# Appendix A: The Impact and Benefits of Green Infrastructure in Stormwater Financing Programs

Green infrastructure is an approach to resource management decision-making that considers the interaction between natural areas and the built environment and looks to use natural systems to address environmental and social priorities. And while the body of research is still emerging, this approach also appears to have the potential to address economic needs as well. Because green infrastructure can yield a number of benefits, the reason communities turn to this approach is varied. At the regional scale, green infrastructure tends to refer to the network of natural areas that provides habitat, flood protection, cleaner air, and cleaner water. At a more local or site scale, green infrastructure often refers to stormwater management systems that mimic nature by soaking up and storing water.

In urban settings green infrastructure is primarily viewed as a method for addressing stormwater impacts, particularly those tied to water quality and quantity, while simultaneously delivering a host of other benefits. In these applications, green infrastructure relies on a combination of vegetation, soils, natural processes, and rain harvesting to manage wet weather and create healthier, more livable communities. When stormwater planning and the implementation of site-scale green infrastructure practices takes into consideration how these applications interact and function as a larger system, the impacts to water quality can be significant, and often at a cost that is less than an approach that relies on gray infrastructure alone.

**The benefits of a green infrastructure approach.** A green infrastructure approach to stormwater management uses practices that slow runoff allowing water to soak into the ground, enabling nutrients and contaminants to be absorbed and treated by vegetation, and reducing the frequency of peak flow events. From an ecological and quality of life perspective, this translates into less runoff, fewer sewer overflows and pollutants in streams, more opportunities for groundwater recharge, and fewer flooding events. From a financing perspective, this means fewer instances of damage to public and private property, reduced water and energy usage and treatment costs, and increases in the available water supply. Green infrastructure practices also tend to have lower capital costs than their gray counterparts.

In addition, green infrastructure has the capacity to deliver benefits beyond those related to water quality and quantity. Incorporating green infrastructure into local stormwater programming can address community priorities related to air quality, recreation, public health and safety, economic development, energy conservation, transportation and a host of social concerns. This means the return on an investment in green infrastructure spans well beyond the improvements to water quality and quantity management.

Green infrastructure can be a vehicle for meeting regulatory requirements for local governments, as well. As communities grapple with combined sewer long term control plans, stormwater pollution discharge permits, and total maximum daily load requirements, many are turning to green infrastructure as a cost effective way of meeting their water quality obligations. In fact, jurisdictions across the country – Portland, Los Angeles, Cleveland,

Milwaukee, Philadelphia, New York City, and others – now specifically require a green infrastructure approach in the agreements that guide their regulatory compliance programs.

**The challenges of a green infrastructure approach.** While a green infrastructure approach to addressing stormwater needs may reduce costs, it is not without its challenges. While the multiple benefits of green infrastructure make the approach appealing and suggest inherent efficiencies, the learning curve it can present to local agencies can be significant.

Traditionally, local governments have relied on separate agencies and departments to deliver the host of services that green infrastructure benefits can achieve. The need to coordinate planning processes, share project implementation and administration responsibilities, and possibly even blend budgets across agencies and departments presents a substantial change in approach and requires a level of innovation that local staff can be hesitant to take on.

The most effective green infrastructure efforts begin with an inventory of natural assets, which requires and understanding and capacity for GIS – to collect, manipulate, and analyze geographical data – that many local governments lack. This GIS capacity becomes even more critical in communities developing fee systems for stormwater management and green infrastructure activities. The ability to accurately assess a parcel's impervious surface lays the foundation for more equitable fee structures that are more closely based on a property's contribution to runoff.

In addition, for green infrastructure practices to operate at the scale necessary to benefit stormwater and water quality management programs can require a good deal of land. Not only are suitable sites significantly harder to come by in major urban areas, the cost to acquire that land can be far beyond anything feasible for local governments.

Finally, the long-term operations and maintenance schemes for green infrastructure are vastly different from their gray counterparts. In most cases, the local agency or department responsible for the management of water resources is rarely prepared to take on the responsibility of managing trees, soils, plants, and other green infrastructure assets. This can lead to the need to retrain staff or develop outside contracts for services existing procurement procedures are ill-equipped to handle.

**Impacts to local stormwater programs.** Green infrastructure will not replace gray infrastructure solutions; however, there are a number of advantages to incorporating green and gray infrastructure into stormwater management programs, many of which have financing implications. Integrating green and gray becomes particularly efficient when considered at the planning stage of efforts. A green infrastructure approach also provides the opportunity to leverage local capacity and revenue streams tied to ancillary benefits and engage private sector resources.

An emerging body of research indicates that under the right circumstances many communities can expect a significant return on their stormwater programming investments in the form of dollars churning in their local economies. In some cases this is a direct result of the installation and maintenance of green infrastructure practices, while in other cases it can be attributed to additional tourism that stems from the revitalizing of attractive, vibrant downtowns, the

restoration of a small town, main street character, or the preservation of natural areas that make a community a recreation or outdoor sporting destination.

Green infrastructure is a stormwater management approach with the capacity to reduce implementation costs, deliver benefits that serve multiple community priorities, engage the private sector and spur behavior change through the marketplace, and provide return on investment to local economies. As an institution that advocates for the efficient use of limited resources, the EFC's approach to financing stormwater management is to advance and expand the implementation of green infrastructure, and this guidebook has been designed accordingly. We believe that green infrastructure can contribute to the resilience of a community's economy, environment, and local way of life in a very powerful and meaningful way.

## Case Study: The City of Lancaster, Pennsylvania

The City of Lancaster serves as the county seat of Lancaster County and is home to some of the largest employers in the region including Lancaster General Hospital, School District of Lancaster and Lancaster County Government. The City's population is just over 59,000 people with a population density of nearly 8,000 persons per square mile. Most of the City is within the Conestoga River watershed, a tributary of the Susquehanna River; the Susquehanna River watershed is the largest major tributary draining the 64,000 square mile Chesapeake Bay watershed.

*Water Quality History.* The adverse impacts of uncontrolled stormwater runoff are exacerbated in communities with combined sewer systems (CSS) where stormwater and sanitary sewage flow through the same system of pipes. Lancaster is one of about 770 cities with a combined sewer system. Eighty-five percent of the time, the City's Advanced Wastewater Treatment Facility (AWTF) is able to manage and clean the volume of wastewater in the system. However, intense rainstorms often cause about 1 billion gallons of untreated wastewater to overflow into the Conestoga River, much of it runoff generated from impervious surfaces including buildings, streets, alleys, and parking lots.

When CSSs were being built across the country in the 19$^{th}$ and early 20$^{th}$ centuries, they were considered a highly efficient method of treating all forms of waste from urbanized areas, because they collected stormwater, municipal wastewater, and industrial wastewater all in the same pipe and conveyed them to a facility to be processed before discharging the treated water into nearby waterways.

The total land area served by the CSS is 2245 acres, representing about 45% of the land area of the City. In addition, portions of Manheim Lancaster Townships also drain into the City's CSS. The remaining areas of the City (2591 acres) drain into a separated storm sewer system.

*Local Priorities and Water Quality Goals.* In May 2010, the City began developing Pennsylvania's first Green Infrastructure Plan (GI Plan) for a Third Class City. Completed in 2011, the 25-year plan outlined strategies to install green infrastructure practices throughout the City, including porous pavement, infiltration and bioretention systems, green rooftops, rain gardens, and rain barrels. The GI Plan promotes an approach that achieves multiple benefits by incorporating stormwater management features into infrastructure renewal projects along with improved aesthetics, increased urban tree canopy, reduction of urban heat island impacts, and

other community improvements, all of which is the key to transforming the City into a sustainable healthy community.

Guided by the mission to provide more livable and sustainable neighborhoods for City residents, as well as to reduce combined sewer overflows and nutrients, the GI Plan was a broad collaborative effort, evaluating specific topics including impervious cover, likely project sites, grant funding, potential benefits, and the policies and actions needed to institutionalize green infrastructure in the City. Further analysis identified more than 50 existing and possible green infrastructure demonstration projects in various locations with the potential to remove an estimated 21 million gallons of urban runoff from the combined sewer system per year. The GI Plan sets forth the following goals:

1. Strengthen the City's economy and improve the health and quality of life for its residents by linking clean water solutions to community improvements (e.g. green streets).
2. Create green infrastructure programs that respond comprehensively to the multiple water quality drivers (e.g. TMDL, CSO and stormwater regulations) to maximize the value of City investments.
3. Use green infrastructure to reduce pollution and erosive flows from urban stormwater and combined sewer overflows to support the attainment of the Watershed Implementation Plan for the Chesapeake Bay and to improve water quality in the Conestoga River.
4. Achieve lower cost and higher benefit from the City's infrastructure investments.
5. Establish Lancaster City as a national and statewide model in green infrastructure implementation.

Based on these five goals, a series of policy objectives were developed emphasizing a results-oriented, inclusionary process that involved partnerships of government, residents and businesses in effectively planning and implementing green infrastructure strategies and demonstration projects. Additional policies addressed the need to further reduce nutrient and sediment loads that ultimately flow into the Chesapeake Bay, and incorporate green infrastructure as a component of the City's Long Term CSO control plan and SWM programs.

In order to implement the GI Plan, the City conducted an evaluation and assessment that required a three-step process:

1. Evaluate impervious cover by type and land ownership.
2. Identify potential green infrastructure project sites and grant funding for early implementation to understand the cost and benefit of each.
3. Determine potential city-wide benefits, and provide actions and policy direction to institutionalize green infrastructure throughout the City.

A green infrastructure calculator was developed to evaluate the potential stormwater benefits and costs associated with green infrastrcture implementation at two levels: approximately a 5-year period and a 25-year period. Major inputs to the calculator included:

- Impervious area by type;
- Implementation levels (by percentage of area managed);

- Runoff capture volume;
- Annual rainfall; Annual impervious runoff coefficients;
- Average redevelopment rate;
- Green infrastructure loading ratios;
- Unit green infrastructure costs (total and marginal); and,
- Typical event mean concentrations for stormwater and combined sewer overflow (CSO) discharges. The results of this modeling exercise are summarized in the following table.

**Green Infrastructure Runoff Reductions**

| Parameter | 5-year Implementation | Long-term Implementation |
|---|---|---|
| Impervious area managed by GI (acres) | 221 | 1,265 |
| Average annual runoff reduction (million gal/yr) | 182 | 1,053 |
| Average annual total suspended solids (lb/yr) | 252,000 | 1,475,000 |
| Average annual total phosphorus reduction (lb/yr) | 4,800 | 27,800 |
| Average annual total nitrogen reduction (lb/yr) | 10,700 | 61,600 |
| Total marginal cost | $7,800,000 | $77,000,000 |
| Total capital/implementation cost | $14,000,000 | $141,000,000 |
| Marginal cost per gallon CSO reduction ($/gal) | $0.06 | $0.10 |
| Total cost per gallon CSO reduction ($/gal) | $0.10 | $0.18 |

*The Cost Benefits of a Green Infrastructure Approach.* Though the City has been proactive in investing in projects that reduce CSS overflows, including investing over $30 million in the past 12 years on a variety of "gray infrastructure" projects and practices, a significant amount of untreated combined sewage continues overflowing into the Conestoga River. The City's approach to addressing these runoff issues will be to implement an infrastructure system that effectively links grey and green practices and approaches.

Experiences in other communities has shown that focusing inclusively on gray infrastructure options for addressing CSOs can be expensive to construct and maintain, while serving the single purpose of holding CSO volume for later treatment. The cost of one storage tank alone in the City's northeast section is estimated to cost $70 million, while managing only 10% of the City's annual CSO volume. To store and treat the current CSO volume is estimated at more than $250 million in construction costs, not including the annual operational costs in energy and personnel to run the new system.

When the GI Plan is fully implemented over the next 25 years, the citizens of the City of Lancaster will realize more than $100 million in savings. The estimated cost to store and treat the billion gallons of annual overflows utilizing traditional "gray infrastructure" would be well over $250 million, while the cost of equivalent "green infrastructure" is anticipated to be approximately $140 million.

*Learning by Doing: Implementing the Green Infrastructure Plan.* Perhaps the most impressive part of the City of Lancaster's Green Infrastructure Plan is that the plan is turning into action. The City has moved forward with a variety of green infrastructure projects including: green alleys and streets, porous parking lots, green roofs, and green enhancements to several parks incorporating a wide variety of green infrastructure techniques including porous paving, cisterns, rain barrels, tree trenches, rain gardens, and other forms of bioretention. The sites are a combination of City-owned properties, School District of Lancaster and other institutions, residential dwellings, as well as commercial and industrial properties. To date, more than 130 green infrastructure projects have been completed, are under construction or in the concept or design stage. When all these projects are completed, an estimated 100 million gallons or more of stormwater runoff will be kept from entering local watersheds per year.

In several locations throughout the City, more than 25 alleys and numerous streets have been redesigned or reconstructed, or are in some stage of being reconstructed to utilize a variety green infrastructure techniques. Several of these alleys are common alleys where all adjacent property owners hold a common share of the alley. The remaining alleys on the demonstration project list are City rights-of-way. One **green alley** alone can capture and infiltrate from between 200,000 and 1,500,000 gallons of rainwater annually. The Plum and Walnut intersection project integrated green infrastructure with traffic circulation and pedestrian safety enhancements to control nearly 1.5 million gallons of stormwater annually.

Several **green parking lots** in the City as well as on the Franklin & Marshall University campus underwent full renovation using green infrastructure technologies including permeable paving, infiltration beds, tree trenches, and rain gardens. In addition to capturing stormwater these projects included repaving, planting trees, improved lighting, and organized parking placement. Combined, these parking lots are estimated to prevent nearly 2.3 million gallons of stormwater from entering the sewer system on an annual basis.

**Green roofs** have been constructed on three School District of Lancaster Elementary Schools, three buildings on the Franklin & Marshall University campus, several private commercial buildings and Lancaster City government facilities including the recently completed City Hall addition for a total of more than 95,000 square feet. In addition to eliminating some 1,800,000 gallons of stormwater every year, these green roofs should extend the life of the roof, and reduce heating and cooling expenses.

Four **recent green** park improvement projects, Sixth Ward Park, Brandon Park, Crystal Park and Rodney Park incorporate a variety of green infrastructure techniques. The park improvements focused on park amenities like basketball courts, play equipment, picnic areas, restroom facilities and water features resulting in a rain gardens and new porous basketball courts to manage more than 6,000,000 gallons of stormwater from park areas and adjacent streets.

As of November 2013, 38 green infrastructure projects have been completed or are under construction for a total estimated annual rainfall capture of more than 20,000,000 gallons. Another 16 projects are in the design phase that when constructed will capture more than 6,000,000 gallons of rainfall annually.

*Establishing a Multifaceted Initial Funding Strategy.* The total project cost for developing the Green Infrastructure Plan was $140,000. The project was partially funded through a $70,000 Department of Conservation and Natural Resources, Community Conservation Partnership Program, Environmental Stewardship Fund grant. Live Green, a Lancaster-based nonprofit environmental organization focused on improving the environment in urban settings, provided $10,000 in matching funds while the City contributed $60,000 through a Capital Bond.

The City has received well over $10 million in grants and low interest loans from federal, state and local sources. A $7 million low interest PENNVEST loan is being used to design and construct the many demonstration projects as well as for leveraging additional grant funds administered by the National Fish and Wildlife Foundation (NFWF); the state departments of Environmental Protection (DEP), Community and Economic Development (DCED), and Conservation and Natural Resources (DCNR), and Lancaster County. These funds are being used for creating the "stormwater utility" and constructing and installing the many demonstration projects, including green streets and alleys, permeable parking lots and basketball courts, street tree plantings and expanding the City's urban tree canopy, green roofs, and vegetated curb extensions.

In order to fully implement the GI Plan and institutionalize green infrastructure as a part of normal development and redevelopment activity, the City is in the process of establishing a Bureau of Stormwater, which will administer the Stormwater Management Fee Program. This impervious area based fee will allocate the costs of stormwater management and water pollution control based on the amount of impervious surface area on each parcel. Commonly known as a "stormwater utility," this would apportion the costs of controlling CSOs and stormwater based on each parcel's proportionate use (as determined by impervious area) of the wastewater collection and treatment facilities. This allows for the reductions in a bill if a property owner installs green infrastructure to manage his or her impervious area and reduce flows to the CSS.

*Establishing a Sustainable Fee-Based Financing System.* Though the City has very effectively leveraged existing revenues with grants and other funding opportunities, long-term implementation success will require consistent and dedicated revenue streams. To that end, in the first quarter of 2014, the City's new Stormwater Management Fee (SWM Fee), based on a property's impervious area, will be rolled out. The fee will be assessable on all property within the City, including commercial, single-family residential, educational and faith-based, as well as all levels of government. The fee will provide secure funding source for the administration of the Green Infrastructure Program. One program objective is to create a GI Grant Fund that would incentivize improvements on private property by funding the marginal cost of the green portion of those improvements. Hand-in-hand with the grant fund will be a credit program to allow property owners a rebate on a portion of their SWM Fee for taking measures to reduce the amount of stormwater leaving their property and entering the City's sewer system.