities specific to their needs. Placing SRCs on a per-square-foot basis would allow buyers to buy no more and no less than what their parcel size requires.

The disadvantage of this approach is that it increases the amount of individual credits needed for commercial parcel owners to fully reduce their stormwater fee, as they may have far larger areas to offset than a residential property or other small property could generate in credits. A potential result is an increased administrative burden and cost to commercial parcel owners—under a bilateral agreement, or agreements, the buyer might have to find multiple sellers to meet his total compliance needs, transact more credit purchases, and possibly pay a fee per transaction. Transaction fees may come in the form of a fee to PWD for minting/certifying the credit, which could be either absorbed by the seller or assumed by the buyer. Another possibility would be for the buyer to use a broker or exchange, which could aggregate credits generated from multiple sellers and bundle those credits into a single
transacting the deal.

**Option 2**

1 credit = 1 inch of stormwater managed per 500 square feet (spatial basis for IA parcel fee)

This option would set a minimum spatial requirement (500 square feet) for off-site credit generation. Because 500 square feet is the minimum threshold for commercial properties under Philadelphia’s parcel-based fee, this requirement should not restrict options on the buy side. In addition, similar transaction costs as discussed above may come into play. On the bilateral side, limiting SRCs to a larger area would limit the amount of sellers a buyer would need to transact with, and thereby limit his potential administrative costs.

However, from the authors’ initial analysis of potential, relatively inexpensive stormwater credit supply, it appears that the largest source of economically viable credits in the city is small residential projects (less than 500 square feet). Using this credit denomination would severely limit the number of credits in the market unless there were a mechanism to combine or aggregate smaller, partial credits.

**Option 3**

Properties not subject to the SMSC:

Partial credits of ¼, ½, and ¾ inch

Properties subject to the SMSC:

½ inch credit for properties mitigating beyond the first inch

This option may be used in conjunction with one of the two options listed above. It is meant to provide financial incentive for parcel owners not subject to the SMSC to voluntarily install any level of retention capacity feasible (both in terms of cost and space). It would also reward SMSC-eligible parcel owners who opt to mitigate beyond their 1” requirement, allowing them to sell off the additional mitigation as an SRC.

As mentioned at the beginning of this section, encouraging properties not subject to the SMSC to mitigate their runoff would add to retrofit incentives currently in place. Capturing a full inch of runoff from impervious areas on a residential property is clearly of value to PWD. PWD should also consider whether it could quantify the value—in terms of reducing sewage overflows—of managing less than a full inch of runoff from such sites. If PWD can quantify that value relative to projects that manage a full inch of runoff, then it could potentially expand the supply of retrofit projects by awarding credits for projects that manage less than an inch of runoff and assigning an appropriate offset ratio.

Second, for properties subject to the parcel-based fee, the option of awarding credit for managing runoff in excess of 1 inch also warrants further study. The majority (roughly 80 to 90 percent) of runoff in Philadelphia is generated by storms of 1 inch of rainfall or less, suggesting diminishing marginal benefits (in terms of reduced sewage overflows) from managing additional increments of runoff beyond 1 inch.22 Yet, once quantified, the environmental benefits of mitigating beyond 1” may be worthy of inclusion in the credit-trading scheme (with an appropriate offset ratio). For the purposes of our supply analysis, we assume that stormwater-credit-eligible properties that can mitigate beyond 1 inch of runoff would be able to sell off their surplus as credits (see Section 4:17, following).

Because a near-term supply of credits is crucial to ensuring that a credit trading system is utilized to its fullest extent, we do not recommend placing any undue barriers on credit generation. Therefore, we recommend using a combination of options 1 and 3 (pending further analysis by PWD of appropriate offset ratios for option 3), in order to allow the maximum number of residential and nonresidential property owners the opportunity to generate credits and participate in the trading scheme.

**4.8 CREDIT CERTIFICATION**

Before buyers and sellers can begin to trade credits, PWD must make key decisions about the features of those credits. Specifically, PWD must determine how those credits will be certified in order to become sellable, what the life span of the credits will be, and when the clock begins to tick on that life span.

Before credits are to be exchanged for a reduction in a ratepayer’s stormwater fee, PWD must certify that the installed retrofit SMP is functional and will actually retain the volume that corresponds to the fee reduction.

As for the entity that will perform the credit certification, PWD has two options: It can certify the credits itself (using its existing on-site requirements as the basis for certification), or it can delegate a third party with granted authority to certify credits. As part of the current Stormwater Credits Program for on-site retrofits, PWD performs all certification itself. The benefit of taking full responsibility for this task, as PWD has likely determined, is that the department can exercise complete oversight and quality control over the credit certification process. However, taking full control can also mean a significant expenditure of resources and staff time. This will particularly be the case if PWD greatly expands the number of properties that are eligible to participate as credit generators in an off-site mitigation program. While the expense to PWD could be partially offset by a user fee similar to the application fee that PWD already charges on-site credit generators, the certification process may nonetheless become unwieldy if the number of program participants increases significantly.

PWD could conserve resources by delegating certification authority to an independent third party, but doing so would require answering questions such as: What are the necessary qualifications for this third party? What benefit will the third party gain from the arrangement—will it receive a cut of the stormwater fee discount, be paid a flat fee by PWD on a contractual basis, or be compensated in some other way? How much oversight will PWD exercise—for example, will it perform occasional audits to ensure that credits are being properly certified? Will the third party be licensed by PWD?
Will it bear any liability if the credit seller’s retrofit SMP fails to perform the necessary retention? In carbon markets, it is standard practice for the party developing the credit to pay the costs of an accredited third-party verifier.

If PWD can devise a cost-effective arrangement that ensures adequate oversight of the certification process while relieving some of the administrative burden on the department, it may want to delegate this process to a third party. If PWD chooses such an arrangement, the third party should be required to document all credit certifications to PWD, with data about each individual project. This documentation must entail sufficient quality assurance and quality control for PWD to be able to vouch for all certified projects in its reporting to Pennsylvania Department of Environmental Protection (PADEP) and the Environmental Protection Agency (EPA) about how many greened acres have been achieved through the off-site mitigation program. As a result, if PWD intends to use a third party for credit certification purposes, the department should secure advance approval of that arrangement from PADEP and EPA. By contrast, the proposed credit program in Washington, D.C., authorizes only the District Department of the Environment (DDOE) to certify credits.53 This arrangement ensures that DDOE will have complete control over the certification and tracking of every credit.

PWD must also address details of the credit certification process. PWD’s current process for certifying on-site credits through its Stormwater Credits Program is generally appropriate for certification of off-site projects as well. As with PWD’s on-site credit process, PWD should require off-site credit applicants to complete an application form and provide required documentation, including a stormwater management plan and photos of the SMP and surrounding drainage area. As discussed below, maintenance plans are also critical and should be submitted with the application.

For example, similar to PWD’s current requirements for on-site credits, Washington, D.C.’s proposed program would require applications for credit certification to include a completed application form, documentation of the right to the credit (typically proof of ownership of the property where the SMP is located), a copy of a stormwater management plan that meets DDOE specifications or the SMP and area draining into it, an executed maintenance contract, and any other documentation that DDOE believes is necessary.54

PWD also needs to determine whether it will charge a fee for credit certification, and if so, the amount of the fee. Charging the current rate (for on-site credits) of $150 for the initial application and $50 for a renewal application would provide administrative consistency as long as this rate continues to cover PWD’s (or a designated third party’s) certification costs. By contrast, DDOE proposes to charge a significantly greater fee of $700 to $1,050 (depending on project size) for department approval of a stormwater management plan.55

PWD could continue to allow certification if the applicant submits photo documentation of the project; this is generally what it does for on-site credit applicants, with physical inspections occurring only at the department’s discretion. This arrangement is in line with the proposed Washington, D.C., regulations, which state that DDOE “may” conduct inspections of SMPs before certifying credits, at the department’s discretion.56 Although routine site visits for each credit applicant are more resource-intensive, they are also more reliable, and consequently we recommend them as an audit system to guard against improper SMP installation (and resulting worse-than-expected retention benefits).57

### 4.9 Credit Life Span

In a perfect world, the life span of a stormwater retention credit would be exactly equal to the life span of the SMP that generated it: this way, the fee discount earned from the credit would last exactly as long as the corresponding volume retention was achieved. However, in reality, this is not a practical goal as the life span (and consistent performance) of an SMP is not easily predicted. Moreover, assigning a different life span to each retention credit would prove an administrative challenge. Thus the designers of a credit trading program must decide upon a standard life span for retention credits.

Problems can arise if stormwater retention credits last indefinitely or for a very long time. For example, if a property subject to the stormwater fee buys credits from another parcel owner to retain stormwater on its behalf and the obligation ends there, there will be a risk that the retention practice will fail or be removed at some point in the future. In such a scenario, the rate-paying property would be receiving a stormwater fee discount even though no stormwater reductions were being realized. In addition, the idea of maintaining an SMP indefinitely may be so daunting to potential credit generators/sellers that they will decline to enter the program, thus reducing the supply of off-site credits.

Because of these factors, it may be desirable for an off-site mitigation program to use credits that have a defined and relatively short life span. If credits have limited life spans, the rate-paying property (the credit buyer) will periodically need to repurchase credits—or “cash in” its credits with PWD—in order to continue receiving a discount on its stormwater fee. Under such a scenario, credits could have a life span on the order of four years, which is the span PWD already uses for its on-site Stormwater Credits Program.

Limited-life credits would reduce the risk of administering unearned credits, while also making the program less daunting for potential credit generators/sellers. This arrangement could also prove more flexible for credit purchasers, in that they could periodically reassess their credit portfolios. For example, a buyer could periodically determine if it was more cost effective to pay more or less of their stormwater fee or purchase more or fewer credits.

Washington, D.C.’s response to this problem is instructive. The District’s first, unofficial trading program proposal required credits to have a very long life span—about 30 or 40 years, which is the average life span for a development in the District. However, DDOE identified three weaknesses with this plan: the two already described (potential SMP failure and daunting responsibility for credit sellers), along
with the problem of market participants facing a high-stakes, one-time opportunity to set the right price for the credit.\textsuperscript{58} Subsequently, the District revised its proposal so that a credit purchaser is subject to a permanent net retention requirement (because this program implements mandatory stormwater retention regulations) for the life of the development, but the credits themselves have a life span of only one year. Each year, a regulated site must prove to DDOE that it has fulfilled its retention obligation by using retention credits corresponding to its volume obligations for the upcoming year (or by paying an in-lieu fee).\textsuperscript{59}

On the other side of the transaction, for credit generators and sellers, DDOE will certify up to three years’ worth of credits for any given retrofit SMP\textsuperscript{60} The credit-generating site is then required to maintain the SMP for that authorized three-year period. At the end of that period, the owner of the credit-generating SMP may apply for another three years’ worth of credits, which DDOE will certify after verifying that the project is still eligible. (By way of example, an SMP with 1,000 gallons of retention capacity per year can be certified for 3,000 credits at a time.) With the exception of the fact that DDOE allows credits to be banked indefinitely, as discussed in the next section, this arrangement is a reasonable one because it ensures that credits represent volume retention by an SMP that has been recently inspected.

4.10 CREDIT TIMING AND BANKING

Once an SMP retrofit is constructed, the life cycle of an off-site mitigation credit is marked by at least four defining events: 1) certification of the credit by PWD, 2) issuance of a tradable credit to the seller, 3) transfer of ownership from seller to buyer, and 4) use (or “retirement”) of the credit by the buyer to receive a benefit (in Philadelphia, a discount on the stormwater management service charge (SMSC)). It is important to note that credits should be usable only after the SMP is fully functioning and retaining the intended volume of stormwater runoff, but not before.\textsuperscript{61} Additionally, a credit should expire if it has not been retired within the determined life span. The life span of the credit would likely start at credit certification in order to parallel the existence of the actual SMP, and end when the SMP needs recertification.

The temporal gap between certification of credits and their use (or retirement) is commonly referred to as credit banking. Credit banking offers several benefits both to market participants and to the program administrator. For property owners considering a retrofit, credit banking provides incentives to take early action and reduces risk by providing certainty that they will be able to sell credits in later years. For potential buyers, credit banking allows for increased flexibility in planning and risk management by allowing them to invest early and hold credits until they most need them. Banking may also eliminate certain complications for program administrators by avoiding the need to cancel or invalidate expired credits. For example, Washington, D.C., has proposed to allow indefinite credit banking as part of its trading program: A credit may be banked indefinitely, and the one-year life span of the credit does not begin until the date the credit is used to fulfill a site’s compliance obligations.\textsuperscript{62}

While credit banking provides some clear benefits, it also creates a problem of non-contemporaneity. In other words, the on-the-ground reductions in stormwater runoff and the benefits being gained by the credit purchaser may not be occurring at the same time. In fact, by the time a credit is used for a fee discount (or, in cities like D.C., for regulatory compliance), the corresponding SMP may no longer exist anymore. This arrangement is potentially problematic because the environmental benefit of retaining stormwater at time A may not be the same as it is at time B.

By way of example, imagine that a credit purchaser buys 10,000 credits at once and then uses 1,000 credits each year to earn a stormwater fee discount for 10 years. In this situation, 10,000 credits’ worth of retention has been achieved in the first year (contributing to CSO reduction), but none in the following nine years (not contributing anything to CSO reduction). This situation would be particularly problematic in Philadelphia due to the need for PWD to show under its consent decree that it has achieved greened acres. PWD must have a certain target number of greened acres actually in place at any point in time. Consequently, allowing credit banking would mean that ratepayers would be allowed to receive discounts on their stormwater fee at a point in time when PWD is unable to get credit toward its own regulatory obligations for the underlying greened acre.
To avoid situations where credits are being used for fee discounts at a time far removed from when the corresponding SMPs have ceased to have any benefit, it is necessary to require that credits be used within a certain period of time. For the purposes of this program we recommend that the clock start ticking on a credit at the point of certification (step 1) and last for the entire four-year certification period. Credit purchasers should not be allowed to bank credits beyond the four-year certification period. However, additional consideration is needed to determine whether it should be permissible to bank credits within the certification period—that is, whether a credit generated by the existence of an SMP in year 1 could be applied to reduce a parcel owner’s charge in year 4.

4.11 GEOGRAPHIC SCOPE OF OFF-SITE PROJECTS

A central concern for any proposed off-site mitigation credit program will be the geographic scope or extent of potential credits—in effect, whether a limit will be placed on off-site project location selection, and if so, how that limit will be defined. This aspect of the off-site mitigation program involves physical characteristics of the city’s watersheds (boundaries defined at the sub-watershed or watershed level, or left open to any location within the city’s jurisdiction), and the differences between areas of the city served by combined sewer systems (CSS) versus those serviced by separate storm sewer systems (MS4).

The goal in establishing a geographic limitation on where off-site mitigation projects could be implemented would help ensure that all program goals for water quality are met. Limiting the geographic scope of credit trading would provide oversight of the distribution of stormwater runoff reduction benefits. Such control and oversight would ensure that sites performing off-site mitigation, or sites purchasing credits, do not cluster in a way that reduces the water quality (and other) benefits desired by PWD. However, when determining the allowable geographic scope of off-site projects, it is important to recognize that the potential supply of mitigation sites, and thus the cost of buyer participation in the credit market, is likely to increase in line with the size of the allowable area.

While potential geographic scoping options are addressed below, a final determination on how to draw geographic boundaries may need to wait until further analysis is undertaken on the number and location of off-site mitigation projects. Ultimately, any program should consider these factors and be designed to achieve the objective of increasing use of green infrastructure within CSO areas.

4.11.1 The Art of Drawing Geographic Boundaries

The PWD jurisdiction has seven main watershed units (or areas of land in which precipitation drains to a particular body of water). They are: Cobbs Creek/Darby Creek (often referred to as the Darby-Cobbs watershed), Schuylkill River, Wissahickon Creek, Pennypack Creek, Poquessing Creek, Tookany-Tacony/Frankford Creek, and Delaware Direct watersheds.63 (These may be further divided by CSO/MS4 boundaries, as discussed in Section 4.12, below.) Historically, natural watersheds were used to “facilitate drainage,” and surface waterways in Philadelphia formed a framework in which to plan a network of conveyance pipes.64

There are multiple ways, both within the watersheds and through combining watersheds, to structure an off-site mitigation credit-trading program. The most likely potential boundaries would be:

- **Entire PWD/city jurisdiction.** This is the least restrictive option, with the least potential control over water quality outcomes.
- **Watershed-level boundary.** This is a moderately restrictive option, with at least partial potential control over water quality outcomes.
- **Sub-watershed or sewershed boundary.** Adopting a geographic boundary limit smaller than the individual watershed scale is the most restrictive potential delineation but also offers the greatest potential control over water quality outcomes and the siting of greened acres.

4.11.1.1 Entire PWD/City Jurisdiction

Opening the entire city to a unified trading program would likely increase potential program participation, including potentially maximizing green infrastructure investments with otherwise-planned capital projects in the public right-of-way or on public lands throughout the city. However, this option would not ensure that each waterbody would benefit from the pollutant load reductions necessary under the EPA CSO Control Policy. The policy requires compliance individually for each of the three distinct combined sewer systems (CSSs) associated with PWD’s three sewage treatment plants. This option would allow sites electing to purchase stormwater runoff credits to become clustered such that certain areas would receive substantially less actual runoff reduction benefit under the program, an undesirable outcome. (A similar concern can be raised for separate storm sewer areas in that city-wide trading would result in certain areas’ purchasing credits rather than using green projects to reduce runoff volume associated pollutant loading.) As a result, this degree of flexibility appears too great to ensure maximum overall benefit from the program.

4.11.1.2 Watershed Boundary

Using watershed boundaries as the geographic scope for each trading program area may provide enough flexibility to ensure adequate participation and adequate opportunity for PWD to maximize green infrastructure investments, while simultaneously assuring that each major creek or surface water within the city sees a substantial enough overall reduction in runoff to result in improved water quality and reduced flooding or to comply with CSO consent decree requirements.

Selection of watershed boundaries for program purposes may raise issues including whether each watershed can be treated similarly. For example, is a transfer of benefits
from the lower Schuylkill River watershed to the upper Schuylkill watershed equivalent to a transfer within a smaller watershed? While this approach has its limitations in terms of providing hyper-localized water quality improvements, from a compliance standpoint it is highly preferable to the unrestricted option of selecting the entire PWD jurisdiction for trading.

4.11.1.3 Sub-Watershed or Sewershed Boundary
Utilizing sub-watersheds (subset drainage areas of a designated watershed) or sewersheds (areas draining to a particular outfall of set of outfalls), consisting of total areas smaller than the entire watershed, provides the greatest control and limits the opportunity for project clustering. However, it is expected that this approach would restrict project and market development by narrowing the supply of potential low-cost projects. Private investors might also be deterred by sub-watershed-level restrictions because they would create a market with less demand, less trading, and thus less liquidity.

4.11.2 Project Safety Net: Philadelphia Water Department
It is important to note that incentivizing private retrofits is not the only strategy PWD will pursue to meet its greened acre development objectives. To fulfill its CSO consent order obligations, the department will also invest directly in retrofits, especially in the public right-of-way or on other publicly owned property. Therefore, the agency will have some ability to offset the negative impacts of project clustering by directing public investment to those areas that receive fewer privately financed retrofits. In light of this PWD “safety net,” if a relatively restrictive geographic scope were found to hinder participation in private retrofit development, it could be desirable to increase project location flexibility and backfill with government-sponsored projects.

4.12 DISTINGUISHING BETWEEN CSO AND MS4
Distinction between CSO and MS4 areas, or (as mentioned above) subdivisions within each combined sewershed, must be considered as part of any trading scheme. While there are important water quality benefits associated with implementing green infrastructure projects in MS4 areas, they will not help Philadelphia meet its consent order obligations to reduce pollution from its combined sewers.

If PWD so desired, it could provide a reduced-value credit for projects within MS4 areas that were purchased by property owners located within a combined sewershed. However, given PWD’s current priority objective of reducing CSO pollution, we suggest that PWD prohibit trading of credits between buyers in the combined sewershed and sellers in MS4 areas.

4.13 PUBLIC PARTICIPATION AND TRANSPARENCY
Public participation and program transparency will be key features of any off-site mitigation and trading program. If the city awards property owners a discount on their stormwater fees based on SRC credits, the public will want to know that such discounts are warranted.

Therefore, PWD should commit to developing a publicly transparent program that takes into account the views of the public and program participants. PWD should allow public input on the proposed structure of the program pursuant to its usual notice-and-comment procedures for proposed regulations. The department should then maintain a publicly accessible online database and credit registry where the details of off-site mitigation transactions can be viewed. To supplement this process, PWD could assign serial numbers to each credit, such that the use of the credit can be traced back to the SMP from which it was derived. Providing information and serial numbers on all credits generated, bought, and sold within the trading system will give buyers, sellers, regulatory agencies, and the public real-time insight into the state of the marketplace.

As the EPA has noted, “[t]ransparency and the free flow of information creates stable expectations and outcomes for market participants. With fewer lurking ‘unknowns,’ participants will feel less vulnerable in the marketplace and their required risk discount may shrink.” Consistent with the public disclosure recommendations EPA’s Water Quality Trading Toolkit, PWD should “clearly articulate the uncertainties associated with [SMPs], their implementation, maintenance and operation, and how these uncertainties will be addressed…. EPA’s Trading Policy encourages states and tribes to make electronically available to the public information on the trading partners, the quantity of credits generated and used, market prices where available, and delineations of watershed or trading boundaries.”

In connection with these public transparency measures, PWD must decide who will be responsible for the cost of setting up the registry, and who will be responsible for maintenance of the technology and the information. Will it be PWD or a third party? When considering whether to internalize responsibility for managing the registry, PWD will need to weigh its interests in maintaining control over what information is released, and how, against the cost and resource savings that could be realized through outsourcing the service.

4.14 ROLE OF A CREDIT EXCHANGE
Exchanges play an important role in financial and environmental markets. A credit exchange, which can be owned and operated either publicly or privately, is a marketplace where buyers and sellers can come together to transact credits. It serves several important roles including providing transparency, price discovery, liquidity, and governance for the market.
An exchange can serve several purposes, which can range from simply listing projects to providing a fully functional trading platform that allows buyers and sellers to transact. In addition to providing liquidity and transparency, an exchange can also provide a transaction clearing function. Clearing is the process by which an intermediary assumes the role of buyer and seller for a transaction in order to reconcile orders between transacting parties. This clearing function reduces counterparty risk and facilitates smooth market operations.

4.15 OPERATIONS AND MAINTENANCE

There are two fundamentally different approaches to SMP operations and maintenance (O&M) requirements in voluntary credit programs.

1. **Contractual obligation.** O&M could be structured as a requirement that is binding on the credit generator throughout the life span of the credit. In such a scenario, a credit generator would have to guarantee maintenance as part of the certification process. PWD could then force the credit generator to continue maintaining the SMP throughout the credit term.

2. **Misuse it, lose it.** Alternatively, O&M obligations could merely be a condition for redeeming a stormwater retention credit, such that a credit generator is free at any time to stop maintaining an SMP, with the only consequence being that the credit is no longer redeemable.

PWD should consider adopting the contractual obligation option, as PWD has a vested interest in being able to certify that greened acres are being delivered and maintained in line with the city's consent decree targets. While allowing credit generators to stop maintaining SMPs and terminate credits in the middle of a credit term might be more attractive to market participants, this factor is outweighed by PWD's obligation to deliver functioning green acres.

As an initial matter, an O&M plan should be submitted and approved as part of credit certification and origination. PWD must decide if O&M plans for off-site SMPs will be standardized, and if so, whether PWD or a third party will create the standardized form or guidance document.

In addition to an O&M plan, a legal mechanism is needed by which PWD can enforce the maintenance obligation in the case of operator default. This legal mechanism could mimic the structure of the city's mandatory stormwater management requirements for new development and redevelopment projects. Under existing regulations, construction on regulated developments may not commence until PWD has approved an O&M plan for the project. The O&M plan must include a signed agreement between the owner and the city to maintain SMPs in accordance with the plan, and both the plan and signed agreement must be recorded with the Philadelphia Department of Records, which makes the agreement enforceable against all current and future property owners.

4.15.1 Current O&M Obligations and Moving Forward

In contrast, PWD currently does not require any maintenance agreements to be signed for its voluntary on-site Stormwater Credits Program. An applicant for stormwater credits must simply submit a management plan for the credit-generating SMP(s) along with its application, and when a credit generator applies for credit renewal, it must merely provide evidence (inspection records) to show that maintenance has been performed on the SMP(s). As a result, PWD lacks any sort of enforceable mechanism to ensure that SMPs generating credits are properly maintained.

The option PWD has selected for compliance with its mandatory program is one of the most enforceable mechanisms available. While maximum enforceability makes it more likely that SMPs will be maintained, enforceable legal mechanisms are also more daunting to property owners and may discourage participation in a voluntary program, reducing the supply of off-site credits. On the other hand, the lack of any maintenance agreement for PWD's current Stormwater Credits Program means that the department has no way of ensuring that SMPs are maintained for the duration of the credit term. Consequently, PWD should consider some intermediate form of maintenance arrangement for its voluntary credit programs—something less daunting than the recorded agreement used for regulatory compliance, but more enforceable than the total lack of agreement currently used for on-site retrofits.

In this section the authors describe and evaluate a number of options that PWD could select for its off-site mitigation program. These options vary in terms of both enforceability and administrative burden—that is, how easy or difficult it is for PWD to negotiate the particular form of the agreement, and how much of the maintenance burden is placed on PWD.

**Option 1: Regulatory Maintenance Requirement**

Under the most straightforward option, PWD's regulations would require credit generators to maintain their SMPs, with attendant punitive consequences (such as fines or fees) should a PWD inspection reveal maintenance violations. The site owner would not be required to sign or file any document agreeing or committing to this obligation. While the regulations would be fully enforceable, this option presents a higher risk of maintenance failure because—this being just an ongoing regulatory requirement—the property owner is not necessarily made conscious or reminded of his obligation. The property owner who initially installs the SMP may become aware of the obligation during the project application and credit certification process, but if the property changes hands, the next owner may not be made aware of it. This option is not recommended (and authors are not aware of any stormwater programs that use this option).
Option 2: Unenforceable Pledge to Maintain SMPs

This option would require credit generators to sign unenforceable pledges to maintain SMPs. This mechanism was used in the recent stormwater retrofit rebate program signed into law in Prince George’s County, Maryland. This legislation authorizes the county’s Department of Environmental Resources to require residential rebate applicants to sign a pledge to maintain the SMP.

This option is the least burdensome for project generators because it is unenforceable. Residential property owners in particular—who are typically less sophisticated regarding stormwater management technologies—will be more likely to participate in such a program if they are not afraid enforcement action will be taken against them if they fail to maintain their SMP. However, because this option produces elevated project risk for PWD, it is not recommended.

Option 3: Enforceable but Unrecorded Maintenance Agreement

This option would require property owners to sign contractual agreements to maintain SMPs located on their properties. Contracts like these are legally enforceable against those who sign but are not recorded against the title to a property and, therefore, would not be enforceable against future owners if the property is sold.

The agreement could contain a provision requiring the owner to notify PWD in the case of property ownership transfer, so a new agreement could be negotiated with the new owner. If the initial owner failed to notify PWD, he would remain liable for maintenance costs even after the property changed hands. If notification was made but the new owner opted not to maintain the SMP or to allow a third party to maintain it, the credit would be terminated. As extra insurance against SMP failure, the maintenance agreements could be structured such that if a property owner failed to maintain the project, PWD could enter the property, perform the maintenance itself, and then levy and collect a special assessment or fee.

Examples of jurisdictions that use enforceable but unrecorded maintenance agreements in connection with on-site SMPs installed to satisfy a property owner’s regulatory obligations for development projects include Suffolk, Virginia, and Mentor, Ohio. This is also the option proposed in Washington, D.C.’s trading program for credit-generating sites. Under that program, retention capacity will be eligible for credit certification if the site owner has submitted an executed maintenance contract or signed a promise to follow a maintenance plan for the period of time during which the certification of credits is requested, in compliance with a District-approved stormwater management plan.

If a property owner violates this contractual obligation, it will be subject to a number of potential consequences. The District will not certify additional credits in the future for the unmaintained SMP; and the District will require the owner of the retention capacity to compensate for the capacity that was not maintained during a given time period by (a) forfeiting the corresponding number of credits, (b) purchasing replacement credits that the District will retire, or (c) paying an in-lieu fee to the District.

This option strikes a reasonable balance between enforceability and maximization of participation (as the property’s title remains unburdened; see below). This option is our preferred option for off-site credit generators if maintenance agreements contain provisions governing property transfer and right of entry for local government, as described above. In addition, if the credit life spans are indeed three to five years, the commitment on the part of the off-site credit generator is limited, which makes administration and enforcement simpler to manage.

Option 4: Recorded Maintenance Agreements

This option, which is currently used by PWD for properties complying with mandatory stormwater regulations, uses property law mechanisms to place a binding obligation on a property where an SMP is located. Real property law provides a number of ways to require certain actions by property owners; these mechanisms vary from state to state. One of the most common is a covenant, a signed agreement that is recorded against the title of the property and can, therefore, be enforced against subsequent owners.

The chief advantage of property law mechanisms, from PWD’s perspective, is that they ensure that the SMP will be maintained even if the property is sold. However, property owners are frequently reluctant to burden their properties with these instruments, primarily because they make it more difficult to sell the property. As a result, imposing a requirement to record a maintenance agreement might discourage participation in a voluntary credit trading program. (Since maintenance obligations apply only during the time-limited period for which a credit is certified, however, an easement would not be permanent, but rather linked to the lifetime of the credit. This would reduce the encumbrance placed on a property by the easement; a property owner would be free not to seek renewal of a credit, letting the easement expire along with the credit.)

One city that uses these mechanisms in its off-site programs is Charlotte, North Carolina. In Charlotte, the O&M agreement for an off-site SMP must be recorded against the title at the deed recorder’s office so that it is binding against all subsequent purchasers and will appear in the chain of title under generally accepted title-searching principles. Washington, D.C.’s draft stormwater regulations also provide that the on-site (regulated) property must file a covenant to maintain the site’s SMPs; this covenant includes both the on-site and off-site responsibilities of the regulated site.

This means that the regulated property owner is liable for violating its regulatory obligations if the off-site SMP(s) are not properly maintained. The covenant is binding on all subsequent owners and must provide for inspection of and access to the SMP at reasonable times by the District or its representative. Credit-generating sites, on the other hand, are not required to file a covenant, as discussed above.
Because this option may discourage participation in a voluntary program, and because having an obligation that runs with the land may not be critical if credit life span is relatively short, PWD may want to consider adopting a different approach for credit-generating sites.

Option 5: Escrow Accounts

Finally, PWD could require property owners to pay some amount (for example, a percentage of SMP construction cost) into an escrow account that is set aside to fund future maintenance of SMPs for the duration of the credit life span. The property owner would be required to replenish the escrow account as funds were withdrawn. The account would act as a guarantee that funds would be available for necessary maintenance activities. Several municipalities in North Carolina require escrow accounts for all structural SMPs constructed within the jurisdiction.  

Under this option, the maintenance could be actually performed by either the property owner or PWD. The latter scenario would be more attractive to property owners, especially those who lack engineering expertise, but it would significantly increase PWD’s administrative burden. Under any circumstances, a forced payment into an escrow account would increase the cost of credits to the buyer. 

Escrow accounts are not necessarily a separate and distinct option; they can be required in conjunction with any one of the legal mechanisms described earlier in this section. They may discourage participation in voluntary programs, however. If PWD does not opt to require escrow accounts, it might want to require some other financial verification to ensure that an off-site property is equipped financially as well as technically for proper maintenance.

4.15.2 Recommendation

In order to ensure that SMPs are maintained for the duration of the credit period, we recommend the combination of Option 3 (enforceable but unrecorded maintenance agreements) and some financial obligation, either in the form of an escrow account or another type of financial verification.

4.16 INSPECTION AND VERIFICATION OF OFF-SITE SMPs

The credit program will be required to develop a protocol for SMP inspection to ensure adequate performance during the lifetime of the credit. PWD will have to determine whether inspections are to be self-reported, conducted by PWD, or handed by a designated third party.

- The inspection programs will implicate, at a minimum, the following considerations:
  - Inventory of type and extent of each SMP/facility;
  - Creation of an inspection checklist for each facility, based on the maintenance needs for that particular facility type;
  - Recordkeeping protocols;
  - Identification of inspection personnel—what training or experience is necessary for a given inspection?
  - Frequency of inspection—may vary according to SMP type and volume/flow rate of runoff;
  - Reporting protocols—are records kept on-site, or collected and reviewed by a central authority?
  - Protocol for addressing violations of inspection requirements or failure to conduct inspections for self-reporting programs, or for addressing failure of project proponent to properly maintain SMPs.

As mentioned above, the final choice of inspection program elements may be influenced by the selection of legal mechanism for SMP maintenance enforcement.

4.17 THEORETICAL SUPPLY AND DEMAND FOR OFF-SITE MITIGATION

The viability of an off-site stormwater mitigation credit program will depend strongly on demonstrating sufficient supply and demand for off-site stormwater mitigation credits. On the demand side, property owners who have seen a dramatic increase in fees due to the switch to parcel-based billing (parking lots, industrial sites, big box retailers, etc.) will seek any way possible to reduce their fee exposure at the lowest cost. However, for many property owners, on-site constraints will preclude the lowest-cost stormwater retrofit options (such as rain gardens). Payback periods for more expensive technologies that work in constrained settings (such as green roofs and subsurface infiltration systems) are often too long—sometimes well in excess of 20 years—to warrant investment. Therefore, assuming SRC purchase prices reflect the lowest-cost option to these property owners, it is likely that the demand for off-site stormwater mitigation credits will be high, and therefore not the limiting factor in establishing a viable off-site stormwater credit market. Of course, this assumption could be undermined if the administrative hurdles of buying and selling credits are too burdensome, or costly, to undertake.

The current stormwater fee for nonresidential customers is approximately $0.10 per square foot of directly connected impervious area (DCIA) per year, with an expected 6 percent increase annually. Using a 10-year payback period, discounted at 8 percent, authors estimate that viable off-site stormwater mitigation credit projects will initially need to have a maximum cost structure of $0.82 per square foot of DCIA. As the SMSC changes over time, the financial viability of retrofit projects will also change. However, if the initial cost to generate off-site stormwater mitigation credits is significantly higher than $0.82 per square foot of DCIA, credit producers are unlikely to find willing buyers and the market will fail to develop. See the break-even analysis of Figure 1.2 for a more detailed look at the financial viability of various SMPs relative to different fee structures.
4.18 THEORETICAL SUPPLY: TYPES OF RETROITS/INTERVENTIONS

Below is a detailed supply analysis for three potential sources of SRFs: residential properties, redevelopment sites, and retrofits of existing nonresidential development. The analysis was conducted by AKRF, an environmental, planning, and engineering consultancy. For a detailed explanation of methodology, please refer to Appendix V.

4.18.1 Residential Properties

The approximately 364,700 residential parcels located in the Combined Sewer Overflow (CSO) boundary of the Philadelphia account for 43 percent of all impervious area within the 432,900 total parcels within the CSO boundary. Under the current stormwater credit regulations, residential properties are not eligible for stormwater credit. Still, managing the impervious area on these properties could generate salable credit “supply” (i.e., credit that would not be used for on-site fee reduction) for nonresidential property owners who lack financially attractive on-site retrofit options. This type of program could provide a means to extend stormwater credit benefits to residential customers.

It is worth noting that PWD recently implemented a program called Rain Check, which offers certain residential property owners partial reimbursement for installing on-site SMPs. The program is currently in a pilot stage, and the selection of eligible properties is in process. If successful, PWD plans to launch the initiative citywide. How the Rain Check program would relate to an off-site stormwater fee credit program requires further consideration.

To estimate the stormwater credit supply associated with residential property retrofits, a random sample of 20 residential parcels within the CSO boundary was selected for analysis, with the results extrapolated to the full universe of residential parcels within the CSO boundary.

Among the 20 sampled properties, the authors estimate that approximately 9 percent of the total impervious area could be treated using downspout disconnection (Figure 4.5). The assumed cost for a downspout disconnect project of up to 500 square feet is approximately $50. The average drainage area size for each sample disconnection was approximately 143 square feet. Scaled to all residential parcels within the CSO boundary, approximately 658 acres of impervious area credit could be generated using downspout disconnection, at a total cost of $10,033,952, or approximately $4.11 per square foot. Given our expected 22 percent margin of error, the total impervious area credited is expected to range from 1,312 acres to 2,052 acres, and the total runoff volume managed is expected to fall between 4,762,560 and 7,448,760 cubic feet.

<table>
<thead>
<tr>
<th>Sample sites</th>
<th>Universe (residential CSO, 1-97% IA)</th>
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<tbody>
<tr>
<td>Total DCIA (sf)</td>
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</tr>
<tr>
<td>Avg. cost/sf treated</td>
<td>$0.35</td>
</tr>
<tr>
<td>Total cost</td>
<td>$800</td>
</tr>
<tr>
<td>Rain gardens only</td>
<td>73,263,779</td>
</tr>
<tr>
<td>Total treated DCIA (sf)</td>
<td>5,643</td>
</tr>
<tr>
<td>Annual credit:</td>
<td>$583</td>
</tr>
<tr>
<td>% treated:</td>
<td>22.8%</td>
</tr>
<tr>
<td>Avg cost/sf treated</td>
<td>$4.11</td>
</tr>
<tr>
<td>Total cost</td>
<td>$24,015</td>
</tr>
</tbody>
</table>

Given the unit costs derived for this study, on average, most residential rain gardens are unlikely to provide a viable source of stormwater credit for an off-site mitigation program without additional subsidy. In rare cases where the homeowner would be able to design, build, and certify the credit without the use of professional design or construction contractors, the cost associated with rain garden construction could be significantly lower than reported here. In contrast with rain gardens, the average cost of downspout disconnections is likely low enough that tradable off-site stormwater fee credits, if available from PWD, would provide a sufficient return on investment to a property owner. Homeowners could relatively easily retrofit their existing downspouts to discharge to existing pervious areas using household tools and materials available from home improvement stores. Downspout disconnection kits and how-to guidance could be developed to assist residential homeowners in implementing disconnections. An online self-registration system could be developed to help homeowners easily obtain credit for their disconnections. Because the annual credit associated with disconnections would be on the order of only $50 (for a 500-square-foot roof area) under current crediting levels, the credit registration process could be a significant barrier to widespread adoption, even if design and construction costs can be kept low. From the PWD perspective, a random system of spot inspections could be useful in ensuring long-term performance while minimizing administrative costs.

It is worth noting that the $50 installation cost assumes...
the homeowners have installed the measure themselves. However, PWD's requirements for SMP certification (e.g., appropriate gradient and size of pervious area into which the downspout is redirected) may be a cumbersome barrier for most homeowners wishing to receive credit. Engineering costs to ensure compliance can run upwards of $1,500. If the homeowner needs to bear this expense, this measure may be cost-prohibitive. However, there may be several possible ways to overcome this barrier. For instance, a project developer with sufficient engineering expertise could aggregate multiple retrofits into one project, assuming all costs. In this case, the developer would be the owner of the subsequent credits and would presumably pay the homeowner a portion of the proceeds. Alternatively, PWD could embark on an educational program and/or partner with local hardware stores to develop a parts kit, so the homeowner would be equipped with the requisite knowledge and tools to perform downspout disconnections to PWD standards without the help of an engineering firm. The authors do not necessarily endorse a self-installation approach; ultimately, PWD will need to ensure that downspout disconnections are never performed in a way that causes flooding, and that any SMP installation for which it grants credit meets the relevant technical requirements to be counted toward PWD's own greened acre obligations under its consent order.

4.18.2 Redevelopment

Redevelopment projects offer a potential source of off-site stormwater mitigation credits. Redevelopment projects in Philadelphia are subject to a variety of stormwater management requirements. The specific requirements that will apply to a given project depend on a number of factors including 1) whether the project is a redevelopment or new development, 2) whether the project directly drains to the Schuylkill River or Delaware River, and 3) the total earth disturbance associated with the project. However, most projects are required to comply with the water quality requirement, which mandates the on-site management of the first inch of runoff from DCIA using an approved SMP. If developers elect to provide on-site water quality management for more than the first inch of runoff from DCIA, up to 1.5 inches (or another agreed-upon cutoff), or are able to manage runoff from DCIA in the adjacent public right-of-way, the surplus management volume could generate a source of off-site stormwater mitigation credit. However, the availability of this source of off-site stormwater mitigation credit depends on property owners' ability to manage the surplus water volume at a cost low enough to justify their additional investment.

Unlike stand-alone retrofit projects, redevelopment projects offer the potential to absorb some of the one-time costs associated with retrofit construction (e.g., survey, mobilization, and closeout). Therefore, opportunities to cost-effectively manage excess runoff may be found in large redevelopment projects (on sizable industrial properties, for instance) where stormwater runoff can be managed via relatively large vegetated surface practices. For smaller projects (e.g., small commercial office buildings) where the redevelopment design calls for the use of structural stormwater management practices like subsurface infiltration systems to meet water quality requirements, the marginal cost associated with managing more than the first inch of runoff from DCIA may be a cost-effective alternative to vegetated surface practices. Overall, redevelopment projects may offer significant cost-effective off-site SMSC mitigation credits.

The authors estimate that approximately 104 acres of DCIA within the CSO boundary is redeveloped each year. For the present analysis, it was assumed that most redevelopment projects would opt to manage stormwater using subsurface infiltration in order to maximize the property's usable area, and that it would generally be feasible to oversize such subsurface facilities. By oversizing SMPs on these redevelopment properties to capture 1.5 inches of runoff, an annual surplus runoff volume of approximately 189,300 cubic feet could be managed using subsurface infiltration. By managing this surplus volume, redevelopers could generate approximately 52.2 acres of off-site stormwater mitigation credit. The off-site stormwater mitigation credit would provide approximately $227,000 in new stormwater fee credits per year, if the surplus stormwater retention capacity were credited at a 1:1 ratio with the first inch of runoff. (However, as discussed in Section 4.6, PWD should actually establish an offset ratio at a lower value for retention capacity greater than 1 inch; the appropriate ratio is not presently known.)

Based on data from recent redevelopment projects in Philadelphia, the average unit cost was estimated to be $1.13 per square foot of off-site stormwater mitigation credit. At this rate, the total annual cost associated with generating off-site stormwater mitigation credit from redevelopment sites is estimated to be $2,555,550. It should be noted, however, that as of FY14 rates, a $1.13 square foot credit would likely not be sufficient to induce private investment (see Chapter 1). This could change over time as the rate increases or if project costs decline.

4.18.3 Nonresidential Properties—Retrofits of Existing Development

The approximately 68,200 nonresidential parcels subject to the parcel-based stormwater fee located within the CSO boundary account for 57 percent of all impervious area on the 432,900 total parcels within the CSO boundary (approximately 10,400 impervious nonresidential acres of the total 18,200 impervious acres). Because nonresidential customers who invest in on-site retrofits to manage the first inch of runoff would likely apply the credits generated toward reducing their own stormwater charges, we assumed that management of more than 1 inch of on-site runoff would be required to generate off-site credit. In effect, nonresidential customers could oversize their treatment facilities to manage more than 1 inch and thus earn supplemental credit that could then be sold to other nonresidential customers. Alternatively, nonresidential customers could earn supplemental, tradable credits by oversizing their retrofits to manage runoff from the adjacent public right-of-way.
For retrofits of existing development, it was assumed that large sites, using SMPs that rely on vegetated surface practices, would account for virtually all opportunities to manage more than 1 inch of runoff from on-site impervious area, or to manage 1 inch of runoff from the adjacent public right-of-way, at a cost low enough to attract private investment under present circumstances. Applying criteria based on this assumption to identify potential projects, we estimate that stormwater retrofits could manage 147,000 cubic feet of surplus runoff volume (including 0.5 inch of on-site surplus runoff and/or up to 1 inch of runoff from the adjacent public right-of-way). This volume would be sufficient to provide 41 acres off-site stormwater mitigation credit at a unit cost of approximately $26,000 per acre of credit—if the surplus stormwater retention capacity is credited at a 1:1 ratio with the first inch of runoff. (However, as discussed in Section 4.6, PWD should actually establish an offset ratio at a lower value for retention capacity greater than 1 inch.)

This supply is associated with design and construction of five SMPs on four large properties at an average cost of $0.60 per square foot of off-site stormwater mitigation credit (including both on-site surplus runoff and runoff from adjacent right-of-way) (Figure 4.6). These were the only sites identified as viable, using the criteria above. If circumstances change such that higher-cost SMPs produce an attractive return on investment, the potential supply would increase significantly.

### 4.19 Chapter Conclusions and Recommendations

Off-site mitigation could play a role in helping PWD meet its stormwater mitigation goals. For some property owners with physically constrained sites, there may be no retrofit options that are financially attractive at present. By allowing such owners to reduce their stormwater fees by investing in off-site project credits, PWD could spur green infrastructure development. However, until more information is gathered on the actual costs of SMPs, it is impossible to accurately estimate the potential market for tradable credits. Additional research on SMPs is necessary to determine a source of supply of off-site projects for which the available stormwater fee credits would provide a sufficient return on investment, and it should be conducted before a decision is made to launch an off-site mitigation credit program. Presented below are a set of recommendations for such research and for the core principles that should be included in a successful, enforceable off-site mitigation program.

- **Conduct further research and analysis to determine more accurately the likely supply of off-site projects.** Determine if the market size is large enough to justify creating an off-site mitigation program.
- **There is significant uncertainty concerning SMP project costs (see Chapter 1).** Further research on costs should include a focus on the specific types of projects as potential sources of credit supply.
- **Given current cost projections, downspout disconnection—a retrofit specific to residential properties—is the only retrofit measure with a positive net present value over 10 years at current SMSC rates (see Chapter 1).** A key assumption underlying the low cost of downspout disconnections ($0.35/ft²) is that homeowners could implement them in a do-it-yourself manner, without the need for professional services for project implementation and certification. A research priority should be to determine the minimum level and cost of professional services that may be needed to ensure the proper design and installation of residential projects.
- **Consider granting residential properties off-site credits.** Based on analysis to date, downspout disconnections are the most promising source of low-cost credit supply. In order to unlock the potential supply from these SMP retrofits and to incentivize residential property owners to participate in green infrastructure retrofits, PWD should:
| If the cost of engineering or other professional services referenced in recommendation #1 are reasonable, PWD should develop a program directed to residential properties to help jump-start this market. This program could include education and technical assistance and could be facilitated through local hardware stores, to emphasize the do-it-yourself nature of this SMP.
| Consider assuming the responsibility for providing any necessary technical assistance to homeowners, free of charge. PWD would make its own assessment as to whether this additional cost is worthwhile.
| Combine the potential off-site credit trading program with PWD’s new Rain Check program (which provides a direct subsidy to homeowners for retrofits).
| Utilize a tradable crediting instrument. Introducing a tradable instrument that can be bought, held, or sold, increases the liquidity of the off-site market, as it would attract more buyers and sellers to the marketplace. Further, a transparent market price for stormwater retention capacity (SRC) based on a tradable instrument would allow property owners to make informed investment decisions.
| Consider allowing credit generation for less than 1 inch on properties not subject to the SMSC. Encouraging properties not subject to the parcel fee and credit to mitigate their runoff would add to retrofit incentives currently created by the credit structure. Capturing a full inch of runoff from impervious area on a residential property is clearly of value to PWD. PWD should also consider whether it could quantify the value—in terms of reducing sewage overflows—of managing less than a full inch of runoff from such sites. If PWD can quantify that value relative to projects that manage a full inch of runoff, then it could potentially expand the supply of retrofit projects by awarding credits for projects that manage less than 1 inch of runoff and assigning an appropriate offset ratio. To follow this approach, PWD would need to ensure it has a valid methodology, acceptable to its regulators, according to which these projects could be counted towards PWD’s consent order targets.
| Consider allowing credit generation for mitigation above 1 inch on all properties. The environmental benefits of mitigating beyond 1 inch may be worthy of inclusion in the credit-trading system. However, PWD should analyze the environmental benefits of managing an additional half-inch or more, and determine whether these benefits are marginal or substantial. PWD would also need to determine whether these credits should be included on a 1:1 basis or discounted.
| Trading of credits within a citywide trading program should be limited geographically in a way that serves PWD’s priorities for stormwater management. The geographic scope of credit trading should be designed to ensure that PWD priorities, such as reducing the number of CSO events, are well served. This would include, at a minimum, prohibiting trades between CSO and non-CSO areas, or reducing the credit value of such trades.
| All tradable credits should be certified by PWD, or a designated third party, before they can be redeemed for a discount from a ratepayer’s stormwater fee. To conserve resources, PWD can contract with a third party to perform credit certifications, as long as the third party is required to document all certifications to PWD with enough information for PWD to determine how many greened acres have been achieved. The credit certification process may include a site visit to inspect and verify the SMP(s).
| Following certification, PWD should ensure that a legal mechanism exists that allows access to a given property for inspection of SMPs. If PWD determines that self-report inspections are sufficient, PWD should penalize failure to self-report. In all cases, PWD must establish criteria and protocols for inspections, reporting, and recordkeeping.
| Credits should have a defined life span, with limited banking. A credit life span, possibly equal to the four-year certification period, is needed to reduce the risk of retention failure and to minimize barriers to entering the credit market. Credit purchasers should not be allowed to bank credits beyond the four-year certification period, since fee reductions should not be awarded after the obligation to maintain the underlying SMP has ended. Additional consideration is needed to determine whether it should be permissible to bank credits within the certification period (that is, whether a credit generated by the existence of an SMP in year 1 could be applied to reduce a parcel owner’s charge in year 4).
| Maintenance requirements for off-site SMPs should be defined and enforced. PWD should view SMP maintenance as a binding obligation that lasts for the duration of the of the credit term so it can reliably count the number of greened acres implemented and track progress toward compliance with its consent order. To enforce this obligation, PWD should require credit generators to sign a binding maintenance agreement. Such agreements should contain provisions governing transfer of the property and right of entry for PWD.

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