FINANCING GREEN INFRASTRUCTURE

LESSONS FROM THE CHESAPEAKE BAY WATERSHED

MAY 2022

ICMA | research

ABOUT ICMA

ICMA, the International City/County Management Association, advances professional local government management worldwide through leadership, management, innovation, and ethics. Through expansive partnerships with local governments, federal agencies, nonprofits, and philanthropic funders, the organization gathers information on topics such as sustainability, health care, aging communities, economic development, cybersecurity, and performance measurement and management data on a variety of local government services—all of which support related training, education, and technical assistance. ICMA provides support, publications, data and information, peer and results-oriented assistance, and training and professional development to more than 13,000 city, town, and county experts and other individuals and organizations throughout the world.

icma.org

ABOUT THE CHESAPEAKE BAY TRUST

The Chesapeake Bay Trust is a nonprofit grant-making organization dedicated to improving the watersheds of the Chesapeake Bay, Maryland Coastal Bays, and Youghiogheny River. Created in 1985 by the Maryland General Assembly, our goal is to increase stewardship through grant programs, special initiatives, and partnerships that support K-12 environmental education, on-the ground watershed restoration, community engagement, and the underlying science of these three realms.

AUTHORS

David Rouse, FAICP
Lead Author

Econsult Solutions, Inc.
Green Infrastructure Valuation and Financing
Steve Wray, Senior VP and Principal
Melissa Wright, Associate
John LaVaccare, Analyst

This report was funded by the United States Environmental Protection Agency Region 3, Maryland Department of Natural Resources, and the Chesapeake Bay Trust.

This product has been funded wholly or in part by the United States Environmental Protection Agency under assistance agreement CB96358501 to Maryland Department of Natural Resources. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does the EPA endorse trade names or recommend the use of commercial products mentioned in this document.

Table of Contents

1. Introduction

Communities in the Chesapeake Bay watershed and across the nation are deploying green infrastructure to manage stormwater and provide economic, environmental, and social benefits for residents. Large cities such as Baltimore, Washington, and Philadelphia are leaders in the use of green infrastructure to 1) fulfill regulatory mandates (i.e., reducing combined sanitary-storm sewer overflows, or CSO) and 2) achieve broader community objectives (i.e., improving health and addressing climate change). For smaller communities, lack of financial resources can be a significant barrier to employing green infrastructure solutions. This report provides a guide for decision makers in small to mid-sized communities on how to pay for green infrastructure. It covers green infrastructure definitions and benefits, the monetary value of benefits provided, available funding sources and financing techniques, and how to develop a funding and financing strategy for green infrastructure investment. The report draws on interviews and research of green infrastructure applications by communities inside and outside the Chesapeake Bay watershed. Several case studies provide examples of green infrastructure practices, financing techniques, and key takeaways from communities that have effectively implemented green infrastructure.

Source: Chesapeake Bay Program

Types of green infrastructure range from green roofs, bioretention areas, green streets, and other green stormwater practices at the site and neighborhood scales to regional parks, greenways, natural areas, and other landscape-scale green spaces. Regardless of scale, green infrastructure provides environmental, economic, and social benefits for communities. These benefits yield monetary returns (i.e., increased property values, reduced energy usage, and capital cost avoidance) while making significant contributions to community health and well-being. A wide range of funding sources and financing mechanisms is available to support initial investment and ongoing maintenance of green infrastructure. Effective green infrastructure programs leverage different sources to achieve multiple benefits, such as improved water quality and reduced flooding (often the primary rationale for green infrastructure) combined with broader goals, such as open space preservation, community revitalization, and climate change mitigation and adaptation.

Communities have the opportunity to use green infrastructure to address major challenges while providing multiple benefits for residents. Developing an effective green infrastructure program involves defining purpose, need, and goals; identifying implementation options; assessing capacity and evaluating costs and benefits of different options; and establishing a funding and financing strategy for the preferred option. The resulting strategy will provide the basis for securing the financial resources needed for successful implementation of green infrastructure to achieve community goals.

2. What Is Green Infrastructure?

Green Infrastructure Definitions

Green infrastructure is a widely used term that has a variety of meanings. Two definitions are in common usage. The first, which dates back to a 1994 report by the Florida Greenways Commission and has been further developed by The Conservation Fund, defines green infrastructure as a *strategically planned network* of natural areas, parks, and other green spaces with conservation value.[1] More recently, a second definition — *green stormwater infrastructure* — has emerged, largely in response to regulatory requirements to address the water quality impacts of stormwater runoff. The U.S. Environmental Protection Agency defines green infrastructure as using soils, vegetation, and other natural systems to "infiltrate, evapotranspirate, and/or recycle stormwater runoff."[2] There is no sharp distinction between these two definitions, which form a continuum across scales of

Key Takeaways

- Green infrastructure provides significant monetary benefits for communities.
- Green infrastructure offers a range of intangible (typically social) benefits that are important to community health and well-being.
- The triple bottom line (TBL) framework is a useful way to characterize the value of green infrastructure, both tangible and intangible.
- Research demonstrating the value provided by green infrastructure can be used to build community support for green infrastructure investments.

concern from site to neighborhood, municipality, county, and region. Examples of green infrastructure at the site scale include green roofs, rain gardens, and pervious pavement. Examples at the neighborhood or district scale include green streets, local parks, constructed wetlands, and bioretention areas. At the larger landscape scale, examples include greenways, regional parks and nature preserves, forests, and agricultural lands. Regardless of scale, the value of green infrastructure lies in the benefits it provides for people and ecosystems.

Benefits Provided by Green Infrastructure

Green infrastructure benefits can be divided into three broad categories corresponding to the triple bottom line of sustainability: environmental, economic, and social (Table 1). Benefits can further be characterized as direct and indirect (coincidental or co-benefits). *Direct benefits* respond to the regulatory driver or other purpose (such as to meet a goal stated in a community

Table 1. Green Infrastructure Benefits[3]

Environmental Benefits
Absorbs stormwater, reducing runoff and impacts such as flooding and erosion
Removes air and water pollutants
Moderates the local climate and lessens the urban heat island effect
Preserves and restores natural ecosystems
Provides habitat for native flora and fauna
Mitigates climate change by reducing energy consumption, sequestering and storing carbon
Economic Benefits
Creates job and business opportunities
Stimulates retail sales and other economic activity in local business districts
Increases property values
Attracts visitors, residents, and businesses to the community
Yields locally produced resources (food, fiber, water)
Reduces energy, health care, and gray infrastructure costs, making funds available for other purposes
Social Benefits
Encourages outdoor physical activity
Improves environmental conditions and impacts on public health
Promotes environmental justice, equity, and access for underserved populations
Connects people to nature
Provides places for people to meet
Improves the aesthetic quality of the built environment
Provides opportunities for public art and expression of cultural values

Green Infrastructure, Equity, and Climate Change

The value of green infrastructure is illustrated by its relationship to two major societal issues: equity and climate change. Co-benefits provided by parks, trees, and other forms of green infrastructure are particularly significant for residents of poor and minority neighborhoods. Examples of these co-benefits include improved air and water quality, better health outcomes, enhanced aesthetics, reduced crime, green job opportunities, and increased food security.[4] However, research consistently demonstrates that these neighborhoods have less access to green resources than more affluent parts of a community. Moreover, green infrastructure accessible to residents of traditionally underserved neighborhoods tends to be of lower quality in terms of amenities, maintenance, and security.[5] Additionally, such neighborhoods are more likely to experience environmental injustice conditions, such as polluted air and water, flooding, and the presence of locally unwanted land uses (i.e., landfills, refineries, and waste incinerators).

Low-income communities and communities of color (along with older adults, children, and persons with chronic health conditions) are also more vulnerable to heat waves, flooding, and other adverse impacts associated with climate change. Green infrastructure has an important role to play in addressing climate change through both *mitigation* (reducing or preventing greenhouse gas emissions) and *adaptation* (increasing community resilience to climate-related impacts). With regard to the former, trees and other vegetation remove and sequester carbon from the atmosphere. With regard to the latter, green infrastructure at the landscape, neighborhood, and site scales absorbs stormwater, ameliorates the urban heat island effect, and filters air and water pollutants, among other benefits.

The relationships between green infrastructure, equity, and climate change outlined above highlight the importance of prioritizing green infrastructure investments that benefit traditionally underserved neighborhoods. However, the complex dynamics of these relationships is illustrated by the potential for such investments to attract new, more affluent residents, leading to increased property values and displacement of existing residents (a process referred to as *environmental gentrification*). This potential can be reduced by engaging existing residents in defining priorities and needs, targeting green infrastructure investments to address the priorities, and coordinating with strategies to address broader needs such as housing, economic opportunity, and mobility.

plan) for implementing a green infrastructure practice. For example, reduced pollution of local waterways is a direct benefit of green stormwater infrastructure used to meet Municipal Separate Storm Sewer System (MS4) requirements. *Co-benefits* are additional benefits beyond the performance specifications of a particular green infrastructure practice. For example, green streets installed for MS4 permit compliance can provide co-benefits, such as improving air quality, reducing temperature extremes, encouraging pedestrian activity, and increasing property values. The true value of green infrastructure is measured by the multiple benefits it provides for the community. In addition, a range of co-benefits can leverage additional funding sources beyond those available for the direct benefit provided.

Green infrastructure presents both an opportunity and challenge for local governments. The opportunity is to use green infrastructure to meet federal and state regulatory requirements, achieve community goals, and provide benefits for residents through coordinated initiatives, programs, and projects. The challenge is that the benefits provided are external (i.e., accrue to the community as

a whole) and do not by themselves generate revenues that can be used to support investment. Addressing this challenge requires *monetizing the value of green infrastructure benefits* through sustainable revenue sources for initial implementation and ongoing maintenance.

3. Valuing Green Infrastructure

The benefits that green infrastructure offer communities in the Chesapeake Bay cannot be overstated. Monetizing these benefits begins by determining their equivalent value in economic terms. This chapter provides empirical estimates of the monetary value of benefits identified in Chapter 2, organized according to the *triple bottom line* (TBL) of environmental, economic, and social impact. Extracted from an extensive body of research, such estimates can be extremely valuable in building community support for green infrastructure investments.

A TBL approach is commonly used to measure the impact of an initiative, program, or project. It goes beyond the limitations of traditional economic analysis to consider three elements, often referred to as *people*, *planet*, *and profit*.[6] While the benefits described in this chapter are assigned a monetary value, green infrastructure contributes to all three elements of the triple bottom line. It can make a community mentally and physically healthier and happier; reduce levels of water, air, and atmospheric pollutants that harm our planet; and deliver balance-sheet savings to local governments.

While this chapter cites a number of different sources, two studies that analyzed the overall benefits of green infrastructure networks at different scales are referenced primarily. The first is a study that estimated the benefits of a proposed green infrastructure plan in Lancaster, Pennsylvania (a city of approximately 60,000 residents that is featured as a case study in Chapter 5).[7] The second is a study that estimated "return on environment" from protected open space in Chester County, Pennsylvania (a county of roughly 500,000 residents in the Philadelphia metropolitan region).[8]

Key Takeaways

- A wide range of funding sources and financing mechanisms is available for green infrastructure investments.
- Effective implementation combines and leverages different sources to achieve multiple benefits.
- Engaging external partners increases resources and capacity for implementation.
- Communities that track federal, state, and philanthropic funding programs can position themselves to secure grants as opportunities arise.

Environmental Benefits

Management of stormwater quantity and quality is the most common reason for using green infrastructure (in other words, the direct benefit it provides). Green infrastructure can also provide a range of environmental co-benefits, such as improved air quality, habitat value, and amelioration of the urban heat island effect.

Stormwater Management

One of the most important impacts of green infrastructure is its ability to capture stormwater runoff, providing both environmental and economic benefits. The environmental benefits include reductions in stormwater runoff, flooding, combined sewer overflows, and pollutants entering local waterways. The economic benefits of green stormwater infrastructure are discussed below.

A California study estimated that trees provide value equivalent to $6 per 1,000 gallons of stormwater uptake. This meant that the stormwater uptake value of each California tree was $4.55 per year; in the higher-rainfall state of Missouri, this figure was as high as $30 per tree per year.[9]

Reductions in runoff lead to reduced levels of pollutants commonly carried by stormwater. The Chester County study estimated the avoided costs of nitrogen pollution due to protected open space at $16 per acre per year, with an estimate of $256 per acre per year for phosphorous and $1,595 per acre per year for sediment.[10] Water quality benefits from green infrastructure come not only from capture of stormwater runoff. They may also result when green infrastructure acts as a buffer between water sources and developed areas.[11]

- Chester County estimated that stormwater pollutant removal from its open space network avoided $107 million in costs. The study also estimated $8.2 million per year in other water quality benefits from its open space network.

Habitat Value

Landscape-scale green infrastructure provides intact habitat for wildlife, including native plant and animal

communities and rare, threatened, and endangered species. Smaller areas of green infrastructure, such as parks, stream corridors, and bioretention areas planted with native species, can provide valuable habitat in urban areas. A Philadelphia Water Department study estimated the combined value of habitat and water quality benefits from stream restoration at $10-15 per household per year.[12]

- Chester County's green infrastructure network was estimated to provide a total of $13 million in habitat benefits, based on the amount that people would be willing to pay to preserve wildlife on protected open space.[13]

Air Quality

Air pollution abatement is another environmental benefit of green infrastructure. Air pollutants are a deadly health hazard that are projected to cause thousands of deaths annually by 2050. Air pollution reduction benefits have been estimated at $4.59 per pound for nitrogen dioxide and ozone, $8.31 per pound for PM-10, and $3.48 per pound for sulfur dioxide.[14] A single green roof can remove hundreds of pounds of air pollutants per year.[15]

The air pollution (along with water management and carbon reduction) benefits of trees in various geographies and currencies can be calculated using the **i-Tree Canopy** tool, developed as a cooperative effort by the U.S. Forest Service and other groups.

- The city of Lancaster's *Green Infrastructure Plan* was estimated to provide $1 million per year in air quality improvements from nitrogen dioxide, ozone, PM-10, and sulfur dioxide reductions.[16]
- Chester County's protected open space was estimated to generate an air pollution reduction benefit of $13.5 million per year.[17]

Carbon Capture and Storage

The climate mitigation benefits of green infrastructure include carbon capture and storage (removing carbon dioxide from the atmosphere) and sequestration (storing carbon dioxide over a longer period of time). The annual volume of carbon captured by urban trees is estimated at 0.8 tons per hectare, while restored wetlands remove 1.5 metric tons per acre per year.[18] The estimated value of carbon sequestration is $71/ton.[19]

- Lancaster's Green Infrastructure Plan was estimated to provide $786,000 in carbon dioxide reduction due to carbon sequestration from green roofs and trees.
- Trees on Chester County's protected open space were estimated to provide $120 million in carbon capture benefits.

Economic Benefits

Green infrastructure has numerous economic benefits, including job creation, economic growth, property value enhancement, reductions in energy usage, and cost savings over gray infrastructure.

Job Creation and Economic Growth

Job creation is an important economic benefit of green infrastructure. Job creation associated with various types of green infrastructure has been estimated at more than a dozen job-years per million dollars spent.[20] A 2019 study estimated that Philadelphia's *Green City, Clean Waters* green infrastructure initiative created nearly one thousand jobs since its inception.[21]

Green infrastructure can also spark economic activity at the local and regional scales. Chester County estimated

that its network of open space stimulates millions of dollars' worth of economic activity in the agriculture, park operations and maintenance, and tourism sectors.[22]

At the local scale, a single green infrastructure intervention can have a catalytic impact on economic growth, as reflected in retail sales and recreational visits. Businesses on streets with trees have been found to earn 12 percent more income.[23] Shopping districts with mature tree canopy have been estimated to command a price premium of 8-12 percent.[24] Improvements to Cobbs Creek Park in Philadelphia were estimated to lead to $3.9 million in annual benefits, with a significant increase in visitors.[25]

- Chester County estimated that open space contributes $238 million per year in expenditures to its economy, including an estimated 1,800 jobs in park maintenance, agriculture, and tourism.

Property Values

Increased property values are among the green infrastructure benefits with the strongest empirical support. These increases have been estimated at a 2-5 percent premium in home values for trees and landscaping alone, and as much as a 20 percent premium for proximity to parks and open space.[26] More modest but still notable benefits have been noted for green stormwater infrastructure installations (including rain gardens, swales, planters, and pervious pavement) as well as for wetlands.[27] For municipalities, a benefit associated with higher property values is increasing property tax receipts; this benefit was estimated at $7.43 per dollar spent on green infrastructure.[28] Property value increases associated with GI are not limited to residential properties; they have also been observed on industrial and commercial properties.[29]

As noted in Chapter 2, increases in property values can potentially have negative impacts, such as increased housing costs, for residents of communities vulnerable to gentrification.[30] Although primarily an issue for larger cities, these potential impacts should be considered in planning and implementing green infrastructure improvements.

- Chester County estimated $1.65 billion in property value added from open space, and $27.4 million per year in associated tax revenues.

Energy Use Reduction

Another benefit of green infrastructure is its potential to decrease energy usage. Trees, green roofs, and other types of green infrastructure can help stabilize indoor temperatures during hot and cold seasons, leading to reduced need for indoor heating and air conditioning, among other effects on energy use.[31] Green infrastructure is particularly valuable in addressing the urban heat island effect, which results when urbanized areas with concentrations of buildings and pavement experience higher temperatures than less developed outlying areas. In addition to increasing energy usage, the urban heat island effect can contribute to heat-related illnesses and deaths.

Street trees have been estimated to save utility customers $455 per hectare per year; total energy savings due to urban trees in Grand Rapids, Michigan, were estimated at $722,000 per year.[32] Green roofs are estimated to reduce building energy costs by 15 cents per square foot per year for a small (5,000 square foot) roof, and 19 cents per square foot per year for a large (50,000 square foot) roof.[33] In southern California, green roofs were estimated to reduce one-story buildings' energy usage by 75 percent or more.[34] As summers become hotter due to climate change, energy use reduction can be paired with the health benefits of moderating the urban heat island effect.

- Lancaster's *Green Infrastructure Plan* was estimated to yield about $2.4 million in annual energy use reductions, including a $1.8 million reduction in natural gas usage and an $0.6 million reduction in electricity usage.[35]

Social Benefits

The social benefits of green infrastructure are vitally important but often do not lend themselves well to monetary valuation. Examples that are difficult to quantify in the same way as environmental and economic benefits include crime reduction, mental health, and improved learning outcomes. For example, the Japanese practice of Shirin-Yoku (forest bathing, which is becoming increasingly popular in the United States) is associated with improvements in both mental health (including reduced stress and reduced levels of negative emotions) and physical health (including strengthened immune system activity and lowered blood sugar levels for diabetics).[36]

Perhaps the easiest to quantify social benefits of green infrastructure are the leisure and health value of outdoor recreation. Leisure benefits can be measured by the amount recreational users would be willing to pay for these amenities if they were not provided for free. Health benefits can be measured by reductions in medical costs, higher productivity at work, and reduced workers' compensation claims — effects that reverberate across society (including the workplace).

Recreation

Willingness to pay for recreational open space in Southeastern Pennsylvania was estimated at $450 per household per year, while in Chester County willingness to pay was estimated at $656 per household per year.[37]

- Chester County's open space network was estimated to deliver nearly $125 million in recreational benefits to county residents.

Health

The health benefits of green infrastructure, such as contact with nature, are well documented.[38] One of the most important of these benefits is associated with recreational activity; nearly half of all urban trail users, for example, are only meeting physical activity guidelines due to their use of the trail.[39]

Physical inactivity has been correlated with more than one-tenth of all medical expenses in the United States; the additional healthcare costs for insufficiently active adults have been estimated at $603 per year.[40] Productivity gains in Chester County due to open space were estimated at more than $2,700 per worker. Workers' compensation costs for inactive workers were estimated at $6-12 per worker in direct costs and $24-48 per worker in indirect costs.[41]

- Chester County estimated medical cost savings of open space at more than $40 million in direct costs and nearly $130 million in indirect medical costs, with $150 million in productivity cost savings, and $2.7 million in savings on workers' compensation.

Green Infrastructure Costs and Benefits

This chapter covers a range of benefits provided by green infrastructure, most of which are external to the local government (i.e., they accrue to the community as a whole rather than directly impacting fiscal balance sheets). As with any sort of investment, implementing green infrastructure solutions comes with costs as well as benefits. At the landscape scale, costs include primarily land acquisition, as well as some level of ongoing maintenance. For green stormwater infrastructure, costs include design, installation, and maintenance.

At the landscape scale, numerous studies have demonstrated that property taxes generated by conversion of open space to new development do not cover the cost of infrastructure and services needed to support new residents.[42] As an alternative to conventional engineering solutions, green stormwater infrastructure can have significant positive impacts on local governmental budgets. One study estimated overall cost savings of green versus gray infrastructure at 25 percent.[43]

In another example, capital cost avoidance for protected open space compared to gray infrastructure required to handle a two-year storm was estimated at $0.42 per gallon of avoided runoff; maintenance cost avoidance for the same infrastructure has been estimated at $0.04 per gallon of avoided runoff.[44] At full capacity, implementation of Lancaster's *Green Infrastructure Plan* was estimated to capture roughly one billion gallons of runoff per year.[45]

- Avoided gray infrastructure costs for Lancaster's *Green Infrastructure Plan* were estimated at $120 million in capital costs and $661,000 per year in maintenance costs. This compared favorably to a $94.5 million cost estimate for the full scope of implementing the plan.
- Chester County estimated $263 million in stormwater infrastructure construction cost avoidance and $27 million per year in maintenance cost avoidance from protected open space.

Green infrastructure can also avoid costs associated with the use of gray infrastructure for water treatment, which can be very costly. This benefit has been valued at about .009 cents per gallon of water for which treatment is avoided.[46]

- Lancaster's *Green Infrastructure Plan* was estimated to lead to a $661,000 per year reduction in costs for wastewater pumping and treatment.

Conclusion

Green infrastructure provides both tangible and intangible benefits for communities. Tangible benefits are those that can be measured in monetary terms. Intangible benefits are more difficult to quantify than tangible benefits but nevertheless make significant contributions to individual and community health and well-being. The value provided by green infrastructure has been documented in an extensive body of research. The following are some key takeaways from a survey of the research literature:

- ***Green infrastructure provides significant monetary benefits for communities.*** These benefits are estimated in the millions and even billions of dollars for landscape-scale green infrastructure. They include avoidance of more expensive gray infrastructure costs, directly impacting local governmental balance sheets.
- ***Green infrastructure offers a range of intangible (typically social) benefits that are important to community health and well-being.*** Examples include improved mental health from contact with nature and contributions to community aesthetics and identity.
- ***The triple bottom line (TBL) framework is a useful way to characterize the value of green infrastructure, both tangible and intangible.*** This framework organizes the direct benefits and co-benefits provided by green infrastructure into three categories: environmental, economic, and social.
- ***Research demonstrating the value provided by green infrastructure can be used to build community support for green infrastructure investments.*** Identifying and measuring these benefits is useful in reaching different audiences and funders.

4. Green Infrastructure Funding and Financing Sources

Chapter 3 shows that substantial environmental, economic, and social benefits can accrue to communities that implement green infrastructure. Achieving these benefits requires garnering the financial resources necessary to make green infrastructure a reality.

Green infrastructure funding can come from a wide variety of sources, both public and private. Public sources include local revenue streams and a variety of state and federal grant and loan programs. Private sources include bonds and public-private partnerships, which can be structured in various ways. The variety of available funding sources and financing mechanisms available can make the process of identifying, securing, and sustaining funding for green infrastructure quite complex. This chapter presents best practices for green infrastructure funding and financing, organized into three major sections: local funding sources, state and federal funding sources, and private financing mechanisms.

In developing a green infrastructure funding and financing program, it is important to distinguish between sources suitable for capital costs and those suitable for ongoing operations and maintenance. Funding sources that provide large sums upfront are typically best suited for capital costs, while sources that can provide a steady revenue stream over time are better suited for operations and maintenance costs.

Key Takeaways

- A wide range of funding sources and financing mechanisms is available for green infrastructure investments.
- Effective implementation combines and leverages different sources to achieve multiple benefits.
- Engaging external partners increases resources and capacity for implementation.
- Communities that track federal, state, and philanthropic funding programs can position themselves to secure grants as opportunities arise.

Local Funding Sources

General Fund

General fund revenues are commonly used to finance green infrastructure projects. However, they are not recommended as a primary source for communities looking to implement a more robust green infrastructure program because of the many competing priorities for a limited pool of dollars. Even if green infrastructure is identified as a priority for general fund allocations in one year, there is no guarantee that this prioritization will continue.[47]

In addition, the general fund is typically financed by property taxes, which are subject to various carve-outs and exemptions. In essence, if general fund revenues are used for green infrastructure, the burden falls disproportionately on those property owners (and, indirectly, renters) who are subject to taxes. Tax-exempt property owners — even though they may contribute to stormwater runoff and other issues that green infrastructure addresses — do not share in the costs.

If general fund dollars for green infrastructure can be secured, municipalities are often best served by combining them with other funding sources. This approach was taken in Ann Arbor, Michigan, which combined a stormwater utility fee and general fund dollars to fund an extensive tree program.[48]

Stormwater Utility Fee

Adopting a stormwater utility fee — a per-user charge used to fund a local stormwater management system — is a best practice to secure a sustainable, long-term revenue stream for green infrastructure. As a user fee rather than a tax, a stormwater utility applies to all properties in the jurisdiction. The proceeds are dedicated to designing, constructing, operating, and maintaining the stormwater management system (including installation and maintenance of green infrastructure), along with ancillary activities, such as public education and outreach.[49]

Stormwater utility fees can be structured in various ways. The most common structures are 1) *intensity of development*, which determines the amount of impervious surface on all properties and apportions the fee accordingly; and 2) *equivalent residential unit*, which charges a flat fee to each single-family residential property based on the average impervious area of

all properties. The first option can be beneficial from an equity standpoint, since it differentiates between residential properties that cause more or less runoff, but the latter (which is most common) can be less complex to administer.[50] For U.S. municipalities with stormwater utility fees, the median fee per single-family residence was $4.75 per month.[51]

Stormwater utility fees are a best practice for local green infrastructure financing because they ensure longevity and consistency of funding, and they are equitably allocated to all properties. Befitting their many advantages, stormwater utility fees are increasing in popularity. Even though fees typically require state enabling legislation, they have been established in at least one municipality in nearly every U.S. state, including each of the six states within the Chesapeake Bay watershed. However, adoption rates vary widely by state. As shown in Table 2, there is considerable room for increase in the number of Chesapeake Bay communities that enact stormwater utility fees. Political opposition to a so-called "rain tax" has been one barrier to more widespread adoption. To overcome such opposition, it is important to differentiate between taxes and user fees and highlight benefits such as reduced flooding and improved water quality that green infrastructure provides.

Table 2. Chesapeake Bay Watershed Stormwater Utilities by State (2019)[52]

State	Number of Utilities
Delaware	3
Maryland	16
New York	1
Pennsylvania	27
Virginia	30
West Virginia	10

Value Capture

Value capture is a type of public financing that recovers some or all of the value that public infrastructure generates for private landowners. Value capture financing methods are often used by local governments but have had limited application to green infrastructure to date. Two well-known mechanisms are *Tax Increment Financing*, or TIF, and *Business Improvement Districts*, or BIDs.[53]

TIF allows communities to borrow against the future tax revenue gains from an infrastructure improvement in order to finance that improvement. Like stormwater utility

fees, TIF requires state enabling legislation. Chicago is an example of a community that has made extensive use of TIF. Chicago's TIF-funded green roof program in its downtown core provides half-matching funds for green roofs in the city's downtown core.[54]

BIDs, which are typically located in commercial districts, are special taxing districts in which a tax collected from business owners is used for a wide variety of purposes, which can include green infrastructure. In effect, the tax captures extra revenue generated in the business district by the BID's improvement efforts and uses it to finance further improvements. BIDs are typically administered on behalf of business owners, such that their actions reflect the priorities of the business community.[55] Philadelphia has an extensive network of BIDs, some of which have included green infrastructure in their improvement programs. For example, the BID in the Old City neighborhood has an extensive street tree program.[56]

Other value capture mechanisms include *Special Assessment Districts* and *Special Service Areas*, which levy taxes on private property to pay for local improvements or services that benefit the properties taxed.[57] In general, value capture has the potential to put the economic benefits of green Infrastructure (i.e., increased property values) described in Chapter 3 to work. However, similar to general fund revenues, green infrastructure must compete with other priorities for value capture funding.

State and Federal Funding Sources

State and federal funding for green infrastructure is typically best suited for capital improvement projects, as it is most often provided in the form of one-time grant

or loan assistance rather than to support recurring costs, such as operations and maintenance.

Revolving Loan Funds

The Clean Water State Revolving Fund (CWSRF) and the Drinking Water State Revolving Fund (DWSRF) are among the largest federal funding sources that can be used for green infrastructure. The CWSRF focuses on water quality infrastructure while the DWSRF focuses on drinking water.[58] Although the Revolving Loan Funds originate from the federal government through the U.S. Environmental Protection Agency (EPA), they are administered at the state level as loans rather than grants.[59] In Pennsylvania, for example, these funds are administered by the Pennsylvania Infrastructure Investment Authority (also known as PENNVEST).

Revolving Loan Funds are primarily used to support gray rather than green infrastructure projects. However, there has been increasing momentum at the federal level to encourage their use on green infrastructure improvements.[60] At the state level, PENNVEST in its 2021-22 CWSRF plan allocates 10% of CWSRF funds to green infrastructure. Its DWSRF plan also identifies green infrastructure as a priority.[61]

A related program is the Water Infrastructure Finance Investment Act, or WIFIA, established in 2014. Focusing primarily on larger, longer-term projects, this program makes loans directly to the Revolving Loan Funds, to public agencies or private entities, or to public-private partnerships.[62]

Federal Grant Programs

A number of federal grant programs are available for green infrastructure. Among the most prominent are several programs administered by EPA, including pollution reduction grants issued under the Clean Water Act and programs specific to regional offices. (In the Chesapeake Bay Watershed region, the latter are administered by EPA's Chesapeake Bay office).[63] The U.S. Department of Agriculture (USDA) provides water-related grant funding that can be used for green infrastructure through its Rural Development program. This program focuses on water infrastructure improvements for rural areas with 10,000 or fewer residents.[64]

Community Development Block Grant (CDBG) funds can be used by local communities on projects that incorporate green infrastructure practices for stormwater management. Disaster recovery and transportation funding can also be applied toward green infrastructure. Housing rehabilitation funds — including weatherization and public health programs — have been identified as potential additional sources of funding for green infrastructure.[65]

Several federal funding programs relevant to green infrastructure have been expanded or strengthened in recent years. Legislation passed in 2020 guarantees a $900 million annual allocation to the Land and Water Conservation Fund, an important funding source for landscape-scale green infrastructure that has been used by Warrington Township, Pennsylvania, among others (see case study in Chapter 5).[66] Various infrastructure programs received significant funding from the 2021 American Rescue Plan Act (ARPA) and Infrastructure Investment and Jobs Act (IIJA), two of President Biden's signature initiatives. IIJA includes $1.4 billion in funding for the Transportation Alternatives Program (which can fund trails), $3.5 billion in funding for FEMA flood mitigation (eligible for use on green infrastructure), and an $11.7 billion allocation to CWSRF, with 10% of that funding dedicated to green infrastructure.[67]

It should be noted that the distinction between federal and state grant programs is not always clear. While funded federally, many of these programs are administered at the state level by branches of state or federal government. Examples of the former include Revolving Loan Funds; examples of the latter include the EPA and USDA programs referenced above. As a general rule, federal grant programs that are administered at the state level are relatively standard in their purpose and requirements compared to state funding programs.

State Funding Programs

State funding programs vary from state to state and (like federal programs) may come and go with changes in administration and political priorities. They fall into two broad categories: programs related to green infrastructure's direct benefits, such as stormwater and water quality management, and programs such as transportation and community development, which can be applied to green infrastructure to achieve co-benefits that are consistent with the program's mission and purpose. As illustrated by the case study communities in Chapter 5, a successful green infrastructure financing strategy leverages funding from multiple sources, including philanthropic organizations.

Leveraging state funding often requires working with various state departments. In Pennsylvania, PENNVEST administers several funding programs, including the Revolving Loan Funds discussed earlier. The Department of Community and Economic Development (DCED) and the Department of Conservation and Natural Resources (DCNR) also issue grants that can be used for green infrastructure financing or administration.[68] Circumstances in New York are similar — while the Department of Environmental Conservation is a primary source of funding for green infrastructure, the Department of State

and the Environmental Facilities Corporation are among other agencies that have relevant grant programs.[69]

Rather than delving into the details of different state funding programs, the bottom line is that successfully procuring grants requires ongoing research and monitoring. Communities that track agency programs that fund infrastructure, environmental protection, community development, and the like can position themselves to secure grant funding for green infrastructure as opportunities arise. While this may represent a challenge for communities with limited capacity, devoting time to monitoring grant opportunities (including those specifically for smaller communities, such as the USDA example cited above) can provide an advantage over other, similar communities.

Private Financing Mechanisms

Although government funding sources are numerous, they may not be adequate for the major investment needed to reap significant benefits from green infrastructure. Successfully capturing private and philanthropic investment can be among the most lucrative financing sources for green infrastructure.[70] However, private financing can come with pitfalls related to the complexity of capital markets. The movement toward *performance-based financing* (that is, financing tied to achieving defined outcomes) is an attempt to counteract some of these pitfalls. This movement structures private financing to incentivize desired outcomes — in some cases, conditioning payback on the achievement of performance goals.[71]

Bonds

Municipal bonds are a traditional method of securing private financing for public infrastructure projects. Privately financed and publicly backed, municipal bonds tend to be favorable to both private and public partners. For private investors, they are a relatively safe method of securing long-term interest gains; for the public sector, they provide an opportunity to secure private financing while retaining control over how those dollars are used. In addition, the long-term repayment schedule of municipal bonds lends itself to projects whose benefits will be realized over a period of years.[72]

With respect to green infrastructure, municipal bonds are most often used to preserve open space, to acquire and develop parkland, or both. Since bonds for these purposes typically must be approved through voter referenda, a key part of the process of securing this funding involves education and outreach to demonstrate the benefits provided by the referendum in question to community members.

When protecting green infrastructure and open space is put to the voters in the form of a bond referendum, the results are typically quite positive. The Trust for Public Lands compiles and endorses green infrastructure ballot measures from across the United States: in 2020, all 26 of their endorsed measures passed, with potential revenues often in the millions of dollars, even in smaller communities.[73] A comprehensive study of all open space referenda in the United States between 1998 and 2006 found that more than three-quarters of such measures

passed, representing more than 1,000 successful ballot initiatives.[74]

Environmental impact bonds are an emerging form of performance-based financing that provides upfront capital to public entities for environmental projects, such as green infrastructure. Returns to private investors are based on successful project outcomes. Environmental Impact Bonds have been implemented in a handful of cities, including Washington, D.C., and in Hampton, Virginia, through an instrument arranged by the firm Quantified Ventures (see case study in Chapter 5).

Public-Private Partnerships

Public-private partnerships are contractual arrangements between a government agency and private company to provide a public asset or service. They can be lucrative for private-sector partners, offering them the opportunity to shape project development, while achieving the objectives of the public entity. Public-private partnerships often involve collaboration at every stage of project development, from design to implementation.[75] A public-private partnership between Prince George's County and the firm Corvias produced more than 100 green infrastructure projects in its first four years, exceeding a goal of 2,000 greened acres while delivering equitable procurement and cost savings benefits.[76] Milwaukee has entered a similar partnership with Corvias.[77]

Successful public-private partnerships represent an opportunity to put both the financial and administrative capacity of the private sector to use in implementing green infrastructure. They can be beneficial to smaller governments that do not have the capacity to implement large green infrastructure projects on their own. Similar to environmental impact bonds, however, public-private partnerships are a relatively new way of financing green infrastructure that can be complex to structure and manage.

Private Landowner Investment

An emerging method of securing private financing is to encourage landowners to invest in green infrastructure improvements on private properties.[78] Private landowner investment can be a particularly effective way of creating a green infrastructure network because most of the land in a typical jurisdiction is privately owned.

Targeted to residential property owners, institutions, developers, and/or businesses, this approach can include both incentives and regulations to promote private landowner investment in green infrastructure. Incentive examples include cost-matching and cost-sharing programs, such as Puyallup, Washington's cost-sharing program for homeowner rain gardens. Binghamton, New York, has a cost-matching program that includes developers and other landowners.[79] Incentives can also include stormwater utility fee reductions for households that install green infrastructure.[80] Regulations include mandatory open space dedications and zoning codes that require inclusion of green infrastructure in development projects. New York City used such a provision to require tree plantings in new developments in specified districts.[81] Chicago requires developments to choose between installing GI sufficient to take in one inch of rainfall and contributing to a stormwater fund.[82]

Conclusion

Although this chapter has discussed different sources of green infrastructure funding separately, effective implementation programs combine and leverage multiple sources to achieve both direct benefits. Key takeaways include:

- ***A wide range of funding sources and financing mechanisms is available for green infrastructure investments.*** Because these sources vary in their purpose and suitability for different applications, it is important to match them to the local context, including community goals, needs, and capacity. Table 3 (see following page) summarizes the pros and cons of different funding and financing sources.
- ***Effective implementation combines and leverages different sources to achieve multiple benefits.*** For example, funding for green stormwater management might be combined with 1) a separate funding source for tree canopy enhancement and 2) financing mechanisms, such as a stormwater utility or BID to support operations and maintenance.
- ***Engaging external partners increases resources and capacity for implementation.*** Potential partners include governmental agencies, philanthropic and other nonprofit organizations, and private landowners and businesses, among others. Using green infrastructure

to achieve priorities beyond stormwater management (i.e., to develop a landscape-scale green infrastructure network) is an effective way to engage partners that can bring funding and other resources to the table.

- ***Communities that track federal, state, and philanthropic funding programs can position themselves to secure grants as opportunities arise.*** Having a plan that identifies green infrastructure goals, priorities, and projects and monitoring potential funding sources to implement the plan can provide a competitive advantage over other communities.

Chapter 5 presents case studies of communities that have leveraged different funding sources to implement green infrastructure initiatives.

Table 3. Pros and Cons of Different Funding Sources and Financing Mechanisms

Funding Source	Pros	Cons
Local		
General Fund	Most accessible source of funding	Limited revenue source that may not be consistently available due to competing priorities Tax-exempt properties do not contribute
Stormwater Utility Fee	Dedicated and consistent funding source that applies to all properties proportionately	May provoke political opposition Can be complex to administer
Value Capture	Can monetize green infrastructure benefits, such as increased property values	Less commonly used for green infrastructure than for other purposes
State and Federal		
Revolving Loan Funds	Significant amounts of funding available for capital projects	Competition with conventional gray infrastructure projects
Federal Grant Programs	Variety of established funding sources available Funding expanded by several major pieces of recent legislation	Competitive nature of programs Require expertise/capacity to prepare applications and manage successful grants
State Grant Programs	Variety of sources available, may be less competitive than better-known programs	Requires expertise/capacity to research, prepare applications, and manage successful grants
Private		
Bonds	A proven way of securing private financing for public infrastructure projects Open space bond referenda tend to be popular with voters	Competition with other funding priorities Bond referenda require public outreach campaigns and are limited by what can pass in an election
Public-Private Partnerships	Can unlock private sector financing and administrative capacity typically not available to small jurisdictions	Can be complex to structure and administer
Private Landowner Investment	Can promote green infrastructure investment on land that is not publicly owned	Requires landowner cooperation

5. Case Studies

This chapter provides examples of communities — several inside and one outside the Chesapeake Bay watershed — that are deploying a variety of strategies and financing mechanisms to implement green infrastructure. These communities are:

Takoma Park, Maryland (a small city in the Washington, D.C., metropolitan area), is using its stormwater utility fee to develop a network of bioretention facilities. It is also implementing a major green street project by leveraging multiple partnerships and funding sources.

Lancaster, Pennsylvania (a mid-sized city at the center of a thriving agricultural county), is using green infrastructure to address combined sanitary-storm sewer overflows (CSO), while achieving broader community co-benefits.

Hampton Roads, Virginia (a large metropolitan region vulnerable to sea level rise and flooding), is an example of coordinating a regional planning framework with green infrastructure implementation by local jurisdictions. The cities of Hampton and Virginia Beach are highlighted in this case study.

Warrington Township, Pennsylvania (a suburban community located in the Delaware River watershed in Bucks County), is using diverse funding sources to plan, prioritize, and implement a landscape-scale green infrastructure network.

While the case study communities vary in size and context, a series of common themes (key takeaways) emerged from the research and interviews. Summarized at the end of the chapter, these takeaways provide guidance for other Chesapeake Bay communities looking to develop and implement effective green infrastructure programs.

Takoma Park, Maryland

Takoma Park is a small city located adjacent to the northeast boundary of the District of Columbia in the Washington, D.C., metropolitan area. It has a land area of approximately two square miles and a population of 17,629 according to the 2020 U.S. Census. Approximately 84 percent of the city is developed with residential, commercial, and industrial uses; 8 percent is parkland and 8 percent is classified as undeveloped land. This land use pattern means that Takoma Park has a relatively high (approximately 31 percent) proportion of impervious surface compared to most suburban communities. Stormwater runoff is managed by a Municipal Separate Stormwater Sewer System (MS4). Tacoma Park's Phase 2 MS4 permit requires that the city provide treatment or reduction equivalent to 20 percent of existing impervious area.

Key Takeaways

- Build support through community engagement, education, and outreach.
- Develop a plan to define the purpose of and need for green infrastructure, develop strategies, and prioritize actions.
- Leverage diverse funding sources to implement the plan.
- Encourage interdepartmental collaboration.
- Build implementation capacity through partnerships.
- Establish a stormwater utility fee or other sustainable funding source.

Environmental issues have long been a priority of city government and residents. With technical assistance provided by the U.S. Environmental Protection Agency (EPA), Takoma Park was an early adopter of a stormwater utility fee in the 1980s. Until recently, single-family properties were billed at a base rate tied to a median impervious area of 1,228 square feet per property (referred to as equivalent residential unit, or ERU). All other developed properties were billed based on actual impervious area. After an FY 2017 increase to a base rate of $92 to cover the rising costs of permit requirements, the

stormwater fee generated approximately $700,000 a year for capital costs, maintenance and services, and personnel.

Program elements funded by Takoma Park's stormwater utility fee include public education and outreach; stormwater best management practices (BMPs); system maintenance and repairs; and control measures, such as regenerative street sweeping, tree planting, and stream restoration. BMPs installed in recent years include over 40 bioretention facilities, two wetland modular systems, two filtration basins, a detention pond, and two green traffic circles, all of which filter runoff and reduce pollutant and sediment loading to local waterways (and, ultimately, the Chesapeake Bay).

A 2018 study revealed that the median figure of 1,228 square feet per single-family property significantly underestimated the actual amount of impervious surface in the city. In 2021, city council changed the stormwater fee from a base rate of $92 per single-family property to a tiered rate of $25 per 500 square feet of impervious area as a more transparent and equitable way of assessing the fee. The city uses remote sensing (LIDAR) data provided by Montgomery County to calculate impervious surface and provides an appeals process for property owners who feel that their fee is incorrect. According to Public Works Director Daryl Braithwaite, the average amount of the fee is currently $100-$125 per single-family property. The city is currently exploring implementation of a Stormwater Fee Credit Program that will reduce a property owner's fee for qualified mitigation measures taken to capture and treat stormwater.

Takoma Park's motivation for implementing green infrastructure extends beyond reducing stormwater runoff and improving water quality to providing co-benefits, such as urban heat island mitigation, a better pedestrian environment, and climate resilience. The largest and most complex capital projects ever undertaken by the city, the Flower Avenue Green Street project, is transforming a one mile long arterial with minimal stormwater facilities and pedestrian and transit amenities into Takoma Park's first green street. Improvements include bioretention areas and rain gardens to capture and store runoff; new sidewalks, ADA-accessible ramps, and crosswalks to enhance pedestrian access and safety; and relocated bus stops, tree plantings, and energy-efficient streetlights.

The Flower Avenue Green Street Project

Developed over a period of nearly 10 years, the Flower Avenue Green Street project involved multiple partnerships and leveraged multiple funding sources for implementation. Flower Avenue is a former state highway located along the city's boundary with Montgomery County. The Maryland State Highway Administration (MSHA) made the project possible by ceding control of Flower Avenue (which is not a high-traffic arterial) to Takoma Park, accompanied by $694,000 that had been set aside in the MSHA budget for future redesign. Montgomery County similarly ceded control of its half of the road right-of-way to Takoma Park and provided $200,000 for pedestrian improvements serving Montgomery County residents. Other funding sources for the approximately $7 million project budget include $1,040,330 from the federal Transportation Alternatives Program (TAP), $168,000 from a National Fish and Wildlife Foundation (NFWF) grant, $284,230 in Community Development Block Grant (CDBG) funding, and a city bond of approximately $1.4 million. In addition, an agreement with WSCC Water helped support utility engineering redesign costs as part of the project.

Community engagement, including multiple meetings during project development and regular updates during implementation, has been instrumental in building public support for the Flower Avenue Green Street project. City leaders have been open and transparent in their approach, and community members appreciate how city investment has leveraged a much larger amount of funding from outside sources for project development and implementation. Leadership by city officials has been a key to project success. Suzanne Ludlow, Takoma Park's former city manager, was an early project advocate and led many of the negotiations with other agencies.

Lancaster, Pennsylvania

The county seat of Lancaster County, Pennsylvania, the city of Lancaster, has a land area of approximately 7.4 square miles and a population of 58,839 according to the 2020 U.S. Census. Lancaster is one of about 770 cities in the United States with a combined sanitary-storm sewer system (CSS). During most rain events, the city's wastewater treatment plant can manage and treat the volume of wastewater in the system. However, intense rainstorms cause untreated wastewater to overflow into the Conestoga River (and ultimately to the Chesapeake Bay via the Susquehanna River). Lancaster's historic center, comprising about 44 percent of its land area and most of its population, is served by the CSS. The remaining 56 percent of the city is served by a separated storm sewer system (MS4).

Lancaster had invested more than $18 million in wastewater system improvements over a 12-year period to reduce combined sanitary-storm sewer overflows (CSO) and remove nutrients from treated wastewater. In 2010 the city published a *Green Infrastructure Plan* as a comprehensive strategy for using green infrastructure to further reduce CSO to the Conestoga River.[83] The plan highlights the environmental, social, and economic co-benefits provided by green infrastructure (i.e., reduced capital costs compared to conventional gray infrastructure). It provides a cost calculator tool that can be used to estimate the benefits and costs of different types of green stormwater infrastructure. The plan was developed through a three-step process:

1. Evaluate the city's impervious cover by type and ownership.
2. Identify potential green infrastructure project sites, costs/benefits for each, and grant funding for implementation.
3. Determine potential citywide benefits as a basis for actions and policy direction to institutionalize green infrastructure in the city.

The impervious cover analysis revealed that most of Lancaster's impervious area outside of roads is privately owned, indicating that private investments — such as green roofs, rain gardens, and green parking lots — are key to a successful green infrastructure program. The plan identifies 74 potential demonstration project sites, mostly located on public lands. Implementation recommendations include establishment of a prioritized capital program for publicly owned sites and a green infrastructure grant fund to incentivize action by private landowners. Other recommendations include establishment of a stormwater fee to equitably apportion costs based on impervious coverage; revisions to city codes and ordinances to promote green infrastructure; partnering and public outreach activities; and more.

Lancaster's implementation efforts have positioned the city as a national leader among small to medium-sized jurisdictions in the use of green stormwater infrastructure. Approximately $10 million in funding was secured for the demonstration projects from various sources, including the Pennsylvania Infrastructure Investment Authority (PENNVEST), the Pennsylvania Department of Conservation and Natural Resources (DCNR), the National Fish and Wildlife Foundation, and the Chesapeake Bay Trust. The initial demonstration projects included

green streets, alleys, roofs, parking lots, and city parks, incorporating green infrastructure practices, such as porous paving, subsurface infiltration basins, cisterns, tree trenches, and rain gardens.[84]

In 2014 city council adopted a stormwater management fee for all landowners based on the amount of impervious surface on their properties. A tiered system is used to calculate the fee, i.e., property owners in Tier 2 (1,001-2,000 square feet of impervious surface) pay an annual fee of $93. Credits are provided to landowners who implement green infrastructure or other practices to reduce runoff. The fee generates approximately $4 million annually for design, construction, and management of stormwater facilities, programs, and operations.

In 2017 Lancaster signed a Consent Decree under the Clean Water Act with the U.S. Environmental Protection Agency and Pennsylvania Department of Environmental Protection to end CSO discharges to the Conestoga River. The decree endorses the use of green stormwater infrastructure distributed throughout the city as an alternative to a conventional engineering approach of costly underground storage facilities.[85] As part of the Consent Decree requirements, in 2019 the city published *Green It! Lancaster* to update the 2011 *Green Infrastructure Plan*. *Green It! Lancaster* documents the city's green infrastructure implementation efforts since 2010, establishes future program goals, and defines strategies for ongoing implementation of green infrastructure to achieve cost-effective Clean Water Act compliance while maximizing economic, environmental, health, and quality of life benefits for residents. Added components include a Green Infrastructure (GI) Design Manual, GI Operations and Maintenance Plan, GI Monitoring Plan, and an Urban Tree Canopy Assessment by DCNR. The latter report informed development of *Trees for People: An Action Plan for Lancaster City's Urban Forest* (2020), an urban forest management plan funded by a grant from Pennsylvania's TreeVitalize program.

As in Takoma Park, community engagement has been critical to the success of Lancaster's green infrastructure program. For example, extensive education and outreach was conducted during development of the stormwater management fee, with the end result being widespread community acceptance when the fee was adopted by city council. The city is currently updating its existing comprehensive plan through a robust community engagement process that is expected to identify green infrastructure as a key direction for Lancaster's future.

Hampton Roads Region

The Hampton Roads region is located in southeast Virginia at the junction of the Elizabeth, James, Nansemond, and York rivers with the mouth of the Chesapeake Bay. The region encompasses ten independent cities and seven counties. The Virginia Beach-Norfolk-Newport News metropolitan statistical area (which also includes two counties in northeastern North Carolina) has a population of about 1.8 million people. Characterized by extensive floodplain and wetland areas, Hampton Roads has been identified as one of the most vulnerable regions to sea level rise and coastal flooding in the United States. While Hampton Roads municipalities are larger than most Chesapeake Bay watershed communities, they provide instructive examples of green infrastructure financing within a regional planning framework.

The Hampton Roads Planning District Commission (HRPDC) is the regional planning agency for the Hampton Roads region. The HRPDC's *Green Infrastructure Plan* was first published in 2006 and updated in 2010 with funding support from the Virginia Coastal Zone Management Program.[86] This plan identifies and prioritizes a regional network of valuable conservation lands that provide benefits, such as habitat preservation, protection of drinking water supplies, stormwater management, and recreational opportunities. It is designed as a framework to guide actions by local governments to address urban development pressures on natural resources, regulatory mandates, sea level rise, and related issues.

Implementation efforts by local governments include both landscape-scale conservation (fee simple acquisition and purchase of development rights on lands identified in the regional network) and green stormwater infrastructure programs and projects. Partners in landscape-scale conservation have included The Conservation Fund, The Nature Conservancy, the U.S. Fish and Wildlife Service, and the Virginia Department of Conservation and Recreation. Jurisdictions throughout the Hampton Roads region have used "nature-based solutions" (another term for green infrastructure) to slow, store, and filter stormwater close to where it falls, allowing it to return to the groundwater system.[87] Examples include rain gardens, green roofs, bioswales, and living shorelines.

Various local jurisdictions have incorporated the regional green infrastructure network developed by HRPDC into comprehensive plan updates, green infrastructure plans, parks and recreation plans, and other planning initiatives. For example, the city of Norfolk published a *Green Infrastructure Plan* in 2018 with grant funding from the National Fish and Wildlife Foundation and additional support from Old Dominion University.[88] This plan defines a citywide network of natural assets to improve environmental and community health, protect built infrastructure, and increase resiliency of a city whose area of approximately 66 square miles is approximately one-third water.

Virginia Beach, Virginia

With approximately 450,000 residents, Virginia Beach is the largest municipality in the Hampton Roads region. The city's total area of 497 miles is divided more or less evenly between land and water, with much of the land in low-lying coastal areas. Like other Hampton Roads municipalities, Virginia Beach has a separate storm sewer system that is subject to an MS4 permit under the Virginia Stormwater Management Program and Act. The permit includes Total Maximum Daily Load (TMDL) targets for nitrogen, phosphorus, and sediments set by the U.S. Environmental Protection Agency to improve the water quality of the Chesapeake Bay. Virginia Beach established a stormwater utility fee in 1993 to fund development, operations, and maintenance of its stormwater management system, which includes both constructed and natural components. Calculated based on an equivalent residential unit (ERU) of 49.3 cents per day, the fee generates approximately $45 million annually.

In recent years, Virginia Beach has experienced increasing flooding resulting from sea level rise and higher annual rainfall amounts. According to city staff, the need for a comprehensive strategy to address this threat was highlighted by a 2014 questionnaire from Moody's that included questions about the resilience and flooding.[89] Since that time, the city has incorporated its resilience efforts into presentations to credit rating agencies and maintains a AAA bond rating.

In 2017 Virginia Beach's city manager established the Stormwater Engineering Center to focus on the management of the major flood protection projects and to comprehensively address the multiple causes and impacts of flooding.[90] In addition to updating the city's existing stormwater management master plan, the Center led development of the *Sea Level Wise Adaptation Strategy*, which defines a watershed-based response to sea level rise and flooding.[91] Computer modeling was used to identify the impacts of different flooding scenarios and help the public visualize options to address those impacts. The resulting strategy identifies natural mitigation (the use of nature-based solutions, or green infrastructure, at the watershed scale) as the first of four pillars to increase resilience to flooding.

Virginia Beach is using diverse funding sources to implement the adaptation strategy. Initial actions included establishment of a Capital Improvement Program for green stormwater infrastructure, with allocation of $75,000 from the General Fund in its first year. A variety of federal and state grant programs are being used to support natural mitigation projects in locations where conventional engineering solutions are not feasible. In 2021 Virginia Beach voters passed a $568 million flood mitigation bond referendum that includes $40 million for green infrastructure. The referendum passed with 73 percent voter approval, reflecting the effectiveness of the city's public education and outreach efforts (the second of *Sea Level Wise Adaptation Strategy's* four pillars).

Hampton, Virginia

Similar to Virginia Beach, Hampton's location along the Chesapeake Bay shoreline makes it vulnerable to sea level rise and flooding. The city has an area of 136 square miles (51 square miles land and 85 square miles water) and a population of approximately 137,000, making it the fifth largest municipality in the region. Hampton established a stormwater utility fee in 1994 to provide a revenue source to meet its MS4 permit requirements. The current rate per equivalent residential unit (ERU) is $129.96, generating approximately $11.2 million per year for management of stormwater flooding and water quality.

Green infrastructure is fundamental to Hampton's stormwater management strategy. The city's goals for green infrastructure are to 1) reduce flooding and 2) improve water quality by slowing down the flow of water over the landscape, storing it, and infiltrating it into the land.[92] In June 2015 Hampton participated in *Dutch Dialogues Virginia: Life at Sea Level*, a five-day workshop that brought together urban water management experts from New Orleans, Netherlands, and Hampton Roads to discuss ideas and solutions to coastal flooding and sea level rise. Following the workshop, the mayors and city managers of Hampton and Norfolk pledged to be leaders in coastal resiliency and Hampton launched the *Resilient Hampton Initiative*. This initiative has been guided by *Living with Water Hampton: A Holistic Approach to Addressing Sea Level Rise and Resiliency*, published in 2017 after an 18-month planning process.[93]

Living with Water Hampton recommends a range of strategies to improve resilience, including development of more detailed watershed plans that identify pilot projects for implementation. The first of these plans, the *Resilient Hampton: Newmarket Creek Water Plan*, identifies nearly two dozen projects connected by a loop trail

along Newmarket Creek.[94] According to city staff, design concepts for these projects have been instrumental in securing funding for project implementation. Sources include Virginia's Community Flood Preparedness Fund (CPFP), American Rescue Plan Act funding, and proceeds from an Environmental Impact Bond (next paragraph).

Implementation of three of the projects identified in the Newmarket Creek Water Plan (Big Bethel Blueway, North Armistead Avenue Road Raising and Green Infrastructure, and Lake Hampton Stormwater Park) is being funded by a $12 million Environmental Impact Bond (EIB), the first of its kind in Virginia. A grant from the Chesapeake Bay Foundation enabled the city to retain Quantified Ventures, an outcomes-based capital firm, to develop the outcome metric, impact measurement, and disclosure aspects of the EIB. The three projects are projected to add more than 8.6 million gallons of stormwater storage capacity while providing recreational and environmental co-benefits.[95]

According to Carolyn Heaps, Hampton's resiliency officer, interdepartmental collaboration is essential to the initiative's success. *The Resilient Hampton* team includes representatives from Community Development; Emergency Management; Parks, Recreation, & Leisure Services; Public Works; and other city departments.[96]

Honor Park Resilience Park

Honor Park is an existing park located between Hampton's Public Safety Building and City Hall that is dedicated to honoring all who have offered public service, especially those public safety officers and military veterans who have lost their lives in the line of duty. Honor Park Resilience Park is a project to redesign the park to provide stormwater storage and community amenities while maintaining its role as a memorial park. A concept drawing of the reimagined park was instrumental in securing a $148,000 CFPF grant to fund design.

Warrington Township, Pennsylvania

Known as the gateway to Bucks County, Warrington Township is located in the Philadelphia metropolitan area within the Delaware River watershed. It has a land area of 13.8 square miles and a population of 25,369 according to the 2020 U.S. Census. Warrington has an MS4 permit issued by the Pennsylvania Department of Environmental Protection that requires implementation of six minimum control measures (public education and outreach, construction and post-construction runoff control, pollution prevention, etc.). Costs associated with these measures are paid for by General Fund revenues.

Warrington Township has experienced increasing development pressures as a result of its location near Philadelphia. In 2012 township residents passed an Open Space Referendum authorizing the Board of Supervisors to borrow up to $3 million over 20 years to acquire and protect open space. The overwhelming (97 percent) support for the bond, which was estimated to result in a $27 annual increase in property taxes paid by an average household, reflected both the high value placed by residents on preserving the township's remaining open space and the effectiveness of outreach efforts by citizen volunteers. Following passage of the Open Space Referendum, EPA's Region 3 Office provided technical support to help the township identify parcels with the most environmental value for potential acquisition. This support included enlisting the University of Maryland's Environmental Finance Center (EFC) to work with the township on a landscape-scale green infrastructure approach to maximizing the impact of the $3 million open space bond.[97]

Published in 2014, *A Green Infrastructure Approach to Leveraging Local Priorities in Warrington Township*, Pennsylvania, focuses on three core opportunities:

1. *Leverage outside funding sources.* The $3 million bond can be used to meet or exceed grant match requirements, making the township a strong competitor for many funding programs. The plan identifies

numerous federal, state, foundation, and private sector funding opportunities that can be leveraged to achieve Warrington's open space priorities.

2. *Develop strategic partnerships.* The plan identifies nonprofit land trusts as primary potential partners because of the alignment of their missions with the goals of Warrington's open space bond.

3. *Integrate green infrastructure into land conservation planning and project site design.* Recommendations include developing a landscape-scale green infrastructure network, using green stormwater infrastructure to meet the township's MS4 and water quality Total Maximum Dailly Load (TMDL) requirements, and developing concept plans and illustrations to help residents visualize the benefits of green infrastructure. Concept plans developed by University of Maryland landscape architecture students for two planned sites in the township were included in the plan.

Since 2014 Warrington Township has used *A Green Infrastructure Approach* to guide implementation of its open space priorities, which include land acquisition and development, trail system improvements, and infrastructure improvements in existing parks. The 67-acre Mill Creek property, identified as an acquisition priority through a ranking system recommended in the plan, was purchased using proceeds from the open space bond, $1.1 million in Land and Water Conservation funding from the Pennsylvania Department of Conservation and Natural Resources (DCNR), and $280,000 from the Bucks County Open Space Fund. The township is working with The Natural Lands Trust, one of the potential partners identified in the plan, to develop a master plan for the Mill Creek Preserve. To supplement its land acquisition program, the township has revised its zoning ordinance to allow Conservation Residential Developments (CRDs) (applicable to the few remaining parcels greater than 25 acres in size) resulting in permanent preservation of a minimum of 65 percent of tract areas. To date, this mechanism has resulted in protection of over 100 acres of open space in three developments. As illustrated by the Mill Creek acquisition, the township has leveraged multiple sources to fund its open space program, including agencies and organizations such as Bucks County (Community Development Block Grant), DCNR, the Delaware Valley Regional Planning Commission, PECO (the local utility company), and the William Penn Foundation. Revenues from these sources and expenses for acquisition and development are detailed in an Open Space Fund included in Warrington Township's annual budget.

As previously noted, support by township residents has been key to the success of Warrington's open space program. Other important factors include leadership by

the Township Board of Supervisors and Manager and the sustained efforts of a core group of citizen volunteers to move Warrington's open space initiatives forward over a period of many years. The members of the Environmental Advisory Council and the Open Space and Land Preservation Committee have provided continuity in these efforts.

Conclusion

The above case study communities vary in size, context, and approaches to implementing green infrastructure. Nevertheless, a series of common themes, or key takeaways, are evident that can inform efforts by other communities in the Chesapeake Bay watershed to develop and fund effective green infrastructure programs. They build on and reinforce the key takeaways presented in Chapters 3 (Valuing Green Infrastructure) and 4 (Green Infrastructure Funding and Financing Sources):

- ***Build support through community engagement, education, and outreach.*** Community representatives consistently identified building community support through engagement, education, and outreach as being instrumental to the success of their green infrastructure programs. Examples include the extensive public outreach conducted for Takoma Park's Flower Avenue Green Street project and Lancaster's new stormwater management fee.
- ***Develop a plan to define the purpose of and need for green infrastructure, develop strategies, and prioritize actions.*** Green infrastructure financing should begin not by identifying funding sources, but by defining why the funding is needed. Motivations may include fulfilling regulatory requirements, contributing to broader community goals, or a combination thereof. Regardless, the most effective funding programs are based on a plan that defines goals, strategies, and priorities for action. Strategic planning is particularly important for communities with limited capacity. Various funding sources are available to help develop a plan, which in turn can open up new funding opportunities.
- ***Leverage diverse funding sources to implement the plan.*** Successful green infrastructure programs utilize a range of the funding sources and financing techniques to implement plan priorities. Identifying co-benefits beyond the direct benefit provided can open up new funding streams for project implementation.
- ***Encourage interdepartmental collaboration.*** Municipal departments tend to operate in silos guided by different missions and work programs. Effectively implementing green infrastructure requires new working relationships between departments. The largest jurisdictions profiled — Virginia Beach and Hampton — established new mechanisms to facilitate interdepartmental collaboration. Smaller jurisdictions can take advantage of less formal, more nimble organizational structures.
- ***Build implementation capacity through partnerships.*** Potential partners include, among others, other local jurisdictions; regional, state, and federal agencies; nonprofit and philanthropic organizations; and private businesses with an interest or expertise in green infrastructure. Partnerships are particularly important for smaller communities with less in-house capacity.
- ***Establish a stormwater utility fee or other sustainable funding source.*** All of the case study communities except for Warrington Township have a fee in place that provides a reliable stream of funding that can be utilized for green stormwater infrastructure. Warrington's Open Space Bond and Fund fulfill a similar purpose for development of the township's green infrastructure network.

Underpinning all of these themes is the pivotal role played by local government leaders, including elected officials and city managers, in shepherding successful green infrastructure initiatives.

6. Developing a Green Infrastructure Funding and Financing Strategy

Previous chapters of this report describe the direct benefits and co-benefits of green infrastructure; the monetary value and return on investment these benefits provide for communities; the range of available funding sources and financing mechanisms; and case studies of effective green infrastructure programs. This final chapter synthesizes this information into a process that communities can use to develop a funding and financing strategy for green infrastructure investments.[98] This process consists of five steps:

1. Define purpose, need, and goals.
2. Identify green infrastructure implementation options.
3. Assess capacity.
4. Evaluate costs and benefits to determine a preferred solution.
5. Develop a funding and financing strategy.

Financing green infrastructure is not an end in itself. Rather, a funding and financing strategy should be developed through a process that accounts for the local context, needs, and capacity. A strategic approach to green infrastructure investment is particularly important for smaller communities, which typically have limited staff and fiscal resources to take on new projects and programs.

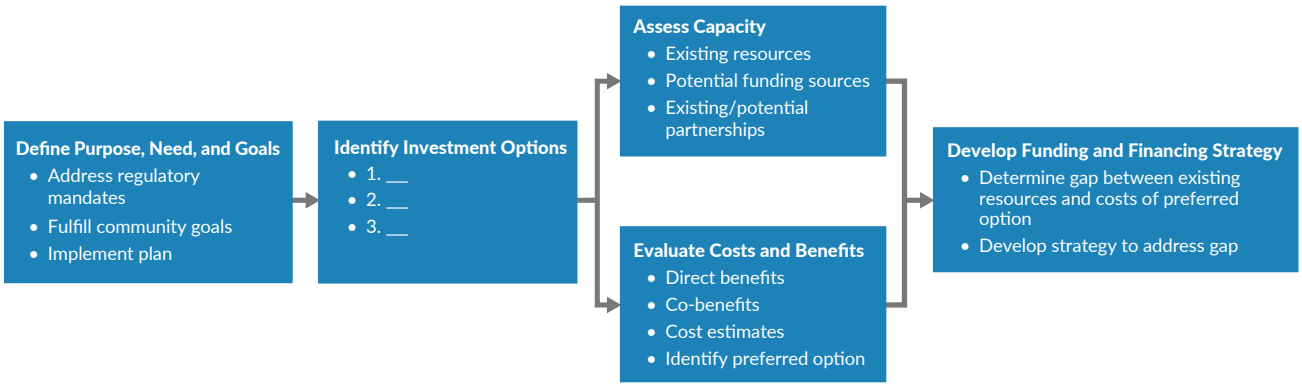
A Strategic Approach to Green Infrastructure Investment

1. Define Purpose, Need, and Goals

Defining purpose, need, and goals for the use of green infrastructure is the first step in developing a funding and financing strategy. The initial motivation is often the need to fulfill regulatory mandates, such as MS4 permit requirements or TMDL standards to reduce pollution of the Chesapeake Bay. Purpose and need can also be driven by broader community issues and values. In Hampton and Virginia Beach, for example, the primary motivation is to address increased flooding associated with sea level rise and a changing climate. In Warrington Township, the primary motivation is to preserve open space and natural resources in a suburban community with relatively little undeveloped land remaining. Different motivations for using green infrastructure are not mutually exclusive. For example, addressing stormwater management requirements in concert with broader community goals can yield a range of co-benefits while leveraging diverse funding sources.

Purpose, need, and goals are most powerful when based on a plan developed through a consensus-building engagement process. Examples are a comprehensive

Green Infrastructure Funding and Financing Process



plan, future land use plan, or green infrastructure plan that defines the community's shared vision, goals, and implementing strategies and actions. Irrespective of source, the purpose, need, and goals should be clearly articulated and used as criteria to set priorities, guide decision-making, and ensure most effective use of limited resources.

2. Identify Green Infrastructure Implementation Options

The second step in the process is to identify project and program options to fulfill the purpose, need, and goals defined in Step 1. Examples from the case study communities include investing in green stormwater infrastructure to meet permit requirements while providing community co-benefits (Takoma Park); acquiring undeveloped land to establish a landscape-scale green infrastructure network (Warrington Township); and using green infrastructure at the site/project and landscape scales to reduce flooding and improve water quality (Hampton). In Warrington and Hampton, project and program options were identified from existing plans. As previously noted, grant funding may be available to support development of a plan, which in turn can be used to attract funding to implement projects and programs identified in the plan.

3. Assess Capacity

The third step in the process is to assess existing and potential capacity to implement the options identified in step 2. Key questions include:

- What existing staff and fiscal resources are currently used or could be available for green infrastructure investments? Could use of existing resources be adjusted or expanded?
- What additional funding sources and financing mechanisms are potentially available for green infrastructure? Are there legal, regulatory, or other barriers to utilizing particular sources or mechanisms?
- Are there existing partnerships that could be leveraged for green infrastructure investments? Are there new partnerships that could be formed for this purpose? Examples include regional, state, and federal agencies; nonprofit and philanthropic organizations; private businesses or landowners; and others with a mission, interest, or expertise related to green infrastructure.

Because green infrastructure resources — such as river corridors and floodplains — transcend jurisdictional boundaries, assessment of existing and potential partnerships should include adjacent jurisdictions and the

regional planning agency. For example, the Hampton Roads Planning District Commission's *Green Infrastructure Plan* provides a framework for green infrastructure investments by local governments. HRPDC convenes a Regional Environmental Committee comprising representatives of member governments who have expertise in land use, water quality, stormwater, and other coastal and planning issues; the committee meets monthly to share activities and lessons learned related to green infrastructure. Lancaster coordinates green infrastructure planning and implementation with the Lancaster County Planning Commission and Lancaster Inter-Municipal Committee (LIMC, a council of 13 governments in the central part of the county) and has partnered with Lancaster Township (an adjacent jurisdiction) on riparian buffer restoration.

4. Evaluate Costs and Benefits to Determine a Preferred Option

Evaluating the costs and benefits of green infrastructure investment options is necessary to identify the most effective way to meet the purpose, need, and goals defined in Step 1.[99]

The evaluation of benefits can be qualitative rather than quantitative in nature. It begins by identifying the direct benefit(s) to be provided, based on the primary motivation(s) for investing in green infrastructure. Additional co-benefits can be determined using a triple-bottom-line (environmental, economic, and social) framework, as presented in Chapter 3. The direct benefits and co-benefits can then be ranked for relative importance based on purpose, need, and goals and the rankings used to evaluate the impact of different green infrastructure investment options.

Order-of-magnitude cost estimates (analogous to those developed for a capital improvement program) are needed to understand the budgetary implications of different options. These estimates should account for full life cycle costs (ongoing maintenance as well as initial installation) and cost savings that may result from the use of green rather than gray infrastructure.

By comparing costs and benefits of the different options evaluated, a preferred option — as measured by return on fiscal investment in terms of benefits provided — can be identified for implementation. An example might be installation of bioretention facilities in areas subject to flooding to meet stormwater management and water quality needs, avoid costs for more expensive gray infrastructure, and provide co-benefits, such as community recreation. Depending on scope of need and capacity, the solution may comprise multiple components (i.e., bioretention facilities, green streets, land acquisition, and trail development).

5. Develop a Funding and Financing Strategy

The final step in the process is to develop a funding and financing strategy to implement the preferred green infrastructure solution. Comparing the capacity assessment conducted in Step 3 to the cost-benefit evaluation conducted in Step 4 will reveal the gap between currently available fiscal resources and the cost of implementing the preferred solution. The funding and financing strategy will define how additional resources will be secured to fill that gap.

The funding and financing categories identified in Chapter 4 (local, state, and federal, philanthropic, and private sector) can be used as a framework to identify the most promising sources for the preferred solution and its components. An effective strategy will leverage funding from multiple sources whose mission and program goals align with the community's purpose, need, and goals statement. As illustrated by the success of the case study communities, conducting a strategic planning process like the one outlined in this chapter will position the community well to secure grant funding for identified priorities.

Strategies not involving new revenue sources should be considered to help implement the preferred solution. For example, Warrington has preserved over 100 acres of open space at minimal cost to the township through use of its Conservation Residential Development ordinance. Engaging outside partners who can leverage other public and private funding sources is another key to success. Because most land within a typical local jurisdiction is privately rather than publicly owned, private landowners are an important constituency to involve in implementation. Incentives, loans, and grant programs can be used to encourage installation of green infrastructure solutions, such as rain gardens, permeable pavement, and green roofs on private property.

An effective green infrastructure investment strategy will account for budgetary impacts (costs versus revenues) and outcomes over time. For example, a larger upfront investment can yield desired benefits more quickly if sufficient funding is available (i.e., Hampton's Environmental Impact Bond). Alternatively, the strategy could begin with a pilot project that requires limited funding, the intent being to scale up investments over a period of years as additional funding becomes available. Budgetary impacts include ongoing maintenance as well as initial implementation costs, highlighting the importance of establishing a stormwater utility fee or other sustainable funding source.

7. Conclusion

Green infrastructure may seem like one of the latest buzzwords, but the basic principle of working in harmony rather than at odds with the forces of nature is as old as human society itself. The indigenous peoples of the Americas and Australia, for example, regarded nature with deep respect and served as stewards of the land and natural resources, sustaining them for generations to come. In an era of unprecedented urban development, unimaginable new technologies, and environmental challenges like climate change, the need to act in harmony with nature is greater than ever.

It is thus not surprising that green infrastructure has become an indispensable tool in the local governmental toolbox. It can be used to address a host of challenges, ranging from satisfying regulatory mandates to increasing resilience to natural disasters to providing ecosystem services and benefits that residents (and businesses) expect. Particularly for smaller communities, lack of financial resources can be the primary barrier to employing green infrastructure solutions. The approach described in this report can be used to overcome this barrier in ways that maximize the full potential of green infrastructure to realize community goals and provide community benefits.

The term green infrastructure was first coined to elevate nature-based solutions to the same level of importance as engineered (gray) infrastructure. Superstorms, such as Katrina and Sandy, have demonstrated the limitations of gray infrastructure in the face of increasingly severe natural disasters. The use of green and gray infrastructure is not mutually exclusive; to the contrary, the most effective strategies are likely to integrate both green and gray solutions. The fiscal health of local governments will increasingly depend on the extent to which they employ such strategies to increase resilience and reduce risks.

The Government Finance Officers Association (GFOA) recommends as a best practice that:

> "...governments (address) environmental risks applicable to municipal issuers and their bonds in statements used in connection with bond sales and in other voluntary disclosure. Governments should also disclose plans developed, strategies deployed, actions taken, and infrastructure built to address the environmental risks..."[100]

Examples of environmental risks identified by GFOA include hurricanes, flooding, drought, and other extreme weather events; climate change impacts on agriculture, industry, and infrastructure; and sea level rise in coastal communities.

While smaller communities have more limited fiscal and staff resources than large cities, they have advantages that lend themselves well to green infrastructure implementation. These advantages include more flexible organizational structures that can facilitate collaborative solutions; the opportunity for direct engagement of community members and volunteers with relevant expertise; and the receptiveness of funders to supporting communities that clearly articulate a need, vision, and strategy to meet the need. Elected officials and executive leaders can play a catalytic role in moving green infrastructure efforts forward to implementation.

The challenges are many, but the opportunity is clear. By developing and implementing a robust green infrastructure program using the approach described in this report, Chesapeake Bay watershed communities will position themselves well to address the challenges they face while achieving multiple benefits for people and ecosystems.

Acknowledgements

INTERVIEW PARTICIPANTS

C.J. Bodnar, Program Manager, Stormwater Engineering Center
Virginia Beach, VA

Daryl Braithwaite, Public Works Director
Takoma Park, MD

William Cesanek, Vice President
CDM Smith

Jennifer Cotting, Director
Environmental Finance Center, University of Maryland

Jennifer Egan, Program Manager
Environmental Finance Center, University of Maryland

Karl Graybill, Environmental Planner, Department of Public Works
Lancaster, PA

Carolyn Heaps, Resiliency Officer
Hampton, VA

Whitney Katchmark, Principal Water Resources Engineer
Hampton Roads Planning District Commission

Cindy McCormick, Deputy Director — Engineering, Department of Public Works
Lancaster, PA

Benjamin McFarlane, Senior Regional Planner
Hampton Roads Planning District Commission

Ivy Ross, Township Grant Administrator; Vice-Chair, Environmental Advisory Council; Chair, Open Space and Land Preservation Committee
Warrington, PA

Scott Smith, Senior Civil Engineer
Hampton, VA

Fred Suffian, Chair, Environmental Advisory Council
Warrington, PA

Toni Utterback, Administrator, Stormwater Engineering Center
Virginia Beach, VA

PHOTO CREDITS

Cover: Will Parson, courtesy of the Chesapeake Bay Program

Page 4: Steve Droter, courtesy of the Chesapeake Bay Program

Page 6: Courtesy of the Philadelphia Water Department

Page 8: Will Parson, courtesy of the Chesapeake Bay Program

Page 9: Courtesy of the Green Roof Palnts

Page 10: Will Parson, courtesy of the Chesapeake Bay Program

Page 12: Will Parson, courtesy of the Chesapeake Bay Program

Page 16: Will Parson, courtesy of the Chesapeake Bay Program

Page 18: Jenna Valente, courtesy of the Chesapeake Bay Program

Page 19: Will Parson, courtesy of the Chesapeake Bay Program

Page 21: Courtesy of the City of Takoma Park

Page 23: (top) Will Parson, courtesy of the Chesapeake Bay Program, (bottom) Steve Droter, courtesy of the Chesapeake Bay Program

Page 24: Will Parson, courtesy of the Chesapeake Bay Program

Page 26: Both images courtesy of the City of Hampton

Page 27: Courtesy of the Town of Warrington

Page 30: Will Parson, courtesy of the Chesapeake Bay Program

Page 32: Will Parson, courtesy of the Chesapeake Bay Program

Endnotes

1 Benedict, Mark and Ed McMahon (2006). *Green Infrastructure: Linking Landscape and Communities.* Washington, DC: Island Press.

2 U.S. Environmental Protection Agency (EPA) (n.d). "Green Infrastructure Glossary." Accessed at https://ofmpub.epa.gov/sor_internet/registry/termreg/searchandretrieve/glossariesandkeywordlists/search.do?details=&glossaryName=Green%20Infrastructure%20Glossary

3 Sources: 1) Rouse, David C. and Ignacio F. Bunster Ossa (2013). *Green Infrastructure: A Landscape Approach*, PAS Report No. 571. Chicago: American Planning Association.
2) Rouse, David (2020). "Green Infrastructure and Resilience," The Routledge Handbook of Urban Resilience, Michael Burayidi et. al., ed., pp. 229-242. London and New York: Routledge.

4 Dunn, Alexandra Dapolito (2010). "Siting Green Infrastructure: Legal and Policy Solutions to Alleviate Urban Poverty and Promote Healthy Communities," Boston College Environmental Affairs Law Review, Vol. 37, Issue 1, pp. 41-66.

5 Rigolon, Alessandro (2016). "A Complex Landscape of Inequity in Access to Urban Parks," Landscape and Urban Planning, Vol. 153, pp. 160–169.

6 Miller, Kelsey (n.d.). "The Triple Bottom Line: What It Is & Why It's Important," Harvard Business School Online. Accessed at https://online.hbs.edu/blog/post/what-is-the-triple-bottom-line

7 Center for Neighborhood Technology (2014). "The Economic Benefits of Green Infrastructure: A Case Study of Lancaster, PA," prepared for the U.S. Environmental Protection Agency. Accessed at https://www.cnt.org/publications/the-economic-benefits-of-green-infrastructure-a-case-study-of-lancaster-pa

8 Delaware Valley Regional Planning Commission, Natural Lands Trust, Econsult Solutions Inc., et al. (2019). "Return On Environment: the Economic Value of Protected Open Space in Chester County, Pennsylvania." Accessed at https://econsultsolutions.com/wp-content/uploads/2019/05/Open-Space-ROE-FINAL_FOR-WEB_201905150942514589.pdf

9 Center for Neighborhood Technology (2020). "Green Values Strategy Guide: Linking Green Infrastructure Benefits to Community Priorities." Accessed at https://www.cnt.org/publications/green-values-strategy-guide-linking-green-infrastructure-benefits-to-community

10 Delaware Valley Regional Planning Commission, Natural Lands Trust, Econsult Solutions Inc., et al. (2019). "Return On Environment: the Economic Value of Protected Open Space in Chester County, Pennsylvania," p.62. Accessed at https://econsultsolutions.com/wp-content/uploads/2019/05/Open-Space-ROE-FINAL_FOR-WEB_201905150942514589.pdf

11 Delaware Valley Regional Planning Commission, Natural Lands Trust, Econsult Solutions Inc., et al. (2019). "Return On Environment: the Economic Value of Protected Open Space in Chester County, Pennsylvania." Accessed at https://econsultsolutions.com/wp-content/uploads/2019/05/Open-Space-ROE-FINAL_FOR-WEB_201905150942514589.pdf

12 Warrington Township, Pennsylvania," pp. 29. Accessed at https://arch.umd.edu/research-creative-practice/centers/environmental-finance-center/project-areas/green-infrastructure/green-infrastructure-warrington-township-pa

13 Delaware Valley Regional Planning Commission, Natural Lands Trust, Econsult Solutions Inc., et al. (2019). "Return On Environment: the Economic Value of Protected Open Space in Chester County, Pennsylvania," p.59. Accessed at https://econsultsolutions.com/wp-content/uploads/2019/05/Open-Space-ROE-FINAL_FOR-WEB_201905150942514589.pdf

14 EFC-UMD (2017). "Holistically Analyzing the Benefits of Green Infrastructure: Guidance for Local Governments." Accessed at https://arch.umd.edu/sites/default/files/docs/publications/EFC_Holistic_Benefits_GI_Report.pdf

15 Center for Neighborhood Technology (2020). "Green Values Strategy Guide: Linking Green Infrastructure Benefits to Community Priorities," p. 12-13. Accessed at https://www.cnt.org/publications/green-values-strategy-guide-linking-green-infrastructure-benefits-to-community

16 Center for Neighborhood Technology (2014). "The Economic Benefits of Green Infrastructure: A Case Study of Lancaster, PA," prepared for the U.S. Environmental Protection Agency. Accessed at https://www.cnt.org/publications/the-economic-benefits-of-green-infrastructure-a-case-study-of-lancaster-pa

17 Delaware Valley Regional Planning Commission, Natural Lands Trust, Econsult Solutions Inc., et al. (2019). "Return On Environment: the Economic Value of Protected Open Space in Chester County, Pennsylvania," p.60. Accessed at https://econsultsolutions.com/wp-content/uploads/2019/05/Open-Space-ROE-FINAL_FOR-WEB_201905150942514589.pdf

18 Center for Neighborhood Technology (2020). "Green Values Strategy Guide: Linking Green Infrastructure Benefits to Community Priorities," p. 28. Accessed at https://www.cnt.org/publications/green-values-strategy-guide-linking-green-infrastructure-benefits-to-community

19 Sources: 1) Delaware Valley Regional Planning Commission, Natural Lands Trust, Econsult Solutions Inc., et al. (2019). "Return On Environment: the Economic Value of Protected Open Space in Chester County, Pennsylvania," p.61. Accessed at https://econsultsolutions.com/wp-content/uploads/2019/05/Open-Space-ROE-FINAL_FOR-WEB_201905150942514589.pdf
2) EFC-UMD and the Alliance for the Chesapeake Bay (2019). "Financing Urban Tree Canopy Programs: Guidebook for Local Governments in the Chesapeake Bay Watershed." Accessed at https://arch.umd.edu/sites/default/files/docs/FinancingUrbanTreeCanopyPrograms_LowRes_040919.pdf

20 McGarity, Arthur, Fengwei Hung, Christina Rosan, Benjamin Hobbs, Megan Heckert, and Shandor Szalay (n.d.) "Quantifying Benefits of Green Stormwater Infrastructure in Philadelphia," p. 12.

21 Sustainable Business Network of Greater Philadelphia (2019). "The Economic, Social, and Environmental Case for Green City, Clean Waters: An Update," p.4. Accessed at https://www.sbnphiladelphia.org/wp-content/uploads/2021/04/SBN-GCCW-Report-071219.pdf

22 Delaware Valley Regional Planning Commission, Natural Lands Trust, Econsult Solutions Inc., et al. (2019). "Return On Environment: the Economic Value of Protected Open Space in Chester County, Pennsylvania." Accessed at https://econsultsolutions.com/wp-content/uploads/2019/05/Open-Space-ROE-FINAL_FOR-WEB_201905150942514589.pdf

23 Burden, Dan (2006). "Urban Street Trees: 22 Benefits, Specific Applications." Accessed at https://www.walkable.org/download/22_benefits.pdf

24 Clements, Janet, Alexis St. Juliana, and Stratus Consulting (2013). "The Green Edge: How Commercial Property Investment in Green Infrastructure Creates Value," NRDC Report, p.9. Accessed at https://www.nrdc.org/sites/default/files/commercial-value-green-infrastructure-report.pdf

25 Center for Neighborhood Technology (2020). "Green Values Strategy Guide: Linking Green Infrastructure Benefits to Community Priorities," p. 22. Accessed at https://www.cnt.org/publications/green-values-strategy-guide-linking-green-infrastructure-benefits-to-community

26 Sources: 1) Clements, Janet, Alexis St. Juliana, and Stratus Consulting (2013). "The Green Edge: How Commercial Property Investment in Green Infrastructure Creates Value," NRDC Report, p.9. Accessed at https://www.nrdc.org/sites/default/files/commercial-value-green-infrastructure-report.pdf

2) Madison, Catherine, "Impact of Green Infrastructure on Property Values within the Milwaukee Metropolitan Sewerage District Planning Area," University of Wisconsin-Milwaukee Center for Economic Development Publications, p.5. Accessed at https://dc.uwm.edu/ced__pubs/16

27 Center for Neighborhood Technology and SB Friedman Development Advisors (2020). "Green Stormwater Infrastructure Impacts on Property Values," p.5-6. Accessed at https://www.cnt.org/publications/green-stormwater-infrastructure-impact-on-property-values

28 Center for Neighborhood Technology (2020). "Green Values Strategy Guide: Linking Green Infrastructure Benefits to Community Priorities," p. 21. Accessed at https://www.cnt.org/publications/green-values-strategy-guide-linking-green-infrastructure-benefits-to-community

29 Clements, Janet, Alexis St. Juliana, and Stratus Consulting (2013). "The Green Edge: How Commercial Property Investment in Green Infrastructure Creates Value," NRDC Report, p. 17. Accessed at https://www.nrdc.org/sites/default/files/commercial-value-green-infrastructure-report.pdf

30 Sources: 1) Morley, David, "Planning for Equity in Parks with Green Infrastructure," American Planning Association. Accessed at https://www.planning.org/publications/document/9137980/

2) U.S. Forest Service (2016). "i-Tree Ecosystem Analysis Grand Rapids." Accessed at https://www.itreetools.org/documents/37/GR_Report.pdf

31 Center for Neighborhood Technology (2014). "The Economic Benefits of Green Infrastructure: A Case Study of Lancaster, PA," prepared for the U.S. Environmental Protection Agency, p.8. Accessed at https://www.cnt.org/publications/the-economic-benefits-of-green-infrastructure-a-case-study-of-lancaster-pa

32 Sources: 1) Center for Neighborhood Technology (2020). "Green Values Strategy Guide: Linking Green Infrastructure Benefits to Community Priorities," p. 28. Accessed at https://www.cnt.org/publications/green-values-strategy-guide-linking-green-infrastructure-benefits-to-community

2) U.S. Forest Service (2016). "i-Tree Ecosystem Analysis Grand Rapids." Accessed at https://www.itreetools.org/documents/37/GR_Report.pdf

33 Center for Neighborhood Technology (2020). "Green Values Strategy Guide: Linking Green Infrastructure Benefits to Community Priorities," p. 28. Accessed at https://www.cnt.org/publications/green-values-strategy-guide-linking-green-infrastructure-benefits-to-community

34 Clements, Janet, Alexis St. Juliana, and Stratus Consulting (2013). "The Green Edge: How Commercial Property Investment in Green Infrastructure Creates Value," NRDC Report, p. 9. Accessed at https://www.nrdc.org/sites/default/files/commercial-value-green-infrastructure-report.pdf

35 Center for Neighborhood Technology (2014). "The Economic Benefits of Green Infrastructure: A Case Study of Lancaster, PA," prepared for the U.S. Environmental Protection Agency. Accessed at https://www.cnt.org/publications/the-economic-benefits-of-green-infrastructure-a-case-study-of-lancaster-pa

36 University of Washington (n.d.) "Green Cities, Good Health: Stress, Wellness, and Physiology." Accessed at https://depts.washington.edu/hhwb/Thm_StressPhysiology.html

37 Sources: 1) Sustainable Business Network of Greater Philadelphia (2019). "The Economic, Social, and Environmental Case for Green City, Clean Waters: An Update," p. 7. Accessed at https://www.sbnphiladelphia.org/wp-content/uploads/2021/04/SBN-GCCW-Report-071219.pdf

2) Economy League of Greater Philadelphia, Econsult Corporation, and Keystone Conservation Trust (2011). "The Economic Value of Protected Open Space in Southeastern Pennsylvania." Accessed at https://economyleague.org/uploads/files/818480472379666121-the-economic-value-of-protected-open-space-in-southeastern-pennsylvania-report.pdf

38 University of Washington (n.d.) "Green Cities, Good Health: Stress, Wellness, and Physiology." Accessed at https://depts.washington.edu/hhwb/Thm_StressPhysiology.html

39 Gotschi, Thomas and Tracy Hadden Loh (2017). "Advancing project-scale health impact modeling for active transportation: A user survey and health impact calculation of 14 US Trails," Journal of Transport & Health 4, 334-347.

40 Carlson, Susan A.; Fulton, Janet E.; Pratt, Michael; Yang, Zhou; Adams, E. Kathleen (2015). "Inadequate Physical Activity and Health Care Expenditures in the United States," Progress in Cardiovascular Diseases 57, 315-323.

41 Delaware Valley Regional Planning Commission, Natural Lands Trust, Econsult Solutions Inc., et al. (2019). "Return On Environment: the Economic Value of Protected Open Space in Chester County, Pennsylvania," p.75-77. Accessed at https://econsultsolutions.com/wp-content/uploads/2019/05/Open-Space-ROE-FINAL_FOR-WEB_201905150942514589.pdf

42 Active Living Research (2010). "The Economic Benefits of Open Space, Recreation Facilities and Walkable Community Design." Accessed at https://activelivingresearch.org/sites/activelivingresearch.org/files/Synthesis_Shoup-Ewing_March2010_0.pdf

43 Congressional Research Service (2016). "Green Infrastructure and Issues in Managing Urban Stormwater." Accessed at https://sgp.fas.org/crs/misc/R43131.pdf

44 Delaware Valley Regional Planning Commission, Natural Lands Trust, Econsult Solutions Inc., et al. (2019). "Return On Environment: the Economic Value of Protected Open Space in Chester County, Pennsylvania," p.62. Accessed at https://econsultsolutions.com/wp-content/uploads/2019/05/Open-Space-ROE-FINAL_FOR-WEB_201905150942514589.pdf

45 Center for Neighborhood Technology (2014). "The Economic Benefits of Green Infrastructure: A Case Study of Lancaster, PA," prepared for the U.S. Environmental Protection Agency, p.3. Accessed at https://www.cnt.org/publications/the-economic-benefits-of-green-infrastructure-a-case-study-of-lancaster-pa

46 EFC-UMD (2017). "Holistically Analyzing the Benefits of Green Infrastructure: Guidance for Local Governments," p. 25. Accessed at https://arch.umd.edu/sites/default/files/docs/publications/EFC_Holistic_Benefits_GI_Report.pdf

47 Sources: 1) EFC-UMD and Main Street Economics (2013). "Calvert County, Maryland Water Quality Financing Strategy." Accessed at https://arch.umd.edu/sites/default/files/docs/publications/calvert_final_10_21_13.pdf

2) Higgins, Phoebe, Timothy Male, and Sanjiv K. Sinha (2021). "Paying for Water Quality Improvements and Resilience in the Great Lakes: Focus on Green Stormwater Infrastructure." Environmental Policy Innovation Center and Environmental Consulting & Technology, Inc. Accessed at https://www.risc.solutions/wp-content/uploads/2021/07/Paying-for-Water-Quality-Improvements-and-Resilience-in-the-Great-Lakes-A-Toolkit-for-Green-Stormwater-Infrastructure.pdf

48 Center for Neighborhood Technology (2011). "Tree Asset Management in Portland, Oregon." Accessed at https://cnt.org/sites/default/files/publications/CNT_PDXTreeAssetMgmt.pdf

49 Sources: 1) Penn State Extension (2021). "What is a Municipal Stormwater Fee?" Accessed at https://extension.psu.edu/what-is-a-municipal-stormwater-fee

2) EFC-UMD and Main Street Economics (2013). "Calvert County, Maryland Water Quality Financing Strategy." Accessed at https://arch.umd.edu/sites/default/files/docs/publications/calvert_final_10_21_13.pdf

3) EFC-UMD (2013). "Financing Feasibility Study for Stormwater Management in Salisbury, Maryland." Accessed at https://arch.umd.edu/sites/default/files/docs/publications/salisbury_stormwater_feasibility_study_final_report.pdf

4) Takoma Park, Maryland (2016). Takoma Park Stormwater Management Funding and Programs," presentation to the Local Government Advisory Committee. Accessed at http://publicworks-takomapark.s3.amazonaws.com/public/stormwater/Takoma%20Park%20Stormwater%20Management%20Funding%20and%20Programs.pdf

50 Sources: 1) EFC-UMD and Main Street Economics (2013). "Calvert County, Maryland Water Quality Financing Strategy." Accessed at https://arch.umd.edu/sites/default/files/docs/publications/calvert_final_10_21_13.pdf

2) EFC-UMD (2013). "Financing Feasibility Study for Stormwater Management in Salisbury, Maryland." Accessed at https://arch.umd.edu/sites/default/files/docs/publications/salisbury_stormwater_feasibility_study_final_report.pdf

3) Campbell, C. Warren (2019). "Western Kentucky University Stormwater Utility Survey 2019." Accessed at https://digitalcommons.wku.edu/cgi/viewcontent.cgi?article=1000&context=seas_faculty_pubs

51 Campbell, C. Warren (2019). "Western Kentucky University Stormwater Utility Survey 2019." Accessed at https://digitalcommons.wku.edu/cgi/viewcontent.cgi?article=1000&context=seas_faculty_pubs

52 Campbell, C. Warren (2019). "Western Kentucky University Stormwater Utility Survey 2019." Accessed at https://digitalcommons.wku.edu/cgi/viewcontent.cgi?article=1000&context=seas_faculty_pubs

53 Center for Neighborhood Technology (2020). "Increasing Funding and Financing Options for Sustainable Stormwater Infrastructure." Accessed at https://www.cnt.org/publications/increasing-funding-and-financing-options-for-sustainable-stormwater-management

54 Sources: 1) Center for Neighborhood Technology (2020). "Increasing Funding and Financing Options for Sustainable Stormwater Infrastructure." Accessed at https://www.cnt.org/publications/increasing-funding-and-financing-options-for-sustainable-stormwater-management

2) Georgetown Climate Center (n.d.). "Green Infrastructure Toolkit: Government Financing." Accessed at https://www.georgetownclimate.org/adaptation/toolkits/green-infrastructure-toolkit/government-financing.html#ref-back-4

3) Adaptation Clearinghouse (n.d.). "City of Chicago Tax Increment Financing and Green Roof Improvement Fund." Accessed at https://www.adaptationclearinghouse.org/resources/city-of-chicago-tax-increment-financing-and-green-roof-improvement-fund.html

55 Center for Neighborhood Technology (2011). "Tree Asset Management in Portland, Oregon." Accessed at https://cnt.org/sites/default/files/publications/CNT_PDXTreeAssetMgmt.pdf

56 Old City District (n.d.). "2019-2023 Plan and Budget for the Old City District." Accessed at https://www.oldcitydistrict.org/sites/default/files/attachments/2021-11/2019-2023%20Plan%20and%20Budget%20for%20the%20Old%20City%20District_0.pdf

57 Center for Neighborhood Technology (2011). "Tree Asset Management in Portland, Oregon." Accessed at https://cnt.org/sites/default/files/publications/CNT_PDXTreeAssetMgmt.pdf

58 Higgins, Phoebe, Timothy Male, and Sanjiv K. Sinha (2021). "Paying for Water Quality Improvements and Resilience in the Great Lakes: Focus on Green Stormwater Infrastructure." Environmental Policy Innovation Center and Environmental Consulting & Technology, Inc., p. 10. Accessed at https://www.risc.solutions/wp-content/uploads/2021/07/Paying-for-Water-Quality-Improvements-and-Resilience-in-the-Great-Lakes-A-Toolkit-for-Green-Stormwater-Infrastructure.pdf

59 Sources: 1) U.S. EPA (n.d.). "How the Drinking Water State Revolving Fund Works," https://www.epa.gov/dwsrf/how-drinking-water-state-revolving-fund-works

2) U.S. EPA (n.d.). "Learn about the Clean Water State Revolving Fund (CWSRF)." https://www.epa.gov/cwsrf/learn-about-clean-water-state-revolving-fund-cwsrf

60 Sources: 1) Higgins, Phoebe, Timothy Male, and Sanjiv K. Sinha (2021). "Paying for Water Quality Improvements and Resilience in the Great Lakes: Focus on Green Stormwater Infrastructure." Environmental Policy Innovation Center and Environmental Consulting & Technology, Inc. Accessed at https://www.risc.solutions/wp-content/uploads/2021/07/Paying-for-Water-Quality-Improvements-and-Resilience-in-the-Great-Lakes-A-Toolkit-for-Green-Stormwater-Infrastructure.pdf

2) U.S. EPA (n.d.). "Learn about the Clean Water State Revolving Fund (CWSRF)." https://www.epa.gov/cwsrf/learn-about-clean-water-state-revolving-fund-cwsrf

3) Sawyers, Andrew D. (2016). "Green Infrastructure Policy for the Clean Water State Revolving Fund Program." Accessed at https://www.epa.gov/sites/default/files/2016-01/documents/cwsrf_green_infrastructure_policy_final.pdf

4) Georgetown Climate Center (n.d.). "Green Infrastructure Toolkit: Government Financing." Accessed at https://www.georgetownclimate.org/adaptation/toolkits/green-infrastructure-toolkit/government-financing.html#ref-back-4

61 Sources: 1) Pennsylvania Infrastructure Investment Authority (PENNVEST) (n.d.). "Mission." Accessed at https://www.pennvest.pa.gov/Pages/Mission.aspx

2) PENNVEST and DEP (2021). "Drinking Water State Revolving Fund Intended Use Plan, SFY 2021-2022 Capitalization Grant," p. 1. Accessed at https://files.dep.state.pa.us/Water/BPNPSM/InfrastructureFinance/StateRevolvFundIntendUsePlan/2021/2021_Draft_Drinking_Water_State_Revolving_Loan_Fund_Intended_Use_Plan.pdf

62 Higgins, Phoebe, Timothy Male, and Sanjiv K. Sinha (2021). "Paying for Water Quality Improvements and Resilience in the Great Lakes: Focus on Green Stormwater Infrastructure." Environmental Policy Innovation Center and Environmental Consulting & Technology, Inc. Accessed at https://www.risc.solutions/wp-content/uploads/2021/07/Paying-for-Water-Quality-Improvements-and-Resilience-in-the-Great-Lakes-A-Toolkit-for-Green-Stormwater-Infrastructure.pdf

63 Sources: 1)) University of Maryland Environmental Finance Center (2017). "Strategies for Financing Water Quality Restoration in Delaware"

2) Georgetown Climate Center (n.d.). "Green Infrastructure Toolkit: Government Financing." Accessed at https://www.georgetownclimate.org/adaptation/toolkits/green-infrastructure-toolkit/government-financing.html#ref-back-4

64 Higgins, Phoebe, Timothy Male, and Sanjiv K. Sinha (2021). "Paying for Water Quality Improvements and Resilience in the Great Lakes: Focus on Green Stormwater Infrastructure." Environmental Policy Innovation Center and Environmental Consulting & Technology, Inc. Accessed at https://www.risc.solutions/wp-content/uploads/2021/07/Paying-for-Water-Quality-Improvements-and-Resilience-in-the-Great-Lakes-A-Toolkit-for-Green-Stormwater-Infrastructure.pdf

65 Sources: 1) Georgetown Climate Center (n.d.). "Green Infrastructure Toolkit: Government Financing." Accessed at https://www.georgetownclimate.org/adaptation/toolkits/green-infrastructure-toolkit/government-financing.html#ref-back-4

2) Center for Neighborhood Technology (2020). "Increasing Funding and Financing Options for Sustainable Stormwater Infrastructure," p. 18. Accessed at https://www.cnt.org/publications/increasing-funding-and-financing-options-for-sustainable-stormwater-management

66 Downey, Hannah (2020). "The Great American Outdoor Act, Explained." Accessed at https://www.perc.org/2020/08/04/the-great-american-outdoors-act-explained/

67 Simpson, Kyle (2021). "Breaking Down the Infrastructure Investment and Jobs Act." Accessed at https://www.nrpa.org/blog/breaking-down-the-infrastructure-investment-and-jobs-act/

68 Sources: 1) Georgetown Climate Center (n.d.). "Green Infrastructure Toolkit: Government Financing." Accessed at https://www.georgetownclimate.org/adaptation/toolkits/green-infrastructure-toolkit/government-financing.html#ref-back-4

2) PENNVEST (n.d.) "Clean Water State Revolving Fund." Accessed at https://www.pennvest.pa.gov/Information/Funding-Programs/Pages/Clean-Water-State-Revolving-Fund.aspx

3) PENNVEST and Department of Environmental Protection (DEP) (2021). "Clean Water State Revolving Fund Intended Use Plan, SFY2021-2022 Capitalization Grant." Accessed at https://files.dep.state.pa.us/Water/BPNPSM/InfrastructureFinance/StateRevolvFundIntendUsePlan/2021/2021_Draft_Clean_Water_State_Revolving_Loan_Fund_Intended_Use_Plan.pdf

4) Garland, Liz (n.d.). "Funding Green Infrastructure in Pennsylvania." Accessed at https://www.americanrivers.org/wp-content/uploads/2017/05/funding-green-infrastructure-pa.pdf

5) EFC-UMD (2016). "Financing Green Infrastructure in Blair County, Pennsylvania." Accessed at https://arch.umd.edu/sites/default/files/docs/blair_county_stormwater_financing_final_report_0.pdf

6) Georgetown Climate Center (n.d.). "State Funding." Accessed at https://www.georgetownclimate.org/adaptation/toolkits/green-infrastructure-toolkit/state-funding.html

69 New York State Department of Environmental Conservation (n.d.). "Green Infrastructure Funding Sources." Accessed at https://www.dec.ny.gov/chemical/108961.html

70 Sources: 1) Higgins, Phoebe, Timothy Male, and Sanjiv K. Sinha (2021). "Paying for Water Quality Improvements and Resilience in the Great Lakes: Focus on Green Stormwater Infrastructure." Environmental Policy Innovation Center and Environmental Consulting & Technology, Inc. Accessed at https://www.risc.solutions/wp-content/uploads/2021/07/Paying-for-Water-Quality-Improvements-and-Resilience-in-the-Great-Lakes-A-Toolkit-for-Green-Stormwater-Infrastructure.pdf

2) Center for Neighborhood Technology (2020). "Increasing Funding and Financing Options for Sustainable Stormwater Infrastructure." Accessed at https://www.cnt.org/publications/increasing-funding-and-financing-options-for-sustainable-stormwater-management

71 USAID (n.d.). "Performance-based financing." Accessed at https://www.fpfinancingroadmap.org/learning/specific-topics/performance-based-financing

72 Sources: 1) Higgins, Phoebe, Timothy Male, and Sanjiv K. Sinha (2021). "Paying for Water Quality Improvements and Resilience in the Great Lakes: Focus on Green Stormwater Infrastructure." Environmental Policy Innovation Center and Environmental Consulting & Technology, Inc. Accessed at https://www.risc.solutions/wp-content/uploads/2021/07/Paying-for-Water-Quality-Improvements-and-Resilience-in-the-Great-Lakes-A-Toolkit-for-Green-Stormwater-Infrastructure.pdf

2) Georgetown Climate Center (n.d.). "Green Infrastructure Toolkit: Government Financing." Accessed at https://www.georgetownclimate.org/adaptation/toolkits/green-infrastructure-toolkit/government-financing.html#ref-back-4

73 The Trust for Public Land (n.d.). "2020 ballot measures." Accessed at https://www.tpl.org/2020-conservation-ballot-measures

74 Banzhaf, H. S., Oates, W. E., & Sanchirico, J. N. (2010). "Success and Design of Local Referenda for Land Conservation," Journal of Policy Analysis and Management, 29(4), pp. 769–798. Accessed at http://www.jstor.org/stable/40802191

75 Georgetown Climate Center (n.d.). "Private Financing." Accessed at https://www.georgetownclimate.org/adaptation/toolkits/green-infrastructure-toolkit/private-financing.html

76 Daniels, Tom (2020). "A Public-Private Partnership Works for Stormwater Management in Prince George's County, Maryland." Accessed at https://watercenter.sas.upenn.edu/a-public-private-partnership-works-for-stormwater-management-in-prince-georges-county-maryland/

77 Sources: 1) Higgins, Phoebe, Timothy Male, and Sanjiv K. Sinha (2021). "Paying for Water Quality Improvements and Resilience in the Great Lakes: Focus on Green Stormwater Infrastructure." Environmental Policy Innovation Center and Environmental Consulting & Technology, Inc. Accessed at https://www.risc.solutions/wp-content/uploads/2021/07/Paying-for-Water-Quality-Improvements-and-Resilience-in-the-Great-Lakes-A-Toolkit-for-Green-Stormwater-Infrastructure.pdf

78 Center for Neighborhood Technology (2020). "Increasing Funding and Financing Options for Sustainable Stormwater Infrastructure," p. 14, p. 19-21. Accessed at https://www.cnt.org/publications/increasing-funding-and-financing-options-for-sustainable-stormwater-management

79 University of Maryland Environmental Finance Center (2014). "Green Infrastructure Financing Map."

80 Sources: 1) Higgins, Phoebe, Timothy Male, and Sanjiv K. Sinha (2021). "Paying for Water Quality Improvements and Resilience in the Great Lakes: Focus on Green Stormwater Infrastructure." Environmental Policy Innovation Center and Environmental Consulting & Technology, Inc. Accessed at https://www.risc.solutions/wp-content/uploads/2021/07/Paying-for-Water-Quality-Improvements-and-Resilience-in-the-Great-Lakes-A-Toolkit-for-Green-Stormwater-Infrastructure.pdf

2) EFC-UMD (2013). "Financing Feasibility Study for Stormwater Management in Salisbury, Maryland." Accessed at https://arch.umd.edu/sites/default/files/docs/publications/salisbury_stormwater_feasibility_study_final_report.pdf

81 Center for Neighborhood Technology (2011). "Tree Asset Management in Portland, Oregon." Accessed at https://cnt.org/sites/default/files/publications/CNT_PDXTreeAssetMgmt.pdf

82 Center for Neighborhood Technology (2020). "Increasing Funding and Financing Options for Sustainable Stormwater Infrastructure," p. 14. Accessed at https://www.cnt.org/publications/increasing-funding-and-financing-options-for-sustainable-stormwater-management

83 Lancaster, PA, City of (2011). Green Infrastructure Plan. Accessed at https://www.cityoflancasterpa.com/wp-content/uploads/2014/01/cityoflancaster_giplan_fullreport_april2011_final_0.pdf

84 Lancaster, PA, City of (2018). Green It! Lancaster. Accessed at https://www.cityoflancasterpa.com/wp-content/uploads/2014/03/GREENIT_LANCASTER_FINAL_withAppendices_022519_LowRes.pdf

85 Crable, AD (2017), "Lancaster city fined $135K, will end decades of polluting Conestoga, Chesapeake Bay," Lancaster Online. Accessed at https://lancasteronline.com/news/local/lancaster-city-fined-135k-will-end-decades-of-polluting-conestoga-chesapeake-bay/article_da78ce0a-e5b4-11e7-ab45-4bc7efdb3ed8.html

86 Hampton Roads Planning District Commission (2010). A Green Infrastructure Plan for the Hampton Roads Region. Accessed at https://www.hrpdcva.gov/departments/planning/green-infrastructure-plan-for-hampton-roads-region

87 Chesapeake Bay Foundation (n.d.). "Fact Sheet: Virginia Green Infrastructure Directory." Accessed at https://www.cbf.org/document-library/sea-level-rise/nature-based-solutions.pdf

88 Norfolk, VA, City of (2018). A Green Infrastructure Plan for Norfolk: Building Resilient Communities. Accessed at https://www.norfolk.gov/DocumentCenter/View/38224/PH-3-Amend-plaNorfolk2030---Adoption-of-Green-Infrastructure-Plan?bidId=

89 C.J. Bodnar and Toni Utterback, Virginia Beach Stormwater Engineering Center, personal communication.

90 Metchis, Karen, C,J. Bodnar, and Toni Utterback (2021). "Virginia Beach Becomes Sea Level Wise," U.S. Climate Resilience Toolkit Case Studies. Accessed at https://toolkit.climate.gov/case-studies/virginia-beach-becomes-sea-level-wise

91 Greenspan-Johnston, Johanna (2020). "Virginia Beach Sea Level Wise Adaptation Strategy," Adaptation Clearinghouse. Accessed at https://www.adaptationclearinghouse.org/resources/virginia-beach-sea-level-wise-adaptation-strategy.html#:~:text=The%20City%20of%20Virginia%20Beach,through%20a%20watershed%2Dbased%20approach

92 Carolyn Heaps, Hampton Resiliency Officer, personal communication.

93 Hampton, VA, City of (2017). Living with Water Hampton: A Holistic Approach to Addressing Sea Level Rise and Resiliency. Accessed at https://hampton.gov/DocumentCenter/View/20644/Resilient-Hampton-Phase-I-Report?bidId=

94 Hampton, VA, City of (2021). Resilient Hampton: Newmarket Creek Pilot Project Area Water Plan. Accessed at https://hampton.gov/DocumentCenter/View/33580/Resilient-Hampton-Newmarket-Creek-Water-Plan--Dec-10-2021-PDF?bidId=

95 Chesapeake Bay Foundation (2020). "City of Hampton Fights Flooding with Issuance of Virginia's First Environmental Impact Bond." Accessed at https://www.cbf.org/news-media/newsroom/2020/virginia/city-of-hampton-fights-flooding-with-issuance-of-vas-first-eib.html

96 Hampton, VA, City of (2020). "State grants will help Hampton address flooding." Accessed at https://hampton.gov/CivicAlerts.aspx?AID=4976

97 Environmental Finance Center at the University of Maryland (EFC-UMD) (2014). "A Green Infrastructure Approach to Leveraging Local Priorities in Warrington Township, Pennsylvania." Accessed at https://arch.umd.edu/research-creative-practice/centers/environmental-finance-center/project-areas/green-infrastructure/green-infrastructure-warrington-township-pa

98 The process incorporates material from the following two sources: 1) EFC-UMD (2017). "Holistically Analyzing the Benefits of Green Infrastructure: Guidance for Local Governments." Accessed at https://arch.umd.edu/sites/default/files/docs/publications/EFC_Holistic_Benefits_GI_Report.pdf

2) Higgins, Phoebe, Timothy Male, and Sanjiv K. Sinha (2021). "Paying for Water Quality Improvements and Resilience in the Great Lakes: Focus on Green Stormwater Infrastructure." Environmental Policy Innovation Center and Environmental Consulting & Technology, Inc. Accessed at https://www.risc.solutions/wp-content/uploads/2021/07/Paying-for-Water-Quality-Improvements-and-Resilience-in-the-Great-Lakes-A-Toolkit-for-Green-Stormwater-Infrastructure.pdf

99 Clements, Janet, Jim Henderson, and Alan Flemming (2021). "Quantifying and Monetizing the Triple Bottom Line Benefits and Costs of Green Stormwater Infrastructure: Framework and Tool Guidance," Water Research Foundation. Accessed at https://www.waterrf.org/research/projects/economic-framework-and-tools-quantifying-and-monetizing-triple-bottom-line

100 Government Finance Officers Association (GFOA) (n.d.). "ESG Best Practice – 'E' Environmental." Accessed at https://www.gfoa.org/materials/esg-best-practice-e-environmental

INTERNATIONAL CITY/COUNTY MANAGEMENT ASSOCIATION
777 N. Capitol St. NE, Ste. 500, Washington, DC 20002
202.962.3680 | icma.org