Green Infrastructure Toolkit

Broadly called "green infrastructure," this new set of strategies seeks to manage stormwater, reduce urban heat island effects, improve air quality, and promote economic development and other sustainability goals. Green infrastructure provides an attractive alternative to traditional concrete (or "gray") infrastructure by making paved and hard surfaces vegetated or permeable. Permeable pavements and green roofs both capture rainfall and retain it on site, keeping it out of the stormwater system. Green infrastructure also provides wildlife habitat and greenhouse gas reduction benefits. While vanguard communities are innovating, most others are struggling to know where to begin. And while the professional design community has explored a new generation of best design practices, municipal policy frameworks have not incorporated these practices appropriately. In addition, limited resources are available to help jurisdictions develop technical expertise and share best practices. This Green Infrastructure Toolkit was developed in collaboration with leading cities to help them identify and deploy green infrastructure approaches in their communities.

This toolkit is powered by the Georgetown Climate Center's Adaptation Clearinghouse. For a full list of resources on green infrastructructure in the Adaptation Clearinghouse click here.

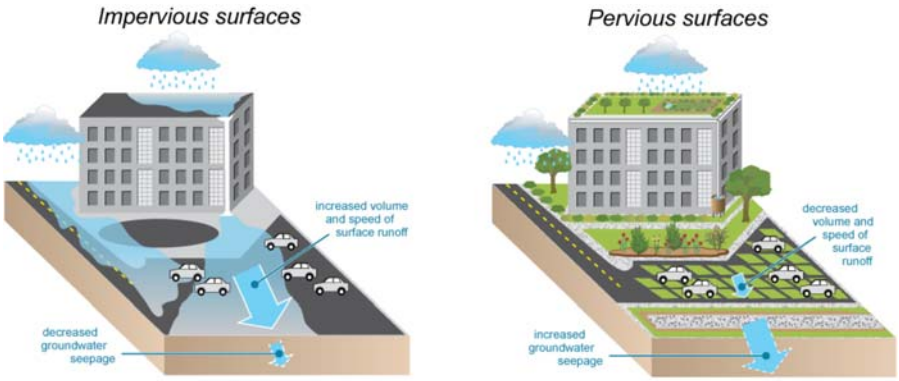
Introduction

Local governments across the country face serious challenges in managing urban stormwater (surface water runoff resulting from rainfall or snowmelt). Aging infrastructure, changes in precipitation patterns, watershed deforestation, and impervious surfaces such as roadways and parking lots cause urban flooding that pollutes waterways. Climate change will exacerbate these flood risks in many places due to more intense storms that could overwhelm existing infrastructure systems. If we fail to adapt these systems, severe repetitive flooding will increasingly affect community health, safety, and welfare, and the consequences of flooding often impose a disproportionate toll on the most vulnerable and disadvantaged populations and communities.

Innovative local communities and regions are beginning to implement a wide array of new "green infrastructure" measures, which retain and treat stormwater where it falls instead of relying on traditional, concrete-based systems largely underground. In order to ensure effective implementation, this toolkit identifies the best green infrastructure practices from cities across the country to guide those still designing their programs.

Conventional development and drainage techniques, also known as gray infrastructure, include man-made, constructed assets like roads and sewers.[1] "Gray surface infrastructure" covers natural landscapes with impervious surfaces such as concrete, asphalt, tile, or compacted gravel that increase the rate and volume of stormwater runoff. Stormwater runoff carries trash, bacteria, heavy metals, and other pollutants from the urban landscape to nearby waterways. Gray stormwater infrastructure generally uses large tunnels or other underground conveyances to move or store stormwater to treatment facilities.[2]

Green infrastructure, in contrast, includes techniques such as using permeable pavements and green roofs to both capture rainfall and retain it on site, keeping it out of the stormwater system.



Impervious 'hard' surfaces (roofs, roads, large areas of pavement, and asphalt parking lots) increase the volume and speed of stormwater runoff. This swift surge of water erodes streambeds, reduces groundwater infiltration, and delivers many pollutants and sediment to downstream waters.

Pervious 'soft' surfaces (green roofs, rain gardens, grass paver parking lots, and infiltration trenches) decrease volume and speed of stormwater runoff. The slowed water seeps into the ground, recharges the water table, and filters out many pollutants and sediment before they arrive in downstream waters.

Conceptual diagram illustrating impervious and pervious surfaces. Impervious surfaces are hard and increase stormwater runoff, causing pollutant and sediment delivery in downstream waters. Pervious surfaces are soft and decrease stormwater runoff, which filters out pollutants and sediments before they arrive in downstream waters.
Diagram courtesy of the Integration and Application Network (ian.umces.edu), University of Maryland Center for Environmental Science. Source: Chesapeake and Atlantic Coastal Bays Trust Fund. 2013. Stormwater Management: Reducing Water Quantity and Improving Water Quality. IAN press, newsletter publication.

These techniques also provide a multitude of benefits. Green infrastructure can:

- reduce urban heat island effects through evaporation of infiltrated water and through shade provided by urban forests;[3]
- improve air quality through increases in vegetation to filter pollutants, as well as indirectly from lowering temperatures (smog forms more easily at higher temperatures);[4]
- absorb carbon, because vegetation uses carbon dioxide as part of photosynthesis;[5]
- improve water quality by reducing runoff and filtering pollutants from the runoff that infiltrates or gets stored;[6] and
- provide urban recreational and open space.[7]

Building green infrastructure is not without challenges, however. In past years stormwater managers have struggled to quantify the effectiveness of green infrastructure, especially as compared to gray infrastructure. Ongoing monitoring programs are detailed in the Getting Started chapter of this toolkit. Green infrastructure can require collaboration by multiple local agencies that do not always work closely, such as transportation, stormwater, and public health. Successful collaboration efforts are also detailed in the Getting Started chapter. Last but not least, green infrastructure requires different, ongoing maintenance than traditional stormwater infrastructure. Coordinating and paying for that ongoing maintenance can be difficult to plan and implement. The Scaling Up chapter and Funding chapter describes how local governments are beginning to solve the maintenance challenge.

While vanguard communities are innovating, many others are struggling to know where to begin. And while the professional design community has developed a new generation of best design practices, municipal policy frameworks (land-use regulations, street design, etc.) have not institutionalized these practices appropriately. In addition, limited resources are available to help jurisdictions develop technical expertise and share best practices. This toolkit therefore has a chapter dedicated to incorporating green infrastructure practices into jurisdiction-wide plans and processes, from comprehensive plans to zoning and building codes.

Green infrastructure also has to operate within legal and regulatory frameworks at the federal, state, and local level. The Clean Water Act, for example, requires the US Environmental Protection Agency (EPA) to address stormwater runoff[8] in its effort to "restore the chemical, physical and biological integrity" of the waters of the nation.[9] In doing so, EPA has created consent agreements with many municipal governments. These agreements legally require cities to come into compliance with the Clean Water Act's requirements including controlling overflows from combined sewer systems. Local governments can incorporate green infrastructure practices in addition to gray infrastructure; cities from Louisville, KY to Chicago, IL, have incorporated green infrastructure into those formal agreements.[10]

State and local legal authority questions also affect implementation of green infrastructure at the local level. For example, some local governments have funded green infrastructure by setting up a stormwater utility or charging stormwater fees. However, to do so, local governments need specific authority delegated from their state legislatures authorizing the creation of a stormwater utility and the collection of those fees. The absence of the legal authority to establish a stormwater utility or to establish a stormwater fee can hinder a local government's ability to implement and pay for green infrastructure. Finally, constraints in some states on local authority over zoning or building codes can diminish a city's ability to change policy to require or encourage green infrastructure. This toolkit addresses these legal constraints and requirements where appropriate throughout.

The next tab in this introductory chapter introduces different green infrastructure techniques and their various applications.

Tools

Green Infrastructure Strategies and Techniques

Green infrastructure techniques for managing stormwater come in a variety of types, and several techniques can often be combined in one project. All provide stormwater management and water quality benefits, but each provides a different variety of co-benefits (social or public health, for example) and different approaches are more appropriate based upon site-specific conditions. The following describes the range of green infrastructure interventions, how each works, the benefits each brings, and the type of sites where the technique can be deployed.

Learn more at https://www.georgetownclimate.org/adaptation/toolkits/green-infrastructure-toolkit/green-infrastructure-strategies-and-techniques.html

About This Toolkit

The purpose of this toolkit is to analyze common trends in the approaches various cities are taking to planning, implementing, and funding green infrastructure to manage stormwater. The toolkit is intended to aid local governments nationwide in comparing best practices across cities, drawing lessons from different approaches, and crafting similar policies for their own jurisdictions.

Learn more at https://www.georgetownclimate.org/adaptation/toolkits/green-infrastructure-toolkit/about-this-toolkit.html

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Figure 1: *Green Infrastructure Approaches*

Street Features
Green infrastructure approaches can be incorporated into street design with permeable pavements, bioswales, tree pits, green streets, green alleys, and green parking.

Building Features
Buildings can be "greened" with green roofs, downspout disconnections, and rain barrels.

Landscape Features
Landscapes can be used to manage stormwater with rain gardens, urban tree canopy, land conservation, stream buffers, and stormwater parks.

Green roofs: Traditional roofs absorb sunlight and radiate heat into the surrounding air.[11] Vegetation on green roofs shades the roof and cools the air through evapotranspiration.[12] In this way, vegetation can cause a green roof to be 100 °F cooler than a traditional black roof,[13] and these cooler roofs transfer less heat to the ambient air. Green roofs do not have as great a cooling effect on air temperatures as ground-level vegetation does, but they have the advantage of not taking up additional land and of keeping building occupants cooler.[14] In addition to managing stormwater, green roofs help decrease energy use, improve air quality, and reduce heat.[15] Green roofs, however, are not without challenges: They require greater structural support than cool roofs and are expensive to install.

Permeable pavements: Permeable pavements have spaces for air and water to pass through; the spaces allow water to infiltrate into the ground, reducing runoff. Asphalt and concrete can both be made porous by omitting the smaller aggregates that are usual components.[16] More specialized forms of porous pavements include interlocking concrete pavers, in which water drains through the gaps between precast blocks, and grass or gravel pavers, in which fill materials are laid on top of a plastic grid.[17] Permeable pavements also have cooling properties due to evaporation and reduced heat storage.[18] Permeable pavements are appropriate for sidewalks, parking lots, alleys, and streets; some concerns about whether permeable pavements are appropriate for cold climates or high-traffic areas are being monitored and evaluated now in cities like Chicago and Washington, DC, with positive results to date.[19]

Bioretention and Bioswales: Bioswales are a type of stormwater retention that use an open-channel shape and vegetation to slow runoff and filter pollutants, reducing strain on stormwater infrastructure and improving water quality.[20] Often integrated into streetscapes or used to convey stormwater away from critical infrastructure, bioswales can also reduce the need for gray stormwater

systems to be installed by capturing and storing some of the stormwater.[21] Bioswales can also reduce temperatures, increase habitat for urban wildlife, and improve air quality. As an added benefit, they are often aesthetically pleasing and potentially increase property values.

Green Streets, Alleys, and Parking Lots: Green streets, alleys, and parking lots can combine all of the above strategies (except perhaps green roofs) into a coherent package. By combining the strategies, green streets can provide multiple benefits, including runoff and pollutant reduction, air quality improvement, and urban heat island mitigation.[22] Local governments primarily install green streets in the public right-of-way, but green alleys and parking lots can be installed on both public and private land. For all three, a critical element can be to minimize pavement in the first place.

Rain Gardens: Rain gardens are small gardens that are designed to survive extremes in precipitation, and help retain or reduce stormwater runoff through infiltration or storage.[23] The gardens are often small and placed strategically in areas where stormwater currently overwhelms drainage capacity. They can be incorporated as part of general landscape design or as part of a larger streetscape (see Green Streets, Alleys, and Parking Lots, just below). In addition to managing stormwater and reducing nutrient pollution, rain gardens can also reduce temperatures, provide wildlife habitat, and improve aesthetics.[24] Rain gardens can be installed in many different areas and do not need to take up much space.

Urban Forestry: Urban forestry is suitable for both public and private properties, including rights-of-way and near existing buildings and homes for shade. Urban trees provide air quality and heat reduction benefits, along with mental health and other social benefits.[25] Urban forestry policies can include not only increasing existing canopy (many local governments are setting percentage targets) and planting new trees, but also ordinances to preserve existing mature trees, which provide greater benefits for stormwater and public health than young trees.[26] Ongoing maintenance and care can be a concern for urban forestry, as well as balancing canopy goals with power utility concerns, particularly during extreme weather events.

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The Georgetown Climate Center would like to thank the Leon Lowenstein Foundation, the John D. and Catherine T. MacArthur Foundation, and the Kresge Foundation for making this work possible, and the other **funders** who support the Center's work.

The Georgetown Climate Center benefitted from the expertise of an extensive network of experts and leading communities pursuing adaptation across the country to develop this toolkit of best practices for using green infrastructure to manage stormwater in the face of changes in precipitation due to climate change. Our advisory group included expert representatives from Milwaukee, WI; Ann Arbor, MI; Detroit, MI; Cambridge, MA; Baltimore, MD; Delaware County, PA; Washington, DC, Santa Fe, NM; and Denver, CO; the Environmental Protection Agency (EPA) Innovation Division and Office of Water; the Urban Sustainability Directors Network (USDN); Smart Growth America (SGA); the National Association of City and County Health Officials (NACCHO); and the University of Maryland Environmental Finance Center. By aligning the development of this toolkit with these organizations, GCC was able to reach a broader national platform, provide desperately needed research capacity to these front-line networks of public officials, and connect this work to public health officials who provide an important constituency in advocating measures that improve water quality. We developed

this toolkit in response to requests made by a number of communities through a Request for Proposals (RFP) GCC released in late 2013. Over a quarter of the applications we received from across the U.S. involved requests for assistance with stormwater, illustrating the needs jurisdictions face in trying to use green infrastructure to adapt. GCC would like to thank representatives from those organizations and local governments listed above for their assistance in developing the content.

Getting Started: Pilot Projects

Introduction

Implementing a comprehensive city-wide green infrastructure policy can be a daunting and challenging process. Regulatory constraints, the need for technical guidance, and inadequate political support are just some of the many barriers that local governments may confront.[27] Pilot or demonstration programs can be an effective way to test green infrastructure strategies without initially making a long-term or expensive commitment. Pilot programs are small-scale programs that can demonstrate the cost and performance of a given green infrastructure practice in a given place, which can result in increased confidence and support of further green infrastructure measures. Pilot projects can be installed on public lands through capital improvement projects. Grant programs can also be established to provide funding to private parties to test approaches on private lands.

This chapter focuses on the role of pilots as both demonstration projects and as stepping-stones towards larger-scale implementation, and presents:

various models for starting green infrastructure pilots,

- tools to make those pilots most effective,
- strategic approaches for choosing pilot sites, and
- effective monitoring strategies to enable scaling pilots up into larger programs.

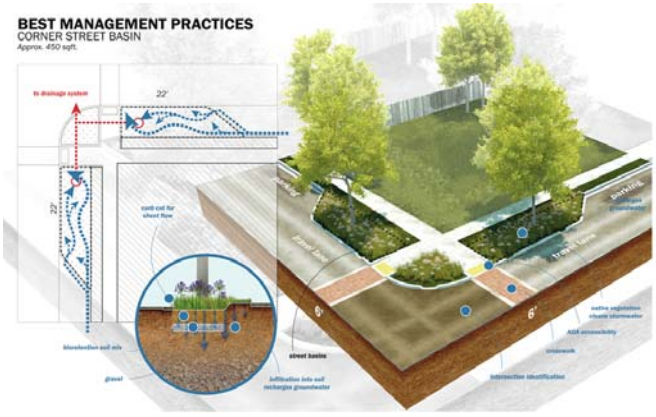

Image Credit: Dana Brown & Associates, Pontilly Stormwater HMGP

For each set of strategies, this toolkit presents real-life examples of local governments using the strategies effectively. For the models for starting pilots and for the approaches to using pilot sites, the toolkit compares the models and approaches along a set of criteria that supports a choice that best fits the local government's needs, priorities, and circumstances (for example, an emphasis on retrofits versus new construction, or a desire to focus on streetscapes or roofs first given willing partners.

Tools

Models for Starting Pilots

This section presents pilot project models based on three types of green infrastructure practices (green streets/alleys, green roofs, and rain gardens) and applies various considerations to help local governments choose among them. Some green infrastructure practices, such as green streets, require significant public resources and planning and can only be carried out on the government level. Other practices, such as green roofs, can also be implemented through incentivizing private actors by means of grants or subsidies. This chapter also includes local government examples of each model. Local governments can compare these models along a set of considerations to enable decision making to meet each local government's particular situation and priorities. These considerations include both the potential benefits that green infrastructure can achieve and the community or administrative considerations that local governments may want to take into account.

Learn more at https://www.georgetownclimate.org/adaptation/toolkits/green-infrastructure-toolkit/models-for-starting-pilots.html

Implementing Pilots: Best Practices and Tools

Best practices and tools are emerging around the country to create green infrastructure pilot programs that yield the best outcomes. These best practices and tools relate to 1) communication strategies and engagement with both the public and with other governmental partners; 2) Creating local partnerships; and 3) conducting both cost-benefit analysis and tracking pilot project benefits for economic, environmental, and social criteria.

Learn more at https://www.georgetownclimate.org/adaptation/toolkits/green-infrastructure-toolkit/implementing-pilots-best-practices-and-tools.html

Being Strategic: Tools to Choose Pilot Sites

To maximize the benefits of green infrastructure installations, decision makers must be strategic in choosing pilot site locations. By clearly defining the goals of a pilot program, local governments can decide which types of installations and which specific locations will best achieve these goals. The most common goals that local governments tend to consider include reducing strain on the stormwater and wastewater management systems, reducing watershed pollution, reducing flooding, creating public education opportunities, reducing carbon emissions, and addressing other effects of climate change (increased urban heat island, excess runoff due to more severe, less predictable weather patterns). Some local governments take a more holistic approach to maximize both the impact of the investment and the public good.

Learn more at https://www.georgetownclimate.org/adaptation/toolkits/green-infrastructure-toolkit/being-strategic-tools-to-choose-pilot-sites.html

Effective Monitoring of Pilot Sites

A critical component of a successful pilot program is to demonstrate the performance of the green infrastructure installations. Monitoring a project's performance (across goals and benefits) allows decision makers to make informed decisions about how to adapt the design of future projects based upon the performance of existing projects. This section of the toolkit describes the types of monitoring that local governments can perform for pilot sites to quantify co-benefits beyond stormwater management, meet regulatory requirements, create accurate performance standards, and use monitoring program to help make the transition from a pilot stage to jurisdiction-wide green infrastructure programs.

Learn more at https://www.georgetownclimate.org/adaptation/toolkits/green-infrastructure-toolkit/effective-monitoring-of-pilot-sites.html

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Benefits

Green infrastructure provides many benefits in addition to managing stormwater. In contrast to gray infrastructure, which can take decades to build and therefore many years for any stormwater management benefits to accrue, green infrastructure can be constructed much more quickly and in more areas, and the benefits are available along that shorter timeline. Pilots can demonstrate those benefits quickly and increase support for green infrastructure as well. The benefits can be categorized into economic, environmental, and social benefits:

Economic: Green infrastructure can provide public and private economic benefits including flooding losses avoided, cost savings, and increased property values.

Environmental: Green infrastructure not only improves water quality by enhancing stormwater management capacity, it can also reduce urban heat islands, sequester greenhouse gases, and improve air quality.

Social: Green infrastructure can enhance green and recreational space, create jobs, and improve public health.

Local governments, in choosing pilot models, may also want to consider some other administrative considerations including:

Public Engagement: Green infrastructure practices that are widely accessible to the public can help to foster a general awareness of green infrastructure as an innovative practice. Engagement with the community can be used to better tailor project designs to the needs of residents and decrease the chance of dissatisfaction with the project.[29]

Public Education: Green infrastructure practices that provide opportunities to educate the public (due to location in the right of way or along pedestrian walkways, for example) can help foster an informed and supportive community.

Coordination: Some green infrastructure practices, such as green streets, require cooperation and coordination among multiple agencies more so than other practices like rain gardens. Collaboration is important to all stages of implementation: planning and design; development and construction; and operations, maintenance and monitoring.

The paragraphs below discuss the relevant benefits and considerations for each of the pilot models, including some examples of those models in practice.

Green Streets and Alleys

Green streets/alleys integrate green elements such as bioswales, bioretention curb extensions, and/or permeable pavement into transportation right-of-ways.[30] These practices use vegetation and porous surfaces to capture, store, and infiltrate stormwater in order to reduce runoff from transportation infrastructure, filter out pollution, and mitigate the burden on existing gray infrastructure and treatment facilities.

- ***Public education***: Green streets are highly visible to the public, and therefore create effective opportunities for public education and outreach concerning green infrastructure and stormwater management issues more generally.
- ***Coordination***: Efficient inter-agency coordination is important for keeping green infrastructure construction costs as low as possible. When coordinated with broader public transportation improvements such as street improvement or redevelopment, green street practices can significantly reduce the cost of stormwater management by preventing the need for additional and costly gray infrastructure.[31] Because multiple departments may be needed in order to carry out the development or redevelopment of roadways, successful green streets/alleys will require effective interagency collaboration and coordination. For example, Chicago's Green Alley Program involved city agencies controlling stormwater management, street design, street-lights, maintenance, and budgeting.[32]

Green Roofs

Green roofs are vegetated systems built on rooftops that capture and filter rain, reducing the amount of stormwater that flows from roofs to the sewer system. Pilot projects focusing on green roofs have been particularly effective in cities such as Washington, D.C., where rooftops constitute a high percentage of the total impervious surface area. In addition to their stormwater management function, green roofs provide many other private and public benefits such as reduced energy costs, reduced noise pollution, improved air quality, and reduced urban heat islands. Green roof programs can also be used to create green jobs, to provide green recreational space on rooftops, and to facilitate educational opportunities.[33] Green roof pilots can focus on either private or public property: many communities provide incentives for private property owners to install green roofs, making them more cost-efficient to install than conventional roofs.[34] Some communities also use green roofs as an opportunity for public education. Seattle published a map with a self-guided tour of over twenty publicly and privately owned green roofs that are open for public viewing.[35]

Rain Gardens

Rain gardens are gardens that slow, filter, and absorb runoff from rooftops, sidewalks, and streets.[36] Rain gardens are particularly effective programs to start with because of their relative simplicity, low cost, and wide application. Unlike green street programs that require significant government involvement, rain gardens can be built and maintained by private individuals on private property. Because they are easy to incorporate into a variety of landscaped areas, rain gardens offer local officials flexibility in how and where to install them, and at what scale.[37] As with other types of green infrastructure, increased community involvement and knowledge of green infrastructure can lead to community support for more and larger-scale projects.

Related Resources

Climate Change Vulnerability Analysis for the Milwaukee Metropolitan Sewage District

The Milwaukee Metropolitan Sewage District (District) requested this vulnerability analysis report, which assesses how climate change will impact the District's existing, as well as proposed, infrastructure and services. The analysis aims to provide the District with the information needed to make strategic planning decisions, such as capital investments. The report documents how climate change may increase flood events and combined sewer overflow volume during larger precipitation events, and increase risk of odor and corrosion within wastewater facilities as well as decreased flow in waterways during periods of warm weather and drought. The analysis also examines the susceptibility of woodpiles and wooden docks at the Jones Island water reclamation facility to degradation resulting from the lower water levels of Lake Michigan brought on by climate change.

View Resource at https://www.adaptationclearinghouse.org/resources/climate-change-vulnerability-analysis-for-the-milwaukee-metropolitan-sewage-district.html

Green City, Clean Waters - City of Philadelphia, Pennsylvania

Green City, Clean Waters is the Philadelphia Water Department's vision for protecting and enhancing local watersheds by managing stormwater with innovative green infrastructure, through its combined sewer overflow control program. The program is pioneering a broad multi-decade investment in green stormwater management practices that reduce sewer overflows to the City's waterways, and in turn, enhances communities and the overall urban environment.

View Resource at https://www.adaptationclearinghouse.org/resources/green-city-clean-waters-city-of-philadelphia-pennsylvania.html

Natural Resource Defense Council: Rooftops to Rivers II

From the Natural Resource Defense Council (NRDC), *Rooftops to Rivers II* describes the challenges of managing stormwater, and the benefits and economics of employing green infrastructure to do so. The report explains how population growth, changing landscapes, aging infrastructure, and climate change are placing increasing pressures on stormwater management. Highly detailed case studies are developed for 14 cities that are all leaders in employing green infrastructure solutions to address stormwater challenges. Local, state and national level policy recommendations are offered also.

View Resource at https://www.adaptationclearinghouse.org/resources/natural-resource-defense-council-rooftops-to-rivers-ii.html

Seattle Public Utilities - Street Edge Alternatives

In 2001, Seattle Public Utilities completed construction of its Seattle Street Edge Alternatives (SEA Streets) project, in which a single residential block was retrofitted with vegetated swales and rain gardens. SEA Streets was a pilot demonstration project designed to return drainage and vegetation in the area to a natural systems approach - providing community and street level aesthetic benefits, as well as contributing to the management of rainfall with green alternatives to stormwater drainage.

View Resource at https://www.adaptationclearinghouse.org/resources/seattle-public-utilities-street-edge-alternatives.html

Chicago Green Alley Handbook

The Chicago Department of Transportation (CDOT) authored the Green Alley Handbook to encourage the use of best management practices (BMPs) in and around Chicago alleyways and to address impacts to the city's infrastructure likely to result from projected increases in precipitation and temperature. The handbook promotes sustainable alley design and adjacent landscaping practices to help reduce flooding and manage stormwater, reduce urban heat, promote recycling, and conserve energy.

View Resource at https://www.adaptationclearinghouse.org/resources/chicago-green-alley-handbook.html

Portland, Oregon Green Streets Program

Portland, Oregon's Green Streets are streets that use vegetated facilities to manage stormwater runoff. Portland's Bureau of Environmental Services (BES) Green Street Program is a sustainable stormwater strategy that meets regulatory compliance and resource protection goals by using a natural systems approach to manage stormwater, reduce flows, improve water quality and enhance watershed health.

View Resource at https://www.adaptationclearinghouse.org/resources/portland-oregon-green-streets-program.html

Portland, Oregon NE Siskiyou Green Street Project Report

In 2003, the Portland Bureau of Environmental Services installed two landscaped stormwater curb extensions designed to capture street stormwater runoff on Siskiyou Street in Portland, Oregon. Essentially disconnecting the street's runoff from the City's combined storm/sewer system, the Siskiyou curb extensions manage it on-site using a landscape alternative. The objective was to maximize the capture, treatment, and infiltration of street stormwater runoff, while enhancing the neighborhood and offering improved pedestrian safety.

View Resource at https://www.adaptationclearinghouse.org/resources/portland-oregon-ne-siskiyou-green-street-project-report.html

Washington D.C. Green Roof Program

In 2003, the Chesapeake Bay Foundation initiated a green roof demonstration project funded under the terms of a consent decree negotiated by the D.C. Water and Sewer Authority. The money was used to issue grants for the installation of eight different pilot green roofs that would reduce the cost of each green roof cost to the building owner by up to 20 percent. The pilot roofs served as models that building owners could use for future green roof projects, by providing data on costs, construction methods, performance, and maintenance needs.

View Resource at https://www.adaptationclearinghouse.org/resources/washington-d-c-green-roof-program.html

Implementing Pilots: Best Practices and Tools

Best practices and tools are emerging around the country to create green infrastructure pilot programs that yield the best outcomes. These best practices and tools relate to 1) communication strategies and engagement with both the public and with other governmental partners; 2) Creating local partnerships; and 3) conducting both cost-benefit analysis and tracking pilot project benefits for economic, environmental, and social criteria.

The following section identifies these best practices and tools, and provides examples of jurisdictions that have used them.

Communication and Engagement

Community involvement is vital to implementing successful pilots.[38] Engagement with the community can be used to tailor projects to meet the needs of residents and decrease the chance of dissatisfaction with the project.[39] Increased public awareness and satisfaction with green infrastructure projects can lead to increased support for further projects as well as as well as increasing the likelihood that private property owners will install their own green infrastructure, such as rain gardens. Collaborating with partner agencies can spread support for green infrastructure practices across the local government, and can help leverage potential funding streams and manpower for ongoing operations and maintenance. As the benefits of green infrastructure are available more quickly than the benefits for gray, effective communication strategies can relay that information to the public to build support.


BioswaleCare workshop, Bronx

Presentations and Workshops: Holding presentations and workshops enables staff to meet individual members of the community and better understand and meet community needs. For example, New York City's Department of Environmental Protection makes presentations to community boards and other civic and environmental organizations, in addition to elected officials and their staffs, about the city's Green Infrastructure Program.[40] Likewise, as part of its 10,000 Rain Gardens Program, Kansas City sponsored "how-to workshops" for private landscaping businesses and municipal employees that explained the initiative and rain gardens, and addressed water quality concerns.[41] These workshops not only raised awareness but trained contractors and city employees in installation and maintenance techniques.[42]

Media Campaigns: Kansas City engaged in an extensive media campaign involving interviews on television and the radio, as well as advertisements and articles in local newspapers.[43] These media campaigns reached an estimated three million people in 2007.[44] In 2013, New York City's Department of Environmental Protection created an educational video on the Green Infrastructure Program, which described some of the environmental challenges caused by combined sewer overflows as well as some green infrastructure solutions such as green roofs, rain gardens, and permeable pavers.[45]

Websites: In 2013, New York City's Department of Environmental Protection launched a new website that provides information on the City's Green Infrastructure Program, including the most common types of green infrastructure practices as well as a map of priority areas. Community members can use the site to see if their neighborhood will receive green infrastructure installations and to better understand the practices. Kansas City's 10,000 Rain Gardens initiative created a website offering residents and other audiences a clearinghouse of information pertaining to the program and to stormwater management more generally, and was receiving over 100,000 visits per year even after the main media campaign had ended.[46]

Written Materials: Written materials such as brochures and surveys can be effective means of engaging the public and partner agencies about stormwater management practices and the municipality's use of green infrastructure. For example, New York City's Department of Environmental Protection developed a brochure that explains the siting and construction process for projects in the right-of-way, answers frequently asked questions, and describes the co-benefits of green infrastructure.[47] Similarly, Seattle Public Utilities (SPU) used parking surveys to better understand and meet the needs of the community for its Street Edge Alternatives Program. The surveys revealed

community concerns about reductions in parking due to reductions in street width caused by the installation of green infrastructure projects. SPU responded to this concern by installing occasional angled parking clustered along the street.[48]

***Inter-Agency Partnerships*:** Creating partnerships between agencies can help to implement green infrastructure practices both efficiently and effectively. By pooling the resources, expertise, and knowledge of different agencies, inter-agency partnerships can be crucial to successful pilot programs. These partnerships can exist to aid in any stage of the process, including planning, installation, maintenance, and monitoring. For example, in New York City, the Departments of Environmental Protection and Parks and Recreation have worked together to develop the Green Infrastructure Maintenance Program in order to allocate appropriate resources for the long-term maintenance of DEP's green infrastructure projects.[49]

Creating Local Partnerships

Utilizing the resources and expertise of local organizations in both the private and public sectors can increase the efficiency and cost-effectiveness of implementing pilot programs. Cities such as New York and Washington, D.C., use grant programs to strengthen their local partnerships, providing funds and other resources to private property owners to build green infrastructure projects. NYC's Department of Environmental Protection (DEP) has used local partnerships to help with green infrastructure retrofit projects.[50] As part of its Schoolyards to Playgrounds program, the DEP has worked with the not-for-profit Trust for Public Land, Department of Parks and Recreation, NYC Department of Education, and NYC School Construction Authority to renovate school playgrounds in an attempt to ensure that all New Yorkers live within a 10-inute walk from a park.[51]

Quantifying Costs and Benefits

Effective engagement with elected officials, partner agencies, and the public requires that proponents of green infrastructure be able to speak to the priorities and concerns of different agencies and interest groups. To do so effectively, proponents need to be able to provide accurate information about the costs of a proposed project and the expected benefits it can create. This information can come from monitoring data on the pilots that have already been constructed, or from available calculators for modeling projected costs and benefits. While specific monitoring techniques will be discussed later in the chapter, the following section provides a number of useful online tools that local governments can use to help calculate and project costs and benefits.

Green Values National Stormwater Management Calculator: developed by The Center for Neighborhood Technology, this online calculator can be used to compare the performance, costs, and benefits of green infrastructure to conventional stormwater practices, as well as to find the appropriate green infrastructure practice for a given location given that location's site-specific conditions and constraints.

EPA National Stormwater Calculator: developed by the EPA, this desktop application can provide approximations of annual rainwater and runoff frequency from any location in the United States. This information will assist a local government's determination as to what green infrastructure practices would be most effective and where. With the update of its Climate Adjustment Tool, local governments can now incorporate the effects of climate change into rainwater and runoff projections.

New York City Co-Benefits Calculator: Developed by the New York City Department of Environmental Protection (DEP), the Co-Benefit Calculator is a single comparative tool that calculates the environmental, social, and economic benefits associated with each type of green infrastructure practice, allowing users to compare the costs and benefits of each green infrastructure practice. The metrics that the calculator uses focus on urban heat island mitigation, increased property values, green jobs, and reduced treatment needs, among other things.

Related Resources

H2O Capture – NRDC green infrastructure benefits calculator

H2O Capture is a green infrastructure benefits "calculator" that can estimate the benefits of a new project. The calculator quickly presents benefits in a concrete numerical fashion – an effective snapshot, meant to be a tool in deciding the feasibility of projects.

View Resource at https://www.adaptationclearinghouse.org/resources/h2o-capture-nrdc-green-infrastructure-benefits-calculator.html

Natural Resource Defense Council: Rooftops to Rivers II

From the Natural Resource Defense Council (NRDC), *Rooftops to Rivers II* describes the challenges of managing stormwater, and the benefits and economics of employing green infrastructure to do so. The report explains how population growth, changing landscapes, aging infrastructure, and climate change are placing increasing pressures on stormwater management. Highly detailed case studies are developed for 14 cities that are all leaders in employing green infrastructure solutions to address stormwater challenges. Local, state and national level policy recommendations are offered also.

View Resource at https://www.adaptationclearinghouse.org/resources/natural-resource-defense-council-rooftops-to-rivers-ii.html

Portland, Oregon NE Siskiyou Green Street Project Report

In 2003, the Portland Bureau of Environmental Services installed two landscaped stormwater curb extensions designed to capture street stormwater runoff on Siskiyou Street in Portland, Oregon. Essentially disconnecting the street's runoff from the City's combined storm/sewer system, the Siskiyou curb extensions manage stormwater onsite using a landscape alternative. The objective was to maximize the capture, treatment, and infiltration of street stormwater runoff, while enhancing the neighborhood and offering improved pedestrian safety.

View Resource at https://www.adaptationclearinghouse.org/resources/portland-oregon-ne-siskiyou-green-street-project-report.html

Portland, Oregon Green Streets Program

Portland, Oregon's Green Streets are streets that use vegetated facilities to manage stormwater runoff. Portland's Bureau of Environmental Services (BES) Green Street Program is a sustainable stormwater strategy that meets regulatory compliance and resource protection goals by using a natural systems approach to manage stormwater, reduce flows, improve water quality and enhance watershed health.

View Resource at https://www.adaptationclearinghouse.org/resources/portland-oregon-green-streets-program.html

Being Strategic: Tools to Choose Pilot Sites

To maximize the benefits of green infrastructure installations, decision makers must be strategic in choosing pilot site locations. By clearly defining the goals of a pilot program, local governments can decide which types of installations and which specific locations will best achieve these goals.[52] The most common goals that local governments tend to consider include reducing strain on the stormwater and wastewater management systems, reducing watershed pollution, reducing flooding, creating public education opportunities, reducing carbon emissions, and addressing other effects of climate change (increased urban heat island, excess runoff due to more severe, less predictable weather patterns). Some local governments take a more holistic approach to maximize both the impact of the investment and the public good.[53]

Designing with green infrastructure often fits within a city's larger sustainable development goals.[54] By considering the co-benefits of green infrastructure (including social, economic and environmental values), decision makers are able to get the most "bang for the buck" from their stormwater management investment.[55]

This section offers decision makers a variety of successful tools for choosing sites for green infrastructure programs, drawn from practices around the country. The three basic models that this chapter covers include 1) a Priority Watersheds approach, which focuses on water quality almost exclusively and is the most traditional of the three; 2) a Public Input-Based Approach, which explicitly incorporates community priorities; and 3) a Score Ranking approach, which allows a local government to delineate a full set of priorities and rank the sites using those priorities.

Criteria

This chapter analyzes each of the three approaches using a set of four criteria to enable local governments to decide among them.

- **Co-Benefits:** Some approaches more easily incorporate and maximize co-benefits, which may range from reduced flood risk, improved air quality, improved public health, financial savings, and more.[56] Intentionally comprehensive green infrastructure programs may create the most robust benefits.
- **Flexibility:** A flexible approach allows decision makers to choose pilot sites based on specific pre-established priorities. A flexible approach can more easily accommodate interagency collaboration, public input, and various outcome goals. A flexible approach can also readily account for adaptive management and comprehensive planning goals.
- **Administrative Burden:** Some approaches are administratively more burdensome than others, requiring more staff time and resources, for example. This criterion assesses how burdensome each approach is in terms of interagency partnerships, program management, and efficiency in implementation.
- **Public Participation:** This criterion measures an approach's tendency to meaningfully incorporate public input. This may include meaningful community engagement strategies, consideration of equity and environmental justice issues, and long-term community goals.

Priority Watersheds Approach

In an urban setting, combined sewer overflows (CSOs), flooding, and other problems that arise from excess runoff are symptomatic of overburdened systems and high percentages of impervious surface.[57] To mitigate these effects, local governments can incorporate green infrastructure on a

watershed scale to reduce the total volume and velocity of stormwater runoff to traditional sewer systems.[58] To meet this set of priorities, local governments first identify tributary areas and construct green infrastructure on sites designed and placed to maximize stormwater retention and water quality benefits.[59]

This approach, by focusing on the water quality priorities within particular watersheds, can create a comprehensive picture of the causes of and remedies for water pollution. Taking a priority watershed approach is appropriate for local governments that are primarily concerned with pollution control in watershed outflows, and can be an effective methodology in green infrastructure development aiming to serve Clean Water Act compliance goals.

A priority watershed approach is efficient for stormwater management purposes. However, because it is most often designed with a singular focus for water quality goals, it may have fewer opportunities for triple bottom line co-benefits.

Public Input-Based Approach

Local governments can address community priorities by engaging the local population in their planning processes while choosing and designing publicly funded projects. Surveys, community workshops, open comment periods, and other direct outreach efforts can supplement project environmental goals and can enhance community support.[60] A public input-based approach is flexible and fosters community buy-in; however, it can be time- and resource-intensive to carry out a robust a public process that results in meaningful engagement.

When the public can participate in the planning process, pilot site installations will better respond to community needs and be tailored to achieve community priorities.[61] This can be particularly transformative for communities facing environmental justice concerns such as lack of access to green space or playgrounds, those with disproportionately poor air quality, food deserts, or living with urban heat island effects.[62] Furthermore, policy makers should be aware that while green infrastructure can enhance local economies via higher property values, this might also increase living costs for low-income residents and accelerate gentrification.[63] Public input and community collaboration can help frame project planning and provide critical information for the long-term success of green infrastructure programs, which may need to be paired with affordable housing or other equitable development policies.

Score Ranking Approach

Decision makers can use a score ranking approach to set program goals and priorities, and to ensure that the chosen pilot sites achieve those priorities. A comprehensive scoring system allows decision makers to rank projects across a set of diverse factors (such as potential for reducing runoff or pollutants, maintenance burdens, educational opportunities, and other co-benefits). This ranking then enables decision makers to create a model for strategically selecting projects based on those factors.[64] For instance, a local government might consider scheduled transportation construction in a site's score. The construction window for road maintenance provides a cost-effective opportunity to install permeable pavement, right-of-way bio-swales, or other green infrastructure.[65] The success of this approach requires close inter-agency collaboration that may include the departments of transportation and public works, among others that can help to increase the public investment's utility and efficiency during construction.[66]

Using a scorecard approach requires decision makers to think carefully about the goals that are most important to them and the types of projects and practices that are most likely to achieve those goals, but also provides a high level of flexibility to set those goals. Setting up those criteria and ranking potential sites may be time intensive. This approach also requires intensive planning and potentially cross-sector collaboration in advance of choosing sites.

Related Resources

San Francisco Public Utilities Commission Green Infrastructure Projects

San Francisco Public Utilities Commission (SFPUC) is implementing multiple green infrastructure projects based on their Urban Watershed Assessment, which will identify green and grey sewer infrastructure improvements over the next twenty years. The SFPUC recognizes that the sewer system, treating both sewage and stormwater runoff, was not built to withstand the impacts of climate change - such as intense rainstorms that overwhelm the system. The watershed-based planning process is being used to help plan the City's Sewer System Improvement Program (SSIP), a multi-billion dollar project to to upgrade aging infrastructure, and ensure the reliability and performance of the sewer system.

View Resource at https://www.adaptationclearinghouse.org/resources/san-francisco-public-utilities-commission-green-infrastructure-projects.html

Storm Lake, Iowa Green Infrastructure Plan for Water

In 2014, the City of Storm Lake, Iowa was chosen for a pilot project by the Iowa Economic Development Authority to develop a plan for city-wide green infrastructure technology for improved urban water management - including storm, sanitary, and potable water solutions. This

Plan is meant to serve as a case study and guidance document for green infrastructure planning in other communities. The Plan demonstrates a process that can be replicated and scaled to any size city.

View Resource at https://www.adaptationclearinghouse.org/resources/storm-lake-iowa-green-infrastructure-plan-for-water.html

Arlington, Virginia Watershed Retrofit Study

Completed in December, 2013, Arlington County, VA produced a Watershed Retrofit Study and plans with the purpose of strengthening the resiliency of its stormwater management systems to climate change. Arlington developed a County-wide project inventory by surveying all of the County's watersheds to find space for small stormwater facilities. This study informed the City of Arlington's Stormwater Master Plan, which was adopted in Sept. 2014.

View Resource at https://www.adaptationclearinghouse.org/resources/arlington-virginia-watershed-retrofit-study.html

Greater New Orleans Urban Water Plan

The Greater New Orleans Urban Water Plan focuses on the improved management of storm water, surface waters and groundwater in New Orleans, Louisiana, in response to flooding, land subsidence and "wasted water assets." The primary area of focus is 155 miles of urban areas and 69 square miles of protected wetlands in Orleans, Jefferson and St. Bernard parishes. The plan discusses how climate change threatens to raise the frequency of extreme weather events, and rising sea levels. Considered along with land subsidence, residents and economic assets are at great risk - and pumping stormwater and keeping floodwaters out are both projected to become more difficult over time.

View Resource at https://www.adaptationclearinghouse.org/resources/greater-new-orleans-urban-water-plan.html

Milwaukee, Wisconsin Regional Green Infrastructure Plan

Milwaukee Metropolitan Sewerage District (MMSD) has established a 2035 Vision for "zero basement backups, zero overflows, and improved water quality." To achieve these goals, MMSD has transformed its approach to managing stormwater by utilizing green infrastructure technologies in its urban watershed management plan. By implementing widespread use of green infrastructure (GI) to complement the region's grey infrastructure, the *Regional Green Infrastructure Plan* documents how to meet the 2035 goal by capturing the first 0.5 inch of rainfall on impervious surfaces, the equivalent of 740 million gallons of stormwater storage. The plan identifies the best GI strategies, presents a cost-benefit analysis, and make recommendations to ensure implementation.

View Resource at https://www.adaptationclearinghouse.org/resources/milwaukee-wisconsin-regional-green-infrastructure-plan.html

Stormwater Management Toolkit: Urban Watershed Planning Game

As part of the Stormwater Management Toolkit, San Francisco Public Utilities Commission (SFPUC) developed the Urban Watershed Planning Game. This game helps the SFPUC understand community priorities by presenting a diverse group of community members with the task of updating San Francisco's sewer system. The game fosters the development of green infrastructure solutions that help San Francisco adapt to the impacts of climate change in a financially feasible, community driven manner. This game is a great resource for city planners, watershed managers, public engagement officers, and citizens.

View Resource at https://www.adaptationclearinghouse.org/resources/stormwater-management-toolkit-urban-watershed-planning-game.html

Effective Monitoring of Pilot Sites

A critical component of a successful pilot program is to demonstrate the performance of the green infrastructure installations. Monitoring a project's performance (across goals and benefits) allows decision makers to make informed decisions about how to adapt the design of future projects based upon the performance of existing projects.[67] This section of the toolkit describes the types of monitoring that local governments can perform for pilot sites to quantify co-benefits beyond stormwater management, meet regulatory requirements, create accurate performance standards, and use monitoring program to help make the transition from a pilot stage to jurisdiction-wide green infrastructure programs.

Local governments can use monitoring data to assess the feasibility of meeting their priority goals with green infrastructure projects, alone or in combination with traditional infrastructure.[68] While goals for green infrastructure fundamentally include water quality, green infrastructure also offers an array of co-benefits that can add value and maximize the value of these investments across multiple sectors. Identifying and measuring these co-benefits through monitoring may contribute to positive

cost benefit analysis and multi-sector/public buy in for green infrastructure programs. Known as a triple bottom line (TBL) approach, local governments can conduct an assessment of the co-benefits associated with green infrastructure, including environmental, social, and economic factors.[69]

Regulatory Requirements

EPA guidance on Clean Water Act compliance encourages use of green infrastructure installations in local government plans, particularly to achieve water quality requirements.[70] Permits and enforcement agreements that incorporate green infrastructure must include green infrastructure performance criteria and post-construction performance standards.[71] To set these criteria, decision makers must first have designed their pilots to include a monitoring component that gauges their performance and sets those performance standards going forward.

The strength of green infrastructure, however, is in its ability to deliver more than just stormwater management and water quality benefits. The following discussion of the triple bottom line takes into account a variety of so-called "co-benefits" that green infrastructure can deliver on an everyday basis, not only during heavy precipitation events. Additionally, green infrastructure can be deployed more quickly than large-scale gray infrastructure projects, resulting in a shorter timeline to realize those benefits. While gray infrastructure is undoubtedly necessary for management of the most intense storms, gray and green infrastructure in combination may provide both protection against extreme events and many of the triple bottom line benefits listed below. By monitoring and quantifying those benefits, local governments may be able to build greater support in the community and among other partner agencies that might initially be skeptical.

Triple Bottom Line (TBL)

In monitoring pilots, collecting data to measure triple bottom line (TBL) goals provides important information on the co-benefits associated with green infrastructure programs. By quantifying these co-benefits in the pilot program stage of implementation, the broader eventual green infrastructure programs can integrate projections about TBL benefits.[72] Because different green infrastructure types may achieve TBL values to varying extents, decision makers may choose pilot projects with particular TBL co-benefits that would best serve their communities' interests.[73] This section next discusses the economic, social, and environmental co-benefits that green infrastructure pilots can provide, and that local governments can monitor for achievement of those benefits.

Economic: Long-term projections based on economic co-benefits can assist decision makers in budgeting and maximizing capital investments. Project proponents can use data demonstrating economic savings in costs avoided (including gray stormwater infrastructure that would otherwise have needed to be built), economic gains in added green jobs, or higher property values, to build public and private support for green infrastructure projects. The Philadelphia Water Department's Comprehensive Monitoring Plan, for example, analyzed its monitoring results from green infrastructure sites and found that the green infrastructure plan for Clean Water Act compliance was projected to be $7.8 million more cost effective than a gray stormwater plan alone.[74]

Social: Monitoring for social co-benefits enables integration with other sustainability goals such as addressing environmental justice. Using pilot sites to design for and monitor social benefits may also boost community support where pilot sites are located.[75] Social co-benefits of green infrastructure projects may include: reduced health risks associated with both urban heat islands and air pollution, increased recreational opportunities, lower localized crime rates,[76] access to fresh produce via community gardens, safer traffic flow, and more.[77]

Environmental: In addition to addressing stormwater runoff and associated pollution, green infrastructure sites add environmental value by supporting important ecosystem services in urban settings. Ecosystem services provided by green infrastructure sites may include: improved air quality from increased urban forest, new wildlife habitats, soil erosion control, decreased localized flooding, and more. These important features may help local governments contribute to reducing the coming impacts of climate change, and are quickly realized due to the short timeline for installing green infrastructure relative to large gray infrastructure projects.[78]

Beyond triple-bottom line considerations, monitoring of pilot installations for a variety of outcomes can also help local governments achieve a variety of goals, including meeting regulatory requirements, creating accurate performance standards, confirming site selection, and scaling up from pilot stage to jurisdiction-wide green infrastructure programs.

Performance Standards

Local governments can use monitoring data to adapt management of green infrastructure projects and to model the projected benefits of larger programs.[79] Performance standards can include rates of runoff, capacity for stormwater retention, reductions in pollution, and more. Performance standards provide a scale to determine program success and to create accurate expectations for the future, as well as enabling decision makers to adapt programs based on performance as they go.[80]

Scaling Up

To successfully move from the pilot stage of a green infrastructure program to a jurisdiction-wide program, local governments need accurate, comparable data. Pilot sites can provide data sets by which decision makers can set goals for large-scale green infrastructure program. Monitoring data

can also be used to help decision makers anticipate both costs and benefits of projects and set targets for long-term implementation,[81] including integrating green infrastructure plans into existing processes such as street design standards or zoning codes.

Related Resources

Climate Interactive, Milwaukee Green Infrastructure Scenarios Tool

Climate Interactive, a "climate change think tank" has created a Green Infrastructure Scenarios Tool (GIST) for Milwaukee, Wisconsin, that allows for scenario testing related green infrastructure investment and future precipitation scenarios. The simulation allows users to test investments into different types of infrastructure for managing stormwater, and supports exploration of different possible future rainfall patterns, to see how investments might turn out under various future climate conditions. Users can build more grey infrastructure or invest in new green infrastructure for 8 different classes of green infrastructure, such as green roofs, pervious pavement, and rain gardens. The simulation reports a full picture of the implications of each investment.

View Resource at https://www.adaptationclearinghouse.org/resources/climate-interactive-milwaukee-green-infrastructure-scenarios-tool.html

Milwaukee, Wisconsin Regional Green Infrastructure Plan

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View Resource at https://www.adaptationclearinghouse.org/resources/milwaukee-wisconsin-regional-green-infrastructure-plan.html

Green City, Clean Waters - City of Philadelphia, Pennsylvania

Green City, Clean Waters is the Philadelphia Water Department's vision for protecting and enhancing local watersheds by managing stormwater with innovative green infrastructure, through its combined sewer overflow control program. The program is pioneering a broad multi-decade investment in green stormwater management practices that reduce sewer overflows to the City's waterways, and in turn, enhances communities and the overall urban environment.

View Resource at https://www.adaptationclearinghouse.org/resources/green-city-clean-waters-city-of-philadelphia-pennsylvania.html

Scaling Up: Integrating Green Infrastructure into Existing Processes

Green infrastructure in this toolkit includes strategies to manage stormwater, reduce urban heat island effects, improve air quality, and promote economic development and other sustainability goals. Green infrastructure provides an attractive alternative and complement to traditional concrete (or "gray") infrastructure by making paved and hard surfaces vegetated or permeable. Permeable pavements and green roofs both capture rainfall and retain it on site, keeping it out of the stormwater system, and can also provide wildlife habitat and greenhouse gas reduction benefits.[82] Climate change will exacerbate stormwater runoff problems in many places due to more intense storms that could overwhelm existing infrastructure systems; green infrastructure, when installed at a larger scale and in combination with gray infrastructure, can help to manage those more intense storms.

While many local governments begin experimenting with green infrastructure practices through pilot or demonstration projects, in order for green infrastructure to have a substantial impact on managing stormwater, it must be constructed and installed on a much larger scale. Therefore, local governments are increasingly incorporating green infrastructure practices into their existing laws, policies, plans, and processes, so that its implementation can be more systematic.

This chapter investigates legal tools designed to integrate green infrastructure into:

- **planning tools** (including green infrastructure-specific plans and comprehensive plans),
- **regulatory tools** (including zoning and building codes and stormwater ordinances),

- **incentive-based tools** (including grants, subsidies, and stormwater fee adjustments), and
- **government operations** (efforts involving public infrastructure, land, or facilities).

These tools vary in their ability to reach new construction versus existing development and in reaching public versus private property. Effective green infrastructure programs leverage multiple tools to encourage or require green infrastructure.[83] As such, it is prudent to consider each set of tools alongside the others and craft an implementation approach that incorporates many of the tools discussed in this chapter. Similarly, many of these approaches deliberately build off of pilot programs that carefully monitored demonstration projects for effectiveness in managing runoff, reducing nutrient pollution, reducing urban temperatures, and other factors. Many are therefore beginning to "scale up" with rigorous data on the effectiveness of individual projects, and are continuing to monitor on a larger scale for cumulative effectiveness.

Criteria

Different types of tools can achieve different goals and will face different challenges in enactment and implementation. The following chart compares the types of tools local governments can use to integrate green infrastructure practices into their existing systems along four sets of criteria.[84]

New vs. Existing Development: some tools are better suited for incorporating green infrastructure into new development – these largely include tools that involve permitting or governmental review of some kind such as zoning. Others might also be able to influence installation on existing development – these tools would more often involve incentive-based approaches than regulatory approaches.

Public vs. Private Property: some tools will more effectively influence design and construction on private property, and others on publicly-owned land such as in the public right-of-way or surrounding public buildings. Government operations tools clearly will most directly affect public property and facilities, while regulatory tools will mainly influence private property. Some tools will be able to impact both types.

Administrative: some tools will require higher levels of organization, coordination across agencies, and participation from residents or other private actors to be successful. Because most local governments are starting from some kind of existing program, they must consider how current policies fit with their adaptation and other goals. The "Administrative" criterion captures how complex each tool is along these dimensions.

Legal: Local governments will need to consider which tools fall within the authority that agencies already possess and which may require further granting of authority from either the local legislative body or the state legislature. In addition, certain methods or tools could conflict with current state or local law. To improve current laws, governments can consider consolidating the laws on a particular topic or revising existing ordinances to better enable green infrastructure practices to become regular practice in that jurisdiction. We have attempted here to identify potential legal obstacles for each local government to consider.

The following table compares the types of policy tools that the rest of the chapter describes in order to provide a starting place for local governments to begin to make their own decisions about how to integrate green infrastructure into their own systems and usual processes. It is not a sufficient guide to the intricacies of every potential cost and benefit, nor does it answer specific questions about each jurisdiction's local law, politics, and geography. Each of the sections of this chapter will explores the methods in more detail, including evaluation of how local governments might implement each one.

Table 1: Comparison of Tools for Integration into Existing Processes

	Type of Development		Public vs. Private Property		Administrative	Legal
	New	Existing	Public	Private		
Planning Tools	+	~	+	+	~	~
Regulatory Tools	+	~	+	+	~	~
Incentive-based Tools	+	+	+	+	~	+
Government Operations	+	+	+	~	~	+

\+ Advantageous: The strategy maximizes benefits and is feasible.
~ Neutral: The strategy may present may present mixed advantages and disadvantages.
\- Disadvantageous: The strategy presents some disadvantages or may be infeasible.

Options for Integrating Green Infrastructure into Existing Processes

Planning Tools

Local governments are increasingly creating plans for their green infrastructure programs and incorporating green infrastructure into other planning documents such as comprehensive plans and general resilience plans. Incorporating green infrastructure goals and practices into those plans can shape local governments' interventions to be as highly effective and strategic as possible, instead of installing green infrastructure on a more ad-hoc basis.

Learn more at https://www.georgetownclimate.org/adaptation/toolkits/green-infrastructure-toolkit/planning-tools.html

Regulatory Tools

Regulatory tools include requirements set in zoning or building codes or stormwater retention ordinances, mandating action by private property owners. In many jurisdictions, stormwater retention ordinances establish retention requirements and then lay the foundation for other regulations that mandate green infrastructure as a specific set of practices to meet those retention requirements.

Learn more at https://www.georgetownclimate.org/adaptation/toolkits/green-infrastructure-toolkit/regulatory-tools.html

Incentive-Based Tools

While mandates are the most certain method to change behavior, both financial and development incentives to build more green infrastructure can be important tools as well. Both types of incentives can stand alone or can accompany mandates; unlike mandates, they can influence stormwater management practices on property that was not otherwise subject to zoning or building code requirements (i.e., existing development not planned for renovation). They therefore can be a critical tool for highly-developed municipalities to spur change on private property.

Learn more at https://www.georgetownclimate.org/adaptation/toolkits/green-infrastructure-toolkit/incentive-based-tools.html

Government Operations

Unlike regulatory and incentive-based tools designed to influence private landowners, local governments have much greater discretion and control over municipal operations. Green infrastructure can be incorporated into processes and plans governing public land, such as street design standards governing road construction, capital planning processes guiding public investment, and facilities management governing construction of public buildings and on public land outside of the streetscape such as parks or recreational areas.

Learn more at https://www.georgetownclimate.org/adaptation/toolkits/green-infrastructure-toolkit/government-operations.html

Planning Tools

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Green Infrastructure-specific plans

Because green infrastructure can involve so many different agencies, partners, and funding streams, some local governments have created green infrastructure-specific plans to coordinate all of those moving pieces. These green infrastructure plans can accomplish several purposes including prioritizing particular neighborhoods or types of locations (such as streetscapes or parking lots), setting goals for research or monitoring of installations, clarifying relationships among partners, and calling for policy changes to support green infrastructure investments.

Because green infrastructure-specific plans are not regulatory, they can influence behavior for both new and existing development and can affect decision-making on both public and private land. Hoboken, NJ has created a green infrastructure-specific plan that lays out the target neighborhoods and even individual parcels for green infrastructure installation. Because these plans are not regulatory, however, they may need changes in law to implement their recommendations. Hoboken's plan identifies the zoning changes that would need to happen to generate more green infrastructure on private property.

Comprehensive plans

Local governments use comprehensive plans to set policy and to plan the direction of their communities for years to come. In some localities, a larger jurisdiction such as a county might create the comprehensive plan, which then would guide the zoning codes set by the municipalities in that county. By incorporating requirements for green infrastructure into its comprehensive plan, a local government can thus require or encourage the use of green infrastructure through requirements or incentives in the zoning code for various types of land uses.

Because comprehensive plans shape future changes in zoning codes, they can directly cause green infrastructure to be required for new development and on private property. However, changes to the zoning code generally must happen for the comprehensive plan to be effective in changing construction and development; this can be a long and burdensome process for small local governments, and developers may resist additional requirements.

Different types of planning tools can achieve different goals and will face different challenges in enactment and implementation. The following chart compares green infrastructure-specific plans and comprehensive plans along four sets of criteria, following the discussion of each type of planning tool above.[85]

Table 2: Comparison of Planning Tools

	Type of Development		Public vs. Private Property		Administrative	Legal
	New	Existing	Public	Private		
Green infrastructure-specific plans	+	+	+	+	~	~
Comprehensive plans	+	~	+	+	~	~

\+ Advantageous: The strategy maximizes benefits and is feasible.
~ Neutral: The strategy may present may present mixed advantages and disadvantages.
\- Disadvantageous: The strategy presents some disadvantages or may be infeasible.

Related Resources

Norfolk, Virginia Resilience Strategy

The City of Norfolk, Virginia released its Resilience Strategy in October 2015 to address the three major challenges facing the city today including sea level rise and recurrent flooding; a shifting economy; and a need to build strong, healthy neighborhoods. The report proposes high-level strategies and actions to address a wide range of challenges the city faces, focusing on sea level rise and broader risks such as an over-reliance on limited industrial or economic sectors and concentrated poverty. This plan was supported by the **Rockefeller Foundation's 100 Resilient Cities** initiative.

View Resource at https://www.adaptationclearinghouse.org/resources/norfolk-virginia-resilience-strategy.html

Greater New Orleans Urban Water Plan

The Greater New Orleans Urban Water Plan focuses on the improved management of storm water, surface waters and groundwater in New Orleans, Louisiana, in response to flooding, land subsidence and "wasted water assets." The primary area of focus is 155 miles of urban areas and 69 square miles of protected wetlands in Orleans, Jefferson and St. Bernard parishes. The plan discusses how climate change threatens to raise the frequency of extreme weather events, and rising sea levels. Considered along with land subsidence, residents and economic assets are at great risk - and pumping stormwater and keeping floodwaters out are both projected to become more difficult over time.

View Resource at https://www.adaptationclearinghouse.org/resources/greater-new-orleans-urban-water-plan.html

Baltimore's Disaster Preparedness and Planning Project (DP3)

The City of Baltimore Maryland's Disaster Preparedness and Planning Project (DP3) was created by the Department of Planning as an effort to address existing hazards while simultaneously preparing for predicted hazards due to climate change. This project develops a program that integrates an All Hazards Mitigation Plan (AHMP), floodplain mapping, and climate adaptation planning. DP3 links research, outreach, and actions to create a comprehensive and new risk-preparedness system for addressing existing and future impacts.

View Resource at https://www.adaptationclearinghouse.org/resources/baltimore-s-disaster-preparedness-and-planning-project-dp3.html

Hoboken, New Jersey Green Infrastructure Strategic Plan

Hoboken's Green Infrastructure Strategic Plan calls for above-ground detention, infiltration, and retention using various green infrastructure strategies, and encourages policy changes, such as zoning requirements and incentives, pilot projects, and plans for public lands and rights-of-way. The Plan identifies neighborhoods, and even specific buildings and parcels, as candidates for a first round of green infrastructure pilot projects, including some pilots in public housing projects in multiple areas of the city in order for low-income and potentially more vulnerable populations to reap the benefits of the green infrastructure practices.

View Resource at https://www.adaptationclearinghouse.org/resources/hoboken-new-jersey-green-infrastructure-strategic-plan.html

Linn County, Iowa Comprehensive Plan - A Smarter Course: Building on the Past and Embracing the Future of Rural Linn County

The 2013 Linn County Comprehensive Plan, effective July 19, 2013, broadens the scope of previous comprehensive plans beyond land use planning to include a broad range of goals such as economic development, sustainability, hazard planning, and renewable energy. While climate adaptation is only briefly mentioned, the plan does describe the expected risk from climate change to the county (including increased floods, heat waves, and other severe weather events). Additionally, the plan encourages the use of green infrastructure to achieve sustainability and hazard mitigation goals.

View Resource at https://www.adaptationclearinghouse.org/resources/linn-county-iowa-comprehensive-plan-a-smarter-course-building-on-the-past-and-embracing-the-future-of-rural-linn-county.html

New York City Green Infrastructure Plan - A Sustainable Strategy for Clean Waterways

NYC's Green Infrastructure Plan was created in 2010 and sets water quality targets with very specific green infrastructure strategies for different land use types and with specific timeframes over the next twenty years. By establishing an interagency task force, engaging the community, using green infrastructure in combination with gray infrastructure, and carefully monitoring the performance of pilot installations, the City has been able to manage shifting priorities and adapt its approach based on real-time data.

View Resource at https://www.adaptationclearinghouse.org/resources/new-york-city-green-infrastructure-plan-a-sustainable-strategy-for-clean-waterways.html

Regulatory Tools

Regulatory tools include requirements set in zoning or building codes or stormwater retention ordinances, mandating action by private property owners. In many jurisdictions, stormwater retention ordinances establish retention requirements and then lay the foundation for other regulations that mandate green infrastructure as a specific set of practices to meet those retention requirements.

Regulatory tools, because of their inherent nature as requirements (as opposed to options or incentives), get surer results than programs that rely solely on capital improvement projects on publicly owned lands or voluntary measures for private land. Private property owners must meet regulatory requirements to obtain a permit and, therefore, they must change their landscaping and building practices to comply. As a result, regulatory approaches may result in some political pushback. Many of the regulatory tools below may be more palatable to local developers if some flexibility is built into the system. For example, Seattle's stormwater ordinance allows some retention offsite if retention is not practical onsite,[86] while the District of Columbia's ordinance allows for payment of a fee or purchase of stormwater credits as alternative methods of meeting its retention obligation.

Last, because of the nature of regulatory requirements as things mandated in laws such as zoning codes or other ordinances, many of these strategies may require legal changes to incorporate those requirements into that particular legal framework. These legal changes can be administratively complicated and time-consuming.

Zoning Codes

Zoning codes can create green infrastructure requirements for new construction and sometimes substantial renovations. Zoning codes are particularly suited to tailoring those requirements to particular land uses such as industrial, residential, etc, and for addressing the entire site under development, including landscaping (in contrast to building codes, which generally focus more specifically on the buildings. Zoning requirements can either set retention requirements that property owners can meet by choosing green infrastructure practices themselves, or can enumerate particular green infrastructure practices that qualify to meet the regulatory requirement. Each local government will need to look at the authority given by its state government to enact zoning regulations in order to determine how strong that local government can make green infrastructure requirements.

Building Codes

Building Codes can similarly create green infrastructure requirements for new construction and sometimes substantial renovations. In contrast to zoning codes, however, building codes are particularly suited to tailoring requirements to particular building types regardless of the use – for example, single-family residential, office buildings, etc. Different states grant different authority to local governments for building codes; some states require local building codes to conform to state standards, while other states give local governments wide latitude to create their own standards.[87] Each local government will need to look at the authority its state government has given it over building codes in order to determine how strong that local government can make green infrastructure requirements.

Stormwater Ordinances

Stormwater Ordinances can directly require green infrastructure practices, as Binghamton, NY's, ordinance does, or can serve as a foundational regulation to encourage green infrastructure to meet retention requirements. Stormwater ordinances can link these practices to reductions in stormwater fees (see incentive-based approaches), or can simply require retention and/or green infrastructure practices. Like zoning and building codes, stormwater ordinances best reach new construction

projects, although they can impact existing buildings when those buildings are undergoing substantial renovation. Unlike state-level authorizing statutes for zoning and building codes, authority delegated to local governments to enact stormwater ordinances can be found in any of several sources, including authority to enact zoning codes, erosion control ordinances, and subdivision regulations.

Table 3: Comparison of Regulatory Tools

	Type of Development		Public vs. Private Property		Administrative	Legal
	New	Existing	Public	Private		
Zoning Codes	+	~	+	+	~	~
Building Codes	+	~	+	+	~	~
Stormwater Ordinances	+	~	+	+	~	~

\+ Advantageous: The strategy maximizes benefits and is feasible.
~ Neutral: The strategy may present may present mixed advantages and disadvantages.
\- Disadvantageous: The strategy presents some disadvantages or may be infeasible.

Related Resources

Building a Better Norfolk: A Zoning Ordinance of the 21st Century

This Norfolk Zoning Ordinance adopted in January 2018 includes a Resilience Quotient System where development is required to earn a certain number of points, based upon size or number of units, by including different resilience measures in the design of the project. Stormwater management is one component where new developments and redevelopment projects must earn points. Points can be earned for installing a green roof, rain-gardens, or other stormwater infiltration systems; using pervious paving systems; providing a community-garden space; preserving pre-development natural, native vegetation; providing for new tree-planting;and/or preserving large non-exotic trees on site. Development projects must show how they are incorporating resilience measures through the site-plan review process and at least one point must be earned for stormwater management measures.

View Resource at https://www.adaptationclearinghouse.org/resources/building-a-better-norfolk-a-zoning-ordinance-of-the-21st-century.html

Buffalo, New York, Green Code Unified Development Ordinance, Article 7.3.4 Best Management Practice

The City of Buffalo, New York's Unified Development Ordinance now includes a Green Code that requires use of green infrastructure best management practices (BMPs) wherever practical to achieve the Code's performance-based stormwater retention standards. The ordinance, at Article 7.3.4 of Section 7 on Stormwater, specifies infiltration on-site using bioswales, rain gardens, and other strategies; or stormwater capture and reuse through cisterns, green roofs, and other strategies. The ordinance clarifies the order of preference for stormwater management facilities utilizing BMPs, prioritizing conservation of natural areas before on-site infiltration practices, and on-site infiltration practices before capture and reuse practices.

View Resource at https://www.adaptationclearinghouse.org/resources/buffalo-new-york-green-code-unified-development-ordinance-article-7-3-4-best-management-practice.html

New Orleans Comprehensive Zoning Ordinance, Article 23: Landscape, Stormwater Management, and Screening

New Orleans Comprehensive Zoning Ordinance directly addresses landscaping and stormwater management. Article 23 of the CZO includes several elements that require or strongly prefer green infrastructure practices to manage stormwater in parking lots, including bioswales, pervious pavement, and green roofs. For example, every parking facility is required to capture, filter, infiltrate, or store the first 1.25 inches of stormwater. Section 23.12 outlines various Best Management Practices (BMPs) which minimize runoff, increase infiltration, recharge groundwater, and improve water quality. These include bioswales, constructed wetlands, detention basins, ditch gardens, sand filters, and tree protected areas. The CZO does not prescribe the use of any specific BMP, but describes them with the goal of providing guidance.

View Resource at https://www.adaptationclearinghouse.org/resources/new-orleans-comprehensive-zoning-ordinance-article-23-landscape-stormwater-management-and-screening.html

District of Columbia Green Area Ratio - Zoning Regulations

The District of Columbia (Washington D.C.) Green Area Ratio (GAR) is an environmental sustainability zoning regulation which sets requirements for landscape elements and site design to help reduce stormwater runoff, improve air quality, and mitigate urban heat. The GAR sets minimum lot coverage standards for landscape and site design features to promote greater livability, ecological function, and climate adaptation in the urban environment. The GAR

requirements provide a firm retention target and allow local governments to weight the elements they prefer in order to influence behavior, while providing some measure of flexibility for property owners.

View Resource at https://www.adaptationclearinghouse.org/resources/district-of-columbia-green-area-ratio-zoning-regulations.html

Washington D.C./District of Columbia Stormwater Ordinance - 2013 Rule on Stormwater Management and Soil Erosion and Sediment Control

In 2013, the District Department of the Environment (DDOE) released an amended Rule on Stormwater Management and Soil Erosion and Sediment Control to require that major development and redevelopment projects incorporate additional measures to retain stormwater and reduce runoff. The District offers compliance flexibility by allowing for some off-site retention, the ability for developers to pay an in-lieu fee, or the option to buy stormwater retention credits. The District also developed a **Stormwater Management Guidebook** (SWMG) to provide technical guidance on stormwater best management practices (BMPs) and how to comply with the rule. The amended 2013 Stormwater Rule and SWMG are designed to improve water quality and reduce runoff to the Anacostia and Potomac Rivers, Rock Creek, and their tributaries. Green infrastructure practices can also help reduce risks from climate impacts by reducing urban drainage flooding and urban heat.

View Resource at https://www.adaptationclearinghouse.org/resources/washington-d-c-district-of-columbia-stormwater-ordinance-2013-rule-on-stormwater-management-and-soil-erosion-and-sediment-control.html

City of Binghamton, New York Erosion Control Ordinances

The City of Binghamton, New York's erosion control ordinances require property owners seeking permits for construction to submit an Urban Runoff Reduction Plan (URRP) to demonstrate how they will manage stormwater after construction. The URRP must show how the development will manage a 10-year, 24-hour storm event and include green infrastructure techniques. Like Seattle Washington's stormwater ordinance, the clear requirement to include green infrastructure takes the code beyond simple retention, specifying the best management practices (BMPs) that the city most wants to see, such as green roofs.

View Resource at https://www.adaptationclearinghouse.org/resources/city-of-binghamton-new-york-erosion-control-ordinances.html

City of Seattle, Washington Stormwater Code

The City of Seattle, Washington's stormwater regulations are implemented in order to improve stormwater management for new development in Seattle, including on-site stormwater management. Seattle's Stormwater Code imposes retention requirements on residential properties. These requirements vary according to several factors, including the type of sewer system or water body to which the site discharges and the size of the land disturbance or impervious surface on that site. For example, if a parcel discharges into small lake basins and its total new-plus-replaced impervious surface is 2000 square feet or more, it must manage stormwater from a 25-year rainfall event (a storm that has a 4% chance of occurring in any given year). Additionally, construction sites are required to maintain natural drainage patterns, protect downstream properties from erosion, and implement green infrastructure, to the maximum extent feasible.

View Resource at https://www.adaptationclearinghouse.org/resources/city-of-seattle-washington-stormwater-code.html

Boulder Green Building and Green Points Program - Boulder, Colorado Municipal Code Chapter 7.5, Ordinance 7565

Boulder, Colorado's municipal building code integrates Ordinance 7565 (Green Building and Green Points Program) which was adopted by Boulder City Council on Nov. 13, 2007 and went into effect on Feb. 1, 2008. The Boulder Green Points Building Program is the nation's first mandatory residential green building program that requires a builder or homeowner to include a minimum amount of sustainable building components based on the size of the proposed structure.

Applicants are required to earn "green points" which are generated from adaptive strategies/sustainable practices in landscaping, shading of hardscape (trees), surface water management, high efficiency irrigation, waste management and building rehabilitation. For example, preserving existing mature trees on site earns one point per tree, up to a maximum of five points.

Points are also awarded for stormwater management practices, such as installing permeable surfaces. The number of points earned is based on the percentage of the site that is permeable, up to four points for a site that is 100% permeable. Applicants must reach a certain number of points (depending on type of project and square footage) in order for the project to be permitted.

View Resource at https://www.adaptationclearinghouse.org/resources/boulder-green-building-and-green-points-program-boulder-colorado-municipal-code-chapter-7-5-ordinance-7565.html

New York City Zoning Code - Permeable pavement requirements

Since 2007, New York City's zoning code has required parking lots for community facilities to allow permeable pavements where appropriate.

Parking lots at community facilities must capture stormwater through larger perimeter plantings and planting islands than is required for other parking lots, and the facility lot must be properly graded to drain runoff to those plantings. Both types of plantings must include trees of a certain diameter and spacing, and all vegetation must be from a list of pre-approved species. The objectives of these zoning requirements are to better manage stormwater on parking lots and reduce urban temperatures by providing shade.

View Resource at https://www.adaptationclearinghouse.org/resources/new-york-city-zoning-code-permeable-pavement-requirements.html

Incentive-Based Tools

While mandates are the most certain method to change behavior, both financial and development incentives for green infrastructure can be important tools as well. Both types of incentives can stand alone or can accompany mandates; unlike mandates, incentives can influence stormwater management practices on property that is not otherwise subject to zoning or building code requirements (i.e., existing development not planned for renovation). They therefore can be a critical tool for highly-developed municipalities to spur change on private property.

Financial incentives

Financial incentives such as subsidies, grants, and rebates can make the initial capital costs needed to install green infrastructure seem less daunting to private property owners, while tax incentives can reduce costs to property owners over time. Both strategies require the local government's having funds available, although tax incentives involve foregone revenue more than direct expenditure. Developing a financial incentive strategy may also require local governments to choose between subsidizing many properties with small amounts of money, or few properties with larger amount of money. Local governments may also want to consider whether to take a "first-come, first-serve" approach to those subsidies, or to be strategic about targeting funds to particular watersheds, neighborhoods, or land-use types that are the highest priority (for example, areas with greater urban heat islands or with high percetages of vulnerable residents). Local governments wishing to use tax incentives will need to look at their taxing authority to determine whether tax incentives are a viable option for them. City or county governments can look to the breadth of the tax authority delegated to them, and other types of governments (i.e., water utilities or regional governments) will need to assess whether they have the authority to tax at all.

Development incentives

Development incentives such as expedited permitting are likely to make a difference only for large development projects, but those projects may have the most potential for intensive green infrastructure installation, due to their higher acreage. The effectiveness of development incentives may also depend on the amount of new development happening in that jurisdiction in the first place; smaller urban areas with less development are likely to see less change from development incentives.

Table 4: Comparison of Incentive-Based Tools

	Type of Development		Public vs. Private Property		Administrative	Legal
	New	Existing	Public	Private		
Financial Incentives	+	+	~	+	~	~
Development Incentives	+	~	~	+	+	~

\+ Advantageous: The strategy maximizes benefits and is feasible.
~ Neutral: The strategy may present may present mixed advantages and disadvantages.
\- Disadvantageous: The strategy presents some disadvantages or may be infeasible.

Related Resources

City of Philadelphia Stormwater Incentives/ Grants

The City of Philadelphia, Pennsylvania has created a suite of subsidies, grants and rebates for both residential and non-residential properties to encourage more stormwater retention and green infrastructure practices. The Stormwater Management Incentives Program and the Greened Acre Retrofit Program offer a reduced price for qualified non-residential customers and contractors to design and install stormwater best management practices which reduce stormwater pollution and enhance water quality.

View Resource at https://www.adaptationclearinghouse.org/resources/city-of-philadelphia-stormwater-incentives-grants.html

New York City Green Infrastructure Grant Program

New York City's Green Infrastructure Program is a multi-agency effort led by the Department of Environmental Protection (DEP). Grants are offered to private property owners in combined sewer areas of New York City. The program provides funding for green infrastructure projects that manage the first inch of rainfall, including blue roofs, rain gardens, green roofs, porous pavement and rainwater harvesting. Private property owners in combined sewer areas are eligible for grants of up to $5 million. In order to ensure that the green infrastructure is well-maintained, grantees must sign a covenant that requires twenty years of maintenance. Due to this covenant, the grant money continues to have a long-term impact long after the funds are disbursed.

View Resource at https://www.adaptationclearinghouse.org/resources/new-york-city-green-infrastructure-grant-program.html

Chicago Zoning Ordinance 17-4-1015 Green Roofs Incentives

Chicago's zoning code awards a Floor-Area Ratio (FAR) bonus for green roofs that cover more than 50 percent of the roof area. FAR bonuses allow developers to build on a higher percentage of the property, or to a higher density, than would ordinarily be permitted for a particular zone. Chicago's FAR is available for buildings in downtown mixed-use districts. This type of incentive does not cost the municipality any additional money beyond a small amount of staff time to assess the plans and grant the FAR bonus. For new buildings, developers can make more money by being able to build more square footage on the same plot, and the city gets more square footage of green roofs without large expense.

View Resource at https://www.adaptationclearinghouse.org/resources/chicago-zoning-ordinance-17-4-1015-green-roofs-incentives.html

New York City Green Roof Property Tax Abatement Program

The Green Roof Property Tax Abatement provides a one-year tax abatement for the construction of a green roof on residential and commercial buildings in New York City. The City of New York and New York State passed legislation in 2008 to provide a one-year tax abatement, or tax relief, of $4.50 per square foot (up to $100,000 or the building's tax liability, whichever is less). Amended in 2013 by New York State's AB 7058, the tax abatement is now available through March 15, 2018.

View Resource at https://www.adaptationclearinghouse.org/resources/new-york-city-green-roof-property-tax-abatement-program.html

Toronto Eco-Roof Incentive Program

The City of Toronto in Ontario, Canada Eco-Roof Incentive Program provides grants to commercial, industrial and institutional property owners to improve the sustainability of Toronto's infrastructure and its resilience to climate change. Financial incentives are provided for the construction of green roofs that support vegetation and cool roofs that reflect the sun's thermal energy. Launched in 2009, the program supports the City's Climate Change Action Plan and complements the City's 'Green Roof Bylaw' and the 'Green Standard' by encouraging owners of existing buildings to retrofit their roofs.

View Resource at https://www.adaptationclearinghouse.org/resources/toronto-eco-roof-incentive-program.html

District of Columbia's RiverSmart Program

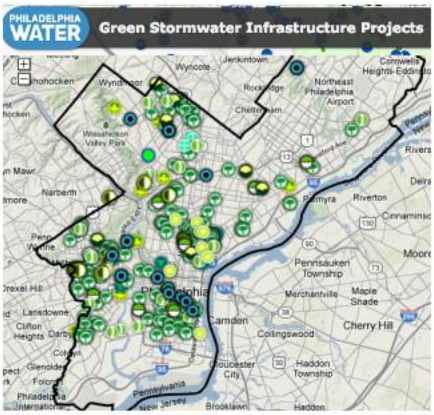
Washington D.C.'s Department of Energy and Environment (DOEE) administers a variety of "RiverSmart" programs to fund projects that reduce stormwater runoff and water pollution. The programs provide financial incentives, in the form of grants and rebates, to fund green infrastructure projects that reduce and treat stormwater runoff from impervious surfaces. Although the RiverSmart program was developed to help the District address water pollution from stormwater runoff, it also supports climate resilience by diverting rainwater from the city's stormwater system to manage increasingly heavy rainfall events. District property owners who install rain barrels, green roofs, permeable pavers, shade trees, and landscaping projects that reduce and/or treat stormwater runoff from impervious surfaces on their property are eligible for grants and rebates from these programs to offset the costs of the investment.

View Resource at https://www.adaptationclearinghouse.org/resources/district-of-columbia-s-riversmart-program.html

Government Operations

Unlike regulatory and incentive-based tools designed to influence private landowners, local governments have much greater discretion and control over municipal operations. Green infrastructure can be incorporated into processes and plans governing public land, such as street design standards governing road construction, capital planning processes guiding public investment, and facilities management governing construction of public buildings and on public land outside of the

streetscape such as parks or recreational areas. By investing public dollars in green infrastructure, local governments can achieve multiple goals simultaneously, from managing stormwater to reducing temperatures and improving water quality.



Street Design Standards

Street Design Standards allow local governments to provide clear direction for employees and contractors who may be installing green infrastructure in rights-of-way along roadways. Street design standards allow green infrastructure to be built to a consistent standard, and to a standard that is well-suited for that particular locality's soil type, traffic priorities, and drainage systems. These design standards may require time and effort to develop, and will require data from monitoring of pilot programs to ensure effectiveness.[88] Street designs that incorporate street trees should develop protocols for ongoing maintenance of trees, particularly in areas anticipating increased temperatures and/or drought.

Capital Planning Processes

Capital planning governs how local governments invest their funds in infrastructure and facilities over time. Local governments are beginning to incorporate green infrastructure into those capital plans, enabling green infrastructure to be funded by the bonds that generally support capital investments.

Facilities Management

Facilities management is the term for the methods that local governments use to guide construction of public buildings and construction on public land outside of the streetscape such as parks or recreational areas. Local governments are now incorporating green infrastructure practices into the management and retrofitting of public properties in order to manage stormwater, increase energy efficiency, and improve water quality. The most innovative local governments are strategically choosing government facilities to get the most "bang for the buck," as in the District of Columbia's Smart Roofs Program, and are ensuring that green infrastructure investments benefit low-income and overburdened communities within their localities.

Table 5: Comparison of Government-Operations Tools

	Type of Development		Public vs. Private Property		Administrative	Legal
	New	Existing	Public	Private		
Street Design Standards	N/A	N/A	+	-	~	+
Capital Planning Processes	N/A	N/A	+	-	~	+
Facilities Management	N/A	N/A	+	-	~	+

\+ Advantageous: The strategy maximizes benefits and is feasible.
~ Neutral: The strategy may present may present mixed advantages and disadvantages.
\- Disadvantageous: The strategy presents some disadvantages or may be infeasible.

Related Resources

Washtenaw County, Michigan Water Resources Commissioner Rules and Guidelines: Procedures and Design Criteria for Stormwater Management Systems

Michigan's Washtenaw County Water Resource Commissioner released stormwater management guidelines in August 2014. The guidelines outline the best management practices (BMPs) that should guide the design criteria for green infrastructure installations. The rules address when different BMPs are appropriate, how to design and build them (including calculations for runoff), how to test their effectiveness, and how to maintain them over time.

To achieve these goals, the guidelines outline a hierarchy of management techniques, placing infiltration techniques that reduce runoff at the top of the hierarchy. Retention and detention of stormwater was identified as the second most effective stormwater control, with the guidelines favoring green and vegetated techniques over structural changes.

View Resource at https://www.adaptationclearinghouse.org/resources/washtenaw-county-michigan-water-resources-commissioner-rules-and-guidelines-procedures-and-design-criteria-for-stormwater-management-systems.html

San Francisco Public Utilities Commission Green Infrastructure Projects

San Francisco Public Utilities Commission (SFPUC) is implementing multiple green infrastructure projects based on their Urban Watershed Assessment, which will identify green and grey sewer infrastructure improvements over the next twenty years. The SFPUC recognizes that the sewer

system, treating both sewage and stormwater runoff, was not built to withstand the impacts of climate change - such as intense rainstorms that overwhelm the system. The watershed-based planning process is being used to help plan the City's Sewer System Improvement Program (SSIP), a multi-billion dollar project to to upgrade aging infrastructure, and ensure the reliability and performance of the sewer system. Phase One of the SSIP, will construct, monitor and evaluate eight green infrastructure projects to manage stormwater before it enters the combined sewer system in each of the eight urban watersheds, including projects with rain gardens and permeable pavement.

View Resource at https://www.adaptationclearinghouse.org/resources/san-francisco-public-utilities-commission-green-infrastructure-projects.html

Baltimore, Maryland Growing Green Initiative

Baltimore, Maryland launched the **Growing Green Initiative (GGI)** on May 14, 2014. This City effort repurposes vacant lots to advance community priorities, including open space, growing fresh food, managing stormwater with green infrastructure, recreational space, and social resilience. The Baltimore Office of Sustainability created a **"Green Pattern Book"** to guide community groups and residents through the process of converting vacant and blighted properties into community spaces that can meet environmental and social equity priorities. To date, city residents and agencies have turned nearly 800 vacant lots into gardens and community open spaces. The goals of the Initiative include increasing tree canopy, creating jobs, and managing stormwater using green infrastructure techniques.

View Resource at https://www.adaptationclearinghouse.org/resources/baltimore-maryland-growing-green-initiative.html

City of Chicago Green Stormwater Infrastructure Strategy

In 2014 Chicago, Illinois released their green stormwater infrastructure plan to improve the city's water quality, reduce flood risks, and build climate resilience. This plan describes ways to integrate green techniques into Chicago's well established, but already overtaxed stormwater system that will only become more burdened as climate change causes increased precipitation. The plan explains how urban landscapes such as Chicago will benefit from capturing, sorting, and filtering water using green techniques rather than diverting it to a sewer system. The long-term stormwater management goals of the plan are to minimize basement flooding, reduce water pollution, enhance environmental quality, and increase extreme rain and climate resilience. The City presents six major new initiatives to meet these goals, including integrating green stormwater infrastructure into future public capital projects and increasing the use of green stormwater infrastructure in streetscape projects. Through this plan, the City of Chicago recognizes the need for significant long-term investment in stormwater infrastructure, committing $50 million over five years to green infrastructure construction. In planning for the future, the report notes that Chicago intends to incorporate projections of climate change to ensure they are addressing the city's long-term challenges.

View Resource at https://www.adaptationclearinghouse.org/resources/city-of-chicago-green-stormwater-infrastructure-strategy.html

Great Lakes Green Streets Guidebook

This guidebook, published by the Southeast Michigan Council of Governments (SEMCOG), provides examples of roadway projects within the Great Lakes Watershed that utilize green infrastructure methods to improve water quality and reduce stormwater runoff. Developed as a complement to the Low Impact Development Manual for Michigan, the guidebook offers support to municipalities interested in planning, designing, and constructing green streets. Chapter 3 describes green street techniques with demonstrated success including:

- Bioretention/bioswales: areas or channels utilizing vegetation to clean stormwater runoff);
- Native plant grow zones: vegetation areas that improve water quality, habitat, and reduce stormwater runoff volume; and
- Permeable pavement: porous surface that drains water into a storage reservoir to facilitate stormwater infiltration.

The guidebook also includes 26 case studies showcasing projects from the Great Lakes regions that utilized green street techniques. Each case study describes the green technique used, the outcome of the project, the funding mechanisms that supported the project, who sponsored and designed the project, and any implementation challenges. Each case study also includes contact information for anyone interested in learning more.

View Resource at https://www.adaptationclearinghouse.org/resources/great-lakes-green-streets-guidebook.html

Washington D.C. Smart Roof - Roof Asset and Energy Management Program

Through the Smart Roof Program, the Washington D.C. Department of General Services (DGS) is successfully integrating roof asset and energy management projects to reduce its energy use by 20 percent across its entire municipal portfolio. The strategic approach to portfolio-based roof management is being applied across 435 buildings including schools, police stations, fire stations, parks and recreation centers, and office buildings that make up 321 acres of roof area in D.C.

View Resource at https://www.adaptationclearinghouse.org/resources/washington-d-c-smart-roof-roof-asset-and-energy-management-program.html

How to Pay for Green Infrastructure: Funding and Financing

Introduction

Communities are increasingly turning to green infrastructure as a vital tool to help manage stormwater and improve climate resilience. However, many local governments seeking to establish green infrastructure programs face budget constraints that may limit the scope or effectiveness of program implementation. Fortunately, local governments have the opportunity to draw upon a wide range of funding sources, revenue models, and financing strategies to support green infrastructure programs. This Funding and Financing Chapter provides strategic guidance on how to pay for green infrastructure.

Stormwater management is increasingly becoming a major expense for local governments addressing persistent flooding or responding to legal and regulatory mandates, such as combined sewer overflow (CSO) consent decrees,[89] total maximum daily load waste load allocations,[90] or municipal separate storm sewer system (MS4) permits.[91]

Investing in green infrastructure can cost-effectively help communities manage stormwater while also producing significant co-benefits. Examples of co-benefits include improvements in air quality and public health, increased climate resilience, opportunities for community recreation, and enhanced community aesthetics.[92] Designing green infrastructure programs to maximize co-benefits may open up funding sources that would otherwise not be available for stormwater management projects or programs. For example, communities can use funds for programs such as transportation and street design, open space and wildlife conservation, or disaster relief to pay for green infrastructure programs. Additionally, communities can implement innovative financing strategies to capture the economic value created by flood costs avoided, increased health benefits, or increased property values. Communities can aggregate multiple funding and revenue sources, or combine a funding source with financing options such as low-interest loans or green bonds.

Green Infrastructure Cost Effectiveness

Green infrastructure can effectively manage the "first flush" of stormwater while producing significant cost savings for local governments. For example, Philadelphia's city-wide Green City, Clean Waters program is projected to save the city $8 billion over a twenty-five year implementation period compared to the traditional gray infrastructure that would have been required under an agreement with the U.S. EPA to control the city's stormwater.[93] Similarly, Chicago, Illinois, has reported that its green infrastructure installations are more effective at managing stormwater than traditional techniques on a per-dollar basis.[94] The Chicago Green Alley Program is estimated to manage stormwater between 3 and 6 times more effectively per dollar compared to traditional stormwater infrastructure.[95] However, it can still be hard to find the funds to build and maintain green infrastructure.

This chapter provides descriptions of multiple strategies that a local government can use to pay for green infrastructure program implementation. The tools covered in this chapter are broken down into five categories. For each of the funding or financing strategies, this toolkit provides an overview of how the mechanism can be used to pay for green infrastructure projects or programs. Linked resources in the Georgetown Climate Center Adaptation Clearinghouse provide more detailed information about funding programs or descriptions of jurisdictions that have successfully paid for green infrastructure projects or programs using the various funding or financing tools. This Chapter explores **federal funding sources**, **state funding sources**, **local funding models**, **government financing options**, and **private financing options** (each described in more detail below).[96]

Each funding or financing strategy can be compared under a set of decision-making criteria, including:

- ***Funding Availability***, which includes the ease of getting funds and the ability to sustain them over time. For example, whether a federal program is available every year and calculated by a

formula, as opposed to being a competitive grant program.

- ***Funding Flexibility***, meaning the amount of discretion the local government has to decide how to use the funds, or the breadth of activities that the funds can support.
- ***Municipal Budget Impact***, meaning whether the particular funding strategy takes money out of the local government's general fund.
- ***Administrative Burden***, which includes the time and resources necessary for the local government to administer or manage that funding strategy, in addition to any potential administrative process to begin the program (writing new regulations, for example).
- ***Legal Constraints***, such as whether the funding strategy is constrained by state statutes that may give the local government legal authority for that strategy (or not), or by related state laws such as, for example, caps on borrowing.

Funding and Financing Options

Federal Funding

Federal programs can provide significant funding for local green infrastructure programs. Local governments may be eligible for federal government grants administered by a range of departments and agencies (e.g., DOT, EPA). Federal funding can come in multiple forms: some in competitive grants, and some in formula programs that local governments are already likely to be receiving. Federal grants may be used to supplement money available to local governments through traditional budgeting or financing. However, federal grants can be highly competitive, may require lengthy application, are limited in size and scope, and often are awarded on a one-time basis.

Learn more at https://www.georgetownclimate.org/adaptation/toolkits/green-infrastructure-toolkit/federal-funding.html

State Funding

Many states have grant programs that may be used to fund green infrastructure projects and programs. Because of the varied and broad benefits of green infrastructure, a diverse array of stormwater and other environmental programs, including those for wildlife preservation, land conservation, tree planting, and water quality improvement, may be available.

Learn more at https://www.georgetownclimate.org/adaptation/toolkits/green-infrastructure-toolkit/state-funding.html

Local Funding

Local governments can also pay for green infrastructure using local revenue sources, including the government's general fund appropriations and capital budget, or through user fees or stormwater utility fees. These local funding sources, if implemented, may be consistently available and more flexible for application to green infrastructure projects; general funds, however, may present a strain on municipal budgets because green infrastructure projects could compete for money with other projects without an increase in revenue.

Learn more at https://www.georgetownclimate.org/adaptation/toolkits/green-infrastructure-toolkit/local-funding.html

Government Financing

Municipal governments may also be able to use public financing methods, such as municipal bonds, to pay for green infrastructure projects. Local governments may be able to use Clean Water State Revolving Fund money to finance green infrastructure projects. Additionally, local governments can explore strategies that capture the value created by installing green infrastructure, such as tax increment financing.

Learn more at https://www.georgetownclimate.org/adaptation/toolkits/green-infrastructure-toolkit/government-financing.html

Private Financing

Communities may also explore innovative strategies to leverage limited municipal funds to attract private capital. One approach that is common to infrastructure projects but has been limited in green infrastructure stormwater management is the use of public-private partnerships (P3s). P3s provide access to private capital and may provide a means to rapidly scale up green infrastructure project installation; however, local governments must take care to ensure that the program will take into account and ultimately reflect the community's needs.

Learn more at https://www.georgetownclimate.org/adaptation/toolkits/green-infrastructure-toolkit/private-financing.html

Federal Funding

Overview

Federal programs can provide significant funding for local green infrastructure programs. Federal funding can come in the form of competitive grants or formula programs.[97] that local governments are already likely to be receiving. Grant funding may provide a local government with the resources to implement green infrastructure projects. However, federal grants can be highly competitive, may require lengthy application, are limited in size and scope, and often are awarded on a one-time basis. Many federal grants require a funding match from state or local sources for some percentage of the awarded funds. Some funding sources also prohibit the use of grant funding for operations and maintenance expenses. Local governments that use grant funding for green infrastructure installation should take these factors into account and recognize the importance of identifying additional funding streams to support on-going expenditures.[98]

Local governments can expand opportunities for federal funding by designing green infrastructure projects in ways that maximize particular co-benefits. For example, designing bioswales with native plants may provide eligibility for wildlife conservation or pollinator grant funding (e.g., State Wildlife Grant Programs, funded by U.S. Fish and Wildlife Service).[99] Similarly, green infrastructure can be included in local programs that already receive or apply for federal funding, such as transportation projects or disaster recovery plans.

This toolkit covers several types of federal funds in more detail below: 1) water quality; 2) economic and community development; 3) disaster recovery; and 4) transportation. Within each substantive area, some federal funding strategies are competitive grant programs and some are regularly given, formula grant programs.

Water Quality Funding

Green infrastructure projects may be funded by federal programs that support efforts to reduce water pollution and manage stormwater. Programs include the US Environmental Protection Agency's Section 319 Nonpoint Source Program[100] and the Urban Waters Small Grants Program (UWSG). Under Section 319 (of the Clean Water Act), EPA provides grant funding to states to reduce pollution from stormwater runoff and other sources; EPA recognizes the "importance of green infrastructure … in managing stormwater" has made clear that funds can be used for green infrastructure projects.[101] EPA's UWSG Program focuses on improving the quality of urban waters and stimulating neighborhood revitalization in underserved communities, and can be used specifically for innovative or new green infrastructure practices.

Economic and Community Development Funding

Community development money can be used to fund green infrastructure because these projects can create jobs, increase economic activity, and increase property values. Urban tree planting can increase economic activity in a commercial district.[102] Additionally, green infrastructure can increase property values by mitigating flooding, improving neighborhood aesthetics, and providing other co-benefits.[103] As a result, green infrastructure can be funded using Community Development Block Grant (CDBG) program funding (formula funding), administered by the U.S. Department of Housing and Urban Development (HUD).

Disaster Recovery Funding

Local governments eligible for disaster recovery and relief funding following a presidentially declared disaster may be able to use this federal funding to pay for green infrastructure projects. Many local governments have included green infrastructure in disaster recovery and rebuilding plans to mitigate flood risk and manage stormwater. The FEMA Hazard Mitigation Grant Program (HMGP) provides post-disaster federal aid to states to mitigate the risks of future disasters and can fund flood mitigation projects, including acquisition and relocation of flood-prone properties and soil stabilization projects like the installation of vegetative buffer strips.[104] The Community Development Block Grant – Disaster Recovery (CDBG-DR) program also provides federal aid to states post-disaster, and funds can be used for a variety of community development activities that benefit low- and moderate-income individuals, reduce blight, or address an urgent community need. In rehabilitating housing and constructing public amenities, cities may be able to incorporate green infrastructure techniques (like street trees and permeable pavements) in street design.

Transportation Funding

Green infrastructure projects are often eligible for transportation funding because they improve transportation networks by efficiently and cost-effectively mitigating street and alley flooding.[105] The U.S. Department of Transportation's (DOT's) Transportation Alternatives Program (TAP) provides funding for "transportation alternatives," including "off-road trail facilities for pedestrians, bicyclists, and other non-motorized forms of transportation." TAP funding could be used to pay for green infrastructure components of trails and sidewalks such as permeable pavements.[106] The Congestion Mitigation and Air Quality (CMAQ) program allocates federal funding for infrastructure projects that reduce congestion and improve air quality.[107] Bicycle transportation and pedestrian walkways are eligible uses of the money, and can be designed to include green infrastructure features, such as permeable surfaces for trails, and bioswales and bioretention for areas adjacent to trail surfaces. The

Transportation Investment Generating Economic Recovery (TIGER) program funds investments in road, rail, transit and port projects. TIGER grants have been awarded to projects that included green infrastructure components.[108]

Related Resources

DOT TIGER Grant Program

The Transportation Investment Generating Economic Recovery (TIGER) Discretionary Grant program, administered by the U.S. Department of Transportation (USDOT), has been used to fund green infrastructure projects as part of transportation improvements. TIGER provides funding for investments in road, rail, transit and port projects. TIGER grants have been awarded to projects that included green stormwater management components, including a project in Syracuse, NY.[109] The Connective Corridor project in Syracuse created more bikeable and walkable streets to encourage active transportation and reduce greenhouse gas emissions, and incorporated green infrastructure elements such as tree trenches and porous pavements.

View Resource at https://www.adaptationclearinghouse.org/resources/dot-tiger-grant-program.html

Clean Water Act: Section 319 Grant Program

EPA Clean Water Act Section 319 grant funding goes to states to reduce nonpoint source pollution (pollution caused by rainfall running over the ground and carrying pollutants including trash, oil and grease, and fertilizers into nearby waterways). EPA's most recent program guidance[110] recognized the "importance of green infrastructure … in managing stormwater" and supported awarding funding to green infrastructure projects. The District of Columbia Department of Energy and Environment (DOEE) used Section 319 funding to partially fund remediation of the Watts Branch watershed in northeast D.C. Watts Branch suffered from severe erosion and sediment pollution due to frequent flooding. DDOE led a project to restore the stream bed and control flooding using tree and shrub plantings, regrading of the stream bed, and upstream low-impact development practices to manage impervious surface runoff.[111]

View Resource at https://www.adaptationclearinghouse.org/resources/clean-water-act-section-319-grant-program.html

City of Milwaukee, Wisconsin All Hazards Mitigation Plan

Milwaukee, WI, included green infrastructure projects for flood control in the City Of Milwaukee All Hazards Mitigation Plan. Stormwater management is included as an element of managing flood hazards in that Plan, and several green infrastructure projects are listed as hazard mitigation strategies relevant to the stormwater management element of the plan, in addition to more tradition stormwater management strategies. Hazard Mitigation Grant program money is identified in the Plan as a potential funding source.

View Resource at https://www.adaptationclearinghouse.org/resources/city-of-milwaukee-wisconsin-all-hazards-mitigation-plan.html

EPA Urban Waters Small Grants

The **EPA's Urban Waters Small Grants Program** provides funding to communities to improve the quality of urban waters while simultaneously stimulating neighborhood revitalization. The Urban Waters Small Grants Program has a focus on underserved communities, defined as "communities with environmental justice concerns and/or susceptible populations." The Program can be used specifically for innovative or new green infrastructure practices that improve water quality; state, local, and tribal governments, as well as universities and nonprofit organizations, are eligible to apply. The Sewerage and Water Board of New Orleans (SWBNO) is utilizing UWSG funding for its Green Infrastructure Monitoring Project,[112] in which data will be collected and analyzed to measure the effects of green infrastructure on water quality at specific sites. The data will then be used for public engagement at community workshops and trainings.

View Resource at https://www.adaptationclearinghouse.org/resources/epa-urban-waters-small-grants.html

HUD Green Infrastructure and the Sustainable Communities Initiative

The U.S. Department of Housing and Urban Development (HUD) Green Infrastructure and the Sustainable Communities Initiative report provides case studies of 30 local governments who have used U.S. HUD Sustainable Communities Regional Planning Grants or Community Challenge Planning Grants to fund green infrastructure programs. Although the HUD Sustainable Communities Initiative grant programs have not received Congressional appropriations since 2011, the case studies provide excellent examples of how local governments can combine various

funding streams to pay for green infrastructure programs. For example, the City of Pittsburgh combined funding from a HUD Community Challenge Planning Grant and a U.S. DOT TIGER II grant to fund the planning of the Allegheny Riverfront Green boulevard project.[113]

View Resource at https://www.adaptationclearinghouse.org/resources/hud-green-infrastructure-and-the-sustainable-communities-initiative.html

HUD Community Development Block Grant Program

The Community Development Block Grant (CDBG) programs, administered by the U.S. Department of Housing and Urban Development (HUD), is a funding program that supports communities' development needs. Communities may be able to use CDBG Program funds to acquire property and build public facilities, including green infrastructure installations. In rehabilitating housing and constructing public amenities, cities can incorporate green infrastructure principles (like street trees and permeable pavements). Detroit, MI, used $8.9 million in CDBG funds in 2014 to create a major flood prevention and economic development program. Detroit is using the funding to demolish blighted properties, landscape and install trees on 200 vacant lots to improve stormwater management and neighborhood aesthetics, and install infrastructure that will direct stormwater into new bio-retention basins.[114]

View Resource at https://www.adaptationclearinghouse.org/resources/hud-community-development-block-grant-program.html

HUD Community Development Block Grant - Disaster Recovery

The Community Development Block Grant – Disaster Recovery (CDBG-DR) program also provides federal aid to states during the post-disaster period. CDBG-DR funds can be used for a variety of community development activities, but must help low- and moderate-income individuals, reduce blight, or address another urgent community need in addition to addressing the effects of the disaster. In rehabilitating housing and constructing public amenities, cities may be able to incorporate green infrastructure principles (like street trees and permeable pavements) in street design.

View Resource at https://www.adaptationclearinghouse.org/resources/hud-community-development-block-grant-disaster-recovery.html

FHWA Transportation Alternatives Program

The **Transportation Alternatives Program (TAP)** is administered by the U.S. Federal Highway Administration (FHWA) and can be used to pay for green infrastructure projects integrated into transportation improvements, including trails and sidewalks with permeable pavement. It can also be used to mitigate environmental impacts from transportation, including for green infrastructure projects that help to manage stormwater or abate water pollution from highway construction or run off. The **Southeast Michigan Council of Governments** (SEMCOG) used TAP funding in 2015 from the state of Michigan to fund the Detroit – Inner Circle Greenway Railroad Acquisition, which included 1) installation of green infrastructure such as green streets and bioretention and 2) repurposing of 8.3 miles of abandoned railway near Detroit.[115]

View Resource at https://www.adaptationclearinghouse.org/resources/fhwa-transportation-alternatives-program.html

Congestion Mitigation and Air Quality program

The Congestion Mitigation and Air Quality (CMAQ) program, jointly administered by the Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA), allocates federal funds for infrastructure projects that reduce congestion and improve air quality. Because CMAQ funding can be used for bicycle transportation and pedestrian walkways, such pathways can be designed to include green infrastructure features, such permeable surfaces for trails and bioswales and bioretention areas adjacent to trail surfaces.

View Resource at https://www.adaptationclearinghouse.org/resources/congestion-mitigation-and-air-quality-program.html

FEMA Hazard Mitigation Grant Program

The FEMA Hazard Mitigation Grant Program (HMGP) provides federal aid to states during the disaster reconstruction process to fund critical projects to mitigate the risks of future disasters and can be used to fund green infrastructure projects. HMGP can be used to fund projects that will both improve water quality and reduce flood risks such as projects involving acquisition and relocation of flood-prone properties, and soil stabilization projects including the installation of vegetative buffer strips. **New Orleans** used HMGP funding for its post-Katrina rebuilding process, including the reconstruction of the city's stormwater infrastructure. Although the New Orleans Stormwater plan calls for a significant expansion of green infrastructure to manage the city's

chronic flooding, the city initially had difficulty demonstrating the benefits of green infrastructure under FEMA's required benefit-cost analysis because the city 1) lacked the data to demonstrate potential flood losses avoided and 2) could not count many of green infrastructure's environmental benefits. Demonstrating the cost-benefit of green infrastructure under HMGP has been much easier since FEMA amended its policy to allow counting of some "ecosystem services" (including aesthetic value, air quality, recreation space, and water filtration) as benefits.[116]

View Resource at https://www.adaptationclearinghouse.org/resources/fema-hazard-mitigation-grant-program.html

State Funding

Overview

Many states have grant programs that may be used to fund green infrastructure projects and programs. Because of the varied and broad benefits of green infrastructure, a diverse array of stormwater and other environmental programs, including those for wildlife preservation, land conservation, tree planting, and water quality improvement, may be available. For example, Cumberland County, Pennsylvania, supported its green infrastructure planning by applying for and receiving funding to develop an open space and smart growth plan from the state Department of Conservation and Natural Resource (DCNR) Keystone Grant Funding program.[117]

The City of Tucson, Arizona, used a grant from the Arizona Department of Environmental Quality to fund a series of green infrastructure projects in the Rincon Heights neighborhood, including the conversion of vacant lots into stormwater management pocket parks featuring bioretention elements, curb cuts, and the removal of impervious surfaces.[118]

State-administered transportation grants can provide a regular funding source for municipal green infrastructure programs. The City of Grand Rapids, Michigan, used a Michigan Department of Transportation Enhancement Grant (complemented with funding from neighborhood and business associations and a regional environmental council) to construct bioretention islands in the roadway. These islands capture stormwater and reduce sediment runoff and phosphorus loading.[119]

The greater Memphis region created a plan to combine multiple sources of federal, state, and local funding – including transportation funding for recreational trails – to implement a regional plan for trails and open space to mitigate flooding and promote community growth. In 2015, the Mid-South Regional GreenPrint, a vision for the next 25 years, envisions a regional network of green space, including parks and greenways. The plan includes a comprehensive description of how multiple sources of funding, from federal funds to state wildlife and conservation funding, could be combined to pay for this network.[120]

Local governments can increase the effectiveness and reach of grant funding by leveraging federal or state grants through environmental loan programs. For example, the City of Lancaster, PA, funded a program that installed stormwater management features in parking lots by leveraging grant money from the state natural resources agency (as well as from the National Fish and Wildlife Foundation) to secure a loan from Pennsylvania's infrastructure bank.[121]

Related Resources

Memphis, Tennessee Mid-South Regional GreenPrint

The Mid-South Regional Greenprint plan, released in 2015, is an example of a plan that provides funding and financing options for implementing green infrastructure projects in jurisdictions throughout a four-county region in Memphis, Tennessee. The plan discusses how the region can apply multiple sources of federal, state, and local funding – including transportation funding for recreational trails – to implement a regional network of trails and open space to mitigate flooding and promote community growth.

View Resource at https://www.adaptationclearinghouse.org/resources/memphis-tennessee-mid-south-regional-greenprint.html

Community-Based Conservation in Tucson's Rincon Heights Neighborhood

The City of Tucson, Arizona, used a grant from the Arizona Department of Environmental Quality to fund a series of green infrastructure projects in the Rincon Heights neighborhood, including the conversation of vacant lots into a stormwater management pocket parks featuring bioretention elements, curb cuts, and the removal of impervious surfaces.

View Resource at https://www.adaptationclearinghouse.org/resources/community-based-conservation-in-tucson-eys-rincon-heights-neighborhood.html

Rainscaping Iowa

The Rainscaping Iowa Program is a collaboration among several state and local agencies in Iowa and is dedicated to educating the public and training professionals in infiltration-based stormwater management. The program is funded through a variety of state and local sources, including the state Department of Transportation's Living Roadway Trust, along with the Iowa Department of

Natural Resources, Department of Agricultural and Land Stewardship, Department of Economic Development, the Iowa Storm Water Education Program, and the Polk Soil and Water Conservation District.

View Resource at https://www.adaptationclearinghouse.org/resources/rainscaping-iowa.html

Local Funding

Overview

Local governments have multiple options for using local funding to pay for green infrastructure projects. If resources are sufficient, local governments can include green infrastructure programs and projects in capital budgets.[122] If local governments want a dedicated source of funds just for green infrastructure and stormwater management, municipal and stormwater utility fees may also provide an important source of revenue.

Coordinating Across Multiple Agencies

Local governments can increase the efficiency of green infrastructure programs and expand the pool of available funding by coordinating funding across municipal agency budgets. Such coordination can reduce project costs by ensuring that projects are installed at the most cost-effective times – for example, when street or sidewalk construction is already scheduled. In addition to improving cost effectiveness, encouraging collaboration among agencies may enable sharing of green infrastructure costs among agency budgets. For example, in Los Angeles, CA, the Bureau of Street Services and the Bureau of Sanitation collaborated to implement the Oros Street project – a $1 million installation of bio-retention areas in the street parkway and a large infiltration basin underneath a nearby park.[123] Boulder, Colorado's Greenways program is funded by equal contributions from the City's Transportation Fund, Stormwater and Flood Control Utility Fund and the state's Lottery Fund, with additional funding by the Urban Drainage and Flood Control District.[124]

Local Funding Options

Municipal Budgets

Many local governments fund green infrastructure and stormwater management programs through the general fund, which in most local governments is primarily funded through income and property taxes. A local government using funds from general tax revenue for green infrastructure will not need to set up new revenue collection and appropriation systems, but funding for green infrastructure programs may not be stable year-to-year if other spending obligations are seen as higher priorities. Additionally, the use of general funds could be seen as inequitable, because some property owners that contribute to stormwater runoff (such as public facilities, universities, and churches) may be exempt from the income or property taxes used to fund the program.[125]

The Ramsey-Washington Metro Watershed District in the Twin Cities in Minnesota provided initial funding for its green infrastructure program with the watershed district's Capital Improvements Budget.[126] The project received additional support from property tax revenue and state grant funding.[127]

Permit Fees

Local governments can assess permit fees to provide additional revenue for green infrastructure programs. The fees allow local governments to raise revenue directly from any proposed development or construction that might worsen stormwater impacts. Portland, Oregon, has established a "One Percent for Green" Fund, which requires that all construction projects in the public right-of-way that do not include "green street facilities" (including curb extensions and porous pavement) must contribute one percent of project costs to a city fund for other green infrastructure projects that exceed city requirements.[128]

However, assessed fees may not provide sufficient funding for full program implementation, and likely would need to be combined with additional funding sources. Additionally, fees may not be a consistent source of revenue, as they may decrease during a time of slow construction.[129]

Stormwater Utility Fees

Local governments may choose to assess stormwater utility fees as a reliable means of paying for green infrastructure programs. This approach is advantageous because it provides a dedicated funding stream with sustainable and predictable revenue over time.

A stormwater utility fee may be seen as a more equitable way to pay for stormwater management, compared to general funds, because local governments or utilities may be able to raise money in a way that is directly related to a property's stormwater impacts. Many local governments allow property owners to offset stormwater user fees or earn incentives and credits by managing stormwater onsite through best management practices such as reducing impervious surface area. For example, the programs in Prince William County, Virginia, and Lenexa, Kansas, provide fee reductions or credits to property owners who manage stormwater onsite.[130]

However, establishing utility fees may face regulatory and legal limitations, including sometimes approval of a legislative body. An entity (local or regional government or utility) that decides to establish a stormwater user fee must first determine its legal authority to do so, and must structure

the user fee in a way that meets all applicable state legal requirements. State law sets the parameters for what types of local or regional entities are allowed to establish fees or taxes, and local governments must be extremely clear that they meet their own states' definition. While these requirements vary by state, they can include procedural questions (e.g., whether a vote by the local elected body or the voters is necessary) and substantive questions (e.g., whether the fee is structured in such a way as to fairly relate to the amount of impervious surface on a particular property).

A number of local governments have faced legal challenges following the imposition of utility fees, including stormwater fees.[131] One of the most commonly litigated issues is whether an assessed utility fee is considered a fee or a tax. Because some jurisdictions require voter approval to assess a tax, this distinction can be critical. In the event of a legal challenge, courts commonly look to several elements to distinguish between a tax and a fee. These elements include: the relationship between the assessed fee and the service provided by the local government, the purpose of the fee, the uniformity of application of the fee, and whether the fee benefits those who pay.[132] Similarly, lawsuits have been filed challenging the authority of a local government to establish a utility. Local governments should carefully consider all applicable legal requirements and relevant case law before implementing a stormwater utility fee.

Establishing and assessing a utility fee requires upfront administrative costs, including a feasibility study, stakeholder outreach, and fee structure design and implementation. Additionally, there have been a few high-profile examples of public resistance to the stormwater user fee model.[133] However, through effective outreach, local governments may be able to establish strong community support for stormwater user fees. The City of **Orlando, Florida**, funds its stormwater management activities through a stormwater utility fee, and successfully built public support for fee implementation by linking the fee to citizens' concerns about flooding and clean waterbodies.[134]

Related Resources

Boulder, Colorado Greenways Master Plan

In addition to traditional revenue sources such as taxes or fees, many local governments draw on other revenue sources. In **Boulder, Colorado**, the city's Greenways program is funded by equal contributions from the City's Transportation Fund, Stormwater and Flood Control Utility Fund and the State's Lottery Fund, with additional funding by the Urban Drainage and Flood Control District.

View Resource at https://www.adaptationclearinghouse.org/resources/boulder-colorado-greenways-master-plan.html

Lenexa, Kansas Rain to Recreation Program

Lenexa, KS, is funding its robust Rain to Recreation program by pairing the city's Storm Systems Development Charge (a 1/8 cent sales tax) and a permit fee that the city called a "capital development charge," along with available sources of local, state and federal funding. Combining multiple sources of funding enables Lenexa to have longer-term and more sustainable funding for its program.

View Resource at https://www.adaptationclearinghouse.org/resources/lenexa-kansas-rain-to-recreation-program.html

Prince William County Stormwater Fee

Prince William County, VA, assesses a stormwater management utility fee to all owners of developed property. Residential property owners are biannually assessed a flat fee based on the type of residence (single family home or apartment). Nonresidential properties are assessed a fee of $18.56 for every 1,000 square feet of impervious area on the property. Property owners can get a fee reduction or a credit for reducing the amount of impervious surface, encouraging more use of green infrastructure.

View Resource at https://www.adaptationclearinghouse.org/resources/prince-william-county-stormwater-fee.html

Government Financing

Overview

In addition to using funding and revenue sources, municipal governments may be able to use public financing strategies to pay for green infrastructure projects. Financing a project through a municipal bond or Clean Water State Revolving Fund loan may have significant advantages. For example, a local government may be able to make upfront investments in green infrastructure programs and realize more immediate benefits from project installation. However, financing strategies have limitations. Local governments may not be able to find sufficient financing for small scale or demonstration projects because investors are generally interested in bigger projects. Additionally, financing may only be available for capital projects and not for the operations and maintenance that are essential to successful green infrastructure programs.

Clean Water State Revolving Fund

One important source of financing for water infrastructure projects is the Clean Water State Revolving Fund (CWSRF). The federal government provides grants to capitalize state CWSRF programs. States contribute a 20 percent funding match, and administer and operate the programs. The state programs function as infrastructure banks: repaid principal and interest from loans is returned to the state program, allowing the state to finance new projects.[135]

States have significant flexibility over CWSRF program administration, and can provide several forms of financial assistance to local governments, including:[136]

- ***Direct loans*:** CWSRF can provide financing for a project and offer interest rates at or below market rates.
- ***Debt purchasing or refinancing*:** CWSRF can be used to purchase a community's stormwater infrastructure debt to relieve unfavorable loan terms; projects may be refinanced using CWRF funds.
- ***Loan guarantees and insurance***: CWSRF funding can be used to increase access to private credit markets or lower a jurisdiction's private borrowing costs.
- ***Additional subsidization:*** Under certain conditions and federal appropriation levels, additional subsidization in the form of loan forgiveness or grants may be available.

States can use the CWSRF to fund the capital costs of both gray and green infrastructure, but CWSRF funding cannot be used for operations and maintenance expenses.[137]

Although only a small percentage of CWSRF funding has historically been directed to green infrastructure projects, the EPA and many states have recently made green infrastructure a priority for CWSRF programs. The CWSRF operates a Green Project Reserve, designed to encourage environmentally responsible investments with CWSRF funds. Green Project reserve guidance requires states to invest at least ten percent of their federal grant funding in four priority areas, including green infrastructure.[138] Since 2009, state CWSRF programs have provided $800 million in assistance to green infrastructure projects. In January 2016, the EPA issued a statement of policy encouraging states to support green infrastructure projects by prioritizing these projects for CWSRF funding.

Bond Financing

Local governments and municipal utilities may be able to finance capital spending through the issuance of municipal bonds.[139] Municipal bonds are a very common way for local governments to finance capital projects – in the United States there are approximately $2.8 trillion in outstanding U.S. municipal bonds.[140] For infrastructure that requires significant upfront capital investment but will operate for a number of years, bond financing allows a local government to pay for a project over the entire life of the infrastructure because the debt is repaid gradually over time.

Municipal bonds can be issued as:

- ***General obligation bonds***: secured by the full faith and credit of a local government, or
- ***Revenue bonds***: secured by a future revenue stream (e.g., a stormwater fee).

While local governments and utilities can raise funds in the private bond market, municipal bonds often provide capital at a lower interest rate.[141] An EPA study found that a typical interest rate on a municipal bond was 3-4 percent, compared to a private bond typical rate of 5-15 percent.[142]

Municipal bond issuance is regulated by state law, and state laws generally cap the total amount a jurisdiction may borrow through bonding. State law also controls a local government's authority to issue bonds at all, the type of projects that can be financed with bond issuance, the eligibility of bond proceeds to pay for operations and maintenance expenses, and other factors.[143] It is important that a jurisdiction considering bond financing look into its applicable state laws on all of these topics to ensure compliance.[144]

Green bonds are an emerging, promising mechanism by which local governments can fund climate resilience and other environmentally focused projects. Green bonds are not significantly different in structure than bonds used for other purposes, but are used to finance environmentally beneficial activities. Because green bonds must be used for environmentally beneficial projects, they may attract the interest of investors interested in environmental issues, as well as traditional investors. This increased interest may in the future reduce borrowing costs (compared to traditional bonds) for governments raising funds through bond issuance.[145]

Many investment institutions, including major private and public banks, have developed independent principles and guidelines governing green bonds.[146] Green infrastructure installations would qualify under most definitions and institutional guidelines for green bonds, due to the numerous environmental benefits of green infrastructure installations. Over the past several years, green bonds have been one of the fastest growing sectors of the bond market, with over $37 billion in green bonds sold globally in 2014.[147]

Tax Increment Financing

Tax Increment Financing (TIF) is a method of financing a project or development in a designated geographic area based on the anticipated increase in property tax that will be generated by the project. The revenue generated by a TIF is the property tax assessed on the increase in property value of a designated district following a development project, compared to the baseline property value prior to the development project. Tax increment financing originally developed as a means of financing the redevelopment of "blighted" areas, but is now used for a broad range of infrastructure improvements.[148] Chicago, Illinois, has established more than 120 TIF districts, and has leveraged its public investment to attract over $6 billion in private capital investment in TIF districts over two decades of development.[149] Revenue from Chicago's Central Loop TIF has been used to fund the city's Green Roof Improvement Fund, which incentivizes and provides partial reimbursement to commercial buildings that install green roofs to manage stormwater.[150]

Green infrastructure may be an important component of a TIF development because the installation of green infrastructure can increase property values. The property value increases are driven by the effectiveness of green infrastructure at mitigating persistent flooding, as well as co-benefits such as providing community amenities and improving aesthetics.[151] The city of Milwaukee performed a quantitative analysis of green infrastructure installations and found that such projects added significant value to neighboring property, as expected when the TIF district was created.[152]

Local governments can use tax increment financing for large capital projects (such as green infrastructure installation) or incremental, longer-term spending. A local government could issue municipal or private bonds to raise capital for a large-scale green infrastructure project, and use the TIF revenue to service bond payments. Alternatively, a local government could use TIF revenue incrementally—as the revenue is collected—to pay for smaller-scale green infrastructure projects[153] or, in many jurisdictions, to provide a sustainable revenue source to pay for operations and maintenance of green infrastructure installations.[154]

Tax increment financing may be a valuable option for a local government because the TIF model allows a development or infrastructure project to "self-finance"—the increase in assessed property value caused by the development is used to repay the cost of the property development. This process allows a local government to finance a capital project without raising property tax rates or exceeding its debt limit.

However, tax increment financing has several limitations that local governments must consider. A local government cannot implement a TIF unless the state has passed TIF-enabling legislation.[155] State-specific statutory and regulatory requirements regulate the type of projects permitted and administrative procedures required for tax increment financing, such as requirements to pass local ordinances.[156] For example, some states require a local government to make a finding of blight in a district before using a TIF as part of a redevelopment plan, which might limit the neighborhoods in which a local government could focus green infrastructure projects.[157] Additionally, TIFs have received significant criticism and opposition due to the potential of TIF financing to divert property tax revenue from other municipal needs, such as school funding.[158]

Related Resources

City of Berkeley, California 2016 Measure T1 - Bonds to Improve Existing City Infrastructure and Facilities

On November 8, 2016 Berkeley voters passed Measure T1 with an 86.5% approval. This measure authorizes the City to sell $100 million of General Obligation Bonds (GO Bonds) to repair, renovate, replace, or reconstruct the City's aging infrastructure and facilities, such as sidewalks and streets, senior and recreation centers, and other important City facilities and buildings. The first round of funding includes the use of green infrastructure for storm drains and parks, and is focused on advancing social equity across projects. City staff prioritized potential T1 projects using Berkeley's Resilience Strategy criteria, which focus on addressing safety, financial, social, and environmental criteria to provide multiple benefits from infrastructure investments.

View Resource at https://www.adaptationclearinghouse.org/resources/city-of-berkeley-california-2016-measure-t1-bonds-to-improve-existing-city-infrastructure-and-facilities.html

EPA Financing Green Infrastructure: A Best Practices Guide for the Clean Water State Revolving Fund

In 2015 the U.S. Environmental Protection agency published a best practices guide for funding green infrastructure projects through states' Clean Water State Revolving Fund (CWSRF) programs. The Best Practices Guide highlights successful case studies from several states, and provides examples of ways in which state CWSRF programs can prioritize green infrastructure projects for program funding. The EPA suggests that states can increase CWSRF support for green infrastructure by implementing priority point systems, program set-asides, and marketing strategies for state programs.

View Resource at https://www.adaptationclearinghouse.org/resources/epa-financing-green-infrastructure-a-best-practices-guide-for-the-clean-water-state-revolving-fund.html

Massachusetts Green Bonds

In 2014, the state of Massachusetts issued $350 million in green bonds to fund water infrastructure projects, including stream bed restoration and open-space protection. Bond funds also covered the planting of new trees in the City of Worcester and surrounding areas, including several urban "orchards." These orchards are small plots within the city designed to accommodate fruit bearing trees, to help with access to healthy foods in these neighborhoods. Bond funding supported the Worcester Tree Initiative, which also engages and trains residents in care for the trees and the benefits of urban forestry.

View Resource at https://www.adaptationclearinghouse.org/resources/massachusetts-green-bonds.html

City of Chicago Tax Increment Financing and Green Roof Improvement Fund

The City of Chicago, Illinois, has successfully used tax increment financing (TIF) to fund public infrastructure and development projects. The city has established more than 120 TIF districts, and has leveraged its public investment to attract over $6 billion in private capital investment in TIF districts over two decades of development. Revenue from Chicago's Central Loop TIF has been used to fund the city's Green Roof Improvement Fund, which provides partial reimbursement to commercial buildings that install green roofs to manage stormwater.[159] Several complete street green infrastructure projects in Chicago have been partially funded by the use of tax increment financing, including the Cermak/Blue Island Sustainable Streetscape project.

View Resource at https://www.adaptationclearinghouse.org/resources/city-of-chicago-tax-increment-financing-and-green-roof-improvement-fund.html

Funding Green Infrastructure in Pennsylvania: Funding the Future of Stormwater Management

American Rivers' **Funding Green Infrastructure in Pennsylvania** report provides an overview of financing and funding strategies currently being employed to fund green infrastructure projects in Pennsylvania, including the Clean Water State Revolving Fund (CWSRF). In Pennsylvania, the CWSRF is administered by PENNVEST, an independent state agency that awards funds allocated to the state. PENNVEST funds all stages of a project: development, construction, and rehabilitation. In 2009, PENNVEST awarded the city of Philadelphia a low-interest loan of $30 million for green infrastructure projects, including street tree planting and permeable pavement installation.

View Resource at https://www.adaptationclearinghouse.org/resources/funding-green-infrastructure-in-pennsylvania-funding-the-future-of-stormwater-management.html

Private Financing

Overview

Communities may also explore innovative strategies to leverage limited municipal funds to attract private capital. One approach that is common to infrastructure projects but has been limited in green infrastructure stormwater management is the use of public-private partnerships. Even more innovative strategies to engage private sector capital include pay-for-performance funding mechanisms such as social impact bonds.

Public-Private Partnerships

A public-private partnership (P3) is a collaboration between a government and one or more private sector partners. Under a P3, the private sector partner contracts to fulfill one or more traditional government functions, including financing, delivery, operations, and/or maintenance of public infrastructure.

A P3 may allow a local government to make significant upfront capital investments without straining its municipal debt limit, by leveraging limited public funds to attract private capital.[160] Commonly cited benefits of P3s include more cost effective and faster program implementation, due to potential economies of scale and technical expertise that a private-sector partner can provide.

However, local governments exploring a P3 must examine several significant legal and policy considerations. A local government must first determine whether its state has passed enabling legislation for P3s, as well as any restrictions in the enabling legislation on the categories or structures of P3s.[161] Additionally, there can be some degree of public opposition to private-sector management of traditional public functions such as operations and maintenance post-installation.[162] Prior to establishing a P3, local governments should conduct meaningful stakeholder and community outreach to ensure that the goals of the P3 and terms of the contract agreement align with community interests and achieve community objectives.

For example, local governments can structure a P3 to achieve those community objectives such as community development and local jobs growth by adding local workforce training and hiring requirements into the P3 contract agreement. Prince George's County, Maryland, has entered into a P3 to address its stormwater management problems through a comprehensive, county-wide green infrastructure program. Corvias Solutions, the private sector partner, assumes responsibility for design, construction, operations, and ongoing maintenance. As part of the P3 agreement, Corvias will

use small and minority businesses in Prince George's County for at least 30 to 40 percent of the total project. To verify the effectiveness of the P3, Prince George's County is independently conducting its own green infrastructure program using conventional public processes during the first three years of the contract. After three years, the county will evaluate the effectiveness of the P3 and determine whether or not to extend the agreement with Corvias.[163]

Related Resources

DC Water Environmental Impact Bond

DC Water and Sewer Authority (DC Water), the water utility in Washington, D.C., has announced the nation's first Environmental Impact Bond (EIB), an innovative bond to fund the construction of green infrastructure to manage stormwater runoff and improve the District's water quality. The $25 million, tax-exempt EIB was sold in a private placement to the Goldman Sachs Urban Investment Group and Calvert Foundation to fund the initial green infrastructure project in its DC Clean Rivers Project, a $2.6 billion program to control stormwater runoff that pollutes the Anacostia River, Potomac River and Rock Creek. The linked case study from the US Environmental Protection Agency's Water Infrastructure and Resiliency Finance Center provides an overview of how the transaction was structured.

View Resource at https://www.adaptationclearinghouse.org/resources/dc-water-environmental-impact-bond.html

Public-Private Partnership (P3) Model State Legislation

The **Bipartisan Policy Center** prepared model legislation to help states pass legislation authorizing the use of public-private partnerships (P3). Before a local government can use a P3 to implement green infrastructure projects, it must determine whether its state has passed enabling legislation for P3s, as well as whether the enabling legislation is broad enough to allow for green infrastructure or stormwater management P3s. As of December 2015, 33 states have passed some form of P3 enabling legislation. Many states' enabling laws contain specific limitations on the types of P3s, the length of P3 agreements, and the process for negotiating P3s.

View Resource at https://www.adaptationclearinghouse.org/resources/public-private-partnership-p3-model-state-legislation.html

Community Based Public-Private Partnerships (CBP3s) and Alternative Market-Based Tools for Integrated Green Stormwater Infrastructure

This report is a comprehensive guide for local governments developed by U.S. EPA Region 3. The *Community Based Public-Private Partnerships* provides background on Public-Private Partnerships (P3s) and a detailed case study of the Prince George's County green infrastructure P3. The guide provides more general information about the cost and cost-effectiveness of green infrastructure techniques for stormwater management and includes an overview of traditional and innovative strategies for communities funding green infrastructure programs.

View Resource at https://www.adaptationclearinghouse.org/resources/community-based-public-private-partnerships-cbp3s-and-alternative-market-based-tools-for-integrated-green-stormwater-infrastructure.html

Prince George's County Clean Water Partnership FAQs

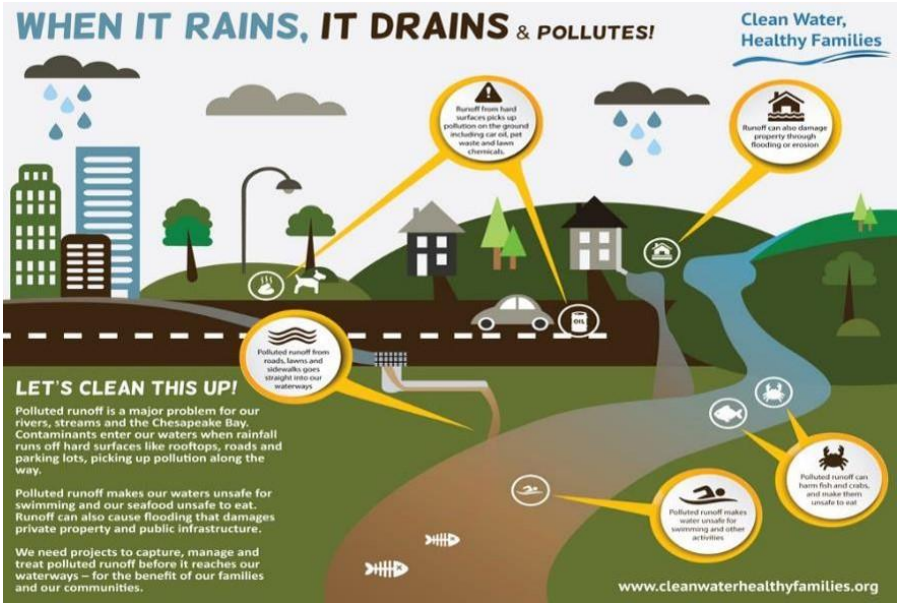
The Clean Water Partnership Frequently Asked Questions document provides an overview of the green infrastructure P3 agreement between Prince George's County, Maryland, and Corvias Solutions, the private-sector partner. The document includes an overview of the project goals and schedule, and explains the role of the private and public-sector parties.

View Resource at https://www.adaptationclearinghouse.org/resources/prince-george-eys-county-clean-water-partnership-faqs.html

Communication Strategies for Green Infrastructure

Communication and Engagement

Communications strategies focusing on both the public and on other government partners are vital to implementing successful green infrastructure programs. Increased public awareness and satisfaction with green infrastructure projects can lead to increased support for further projects as well as potential opportunities for private property owners to install their own green infrastructure practices, such as rain gardens. Collaborating with partner agencies can increase the potential buy-in for green infrastructure practices throughout the local government, as well as to increase the potential funding streams and manpower for ongoing operations and maintenance. As the benefits of green infrastructure are available more quickly than the benefits for gray, effective communication strategies can relay that information to the public to build support. Several strategies exist to communicate the benefits of green infrastructure:



Source: Clean Waters, Healthy Families Coalition, www.cleanwaterhealthyfamilies.org

Presentations and Workshops: Holding presentations and workshops enables staff to meet individual members of the community and better understand and meet community needs. For example, **New York City's Department of Environmental Protection** makes presentations to community boards and other civic and environmental organizations, in addition to elected officials and their staffs, about the city's Green Infrastructure Program. Likewise, as part of its **10,000 Rain Gardens Program**, Kansas City sponsored "how-to workshops" for private landscaping businesses and municipal employees that explained the initiative, rain gardens, and water quality concerns. These workshops not only raised awareness but trained contractors and city employees in installation and maintenance techniques.

Media Campaigns: Kansas City engaged in an **extensive media campaign** involving interviews on television and the radio, as well as advertisements and articles in local newspapers. These media campaigns reached an estimated three million people in 2007. In 2013, New York City's Department of Environmental Protection created an **educational video** on the Green Infrastructure Program, which described some of the environmental challenges caused by combined sewer overflows as well as some green infrastructure solutions such as green roofs, rain gardens, and permeable pavers.

Websites: In 2013, New York City's Department of Environmental Protection launched a **new website** that provides information on the City's Green Infrastructure Program, including the most common types of green infrastructure practices as well as a map of priority areas. Community members can use the site to see if their neighborhood will receive green infrastructure installations and to better understand the practices. Kansas City's **10,000 Rain Gardens initiative** created a website offering residents and other audiences a clearinghouse of information pertaining to the program and to stormwater management more generally, and was receiving over 100,000 visits per year even after the main media campaign had ended.

Written Materials: Written materials such as brochures and surveys can be effective means of engaging the public and partner agencies about stormwater management practices and the municipality's use of green infrastructure. For example, New York City's Department of Environmental Protection developed a **brochure** that explains the siting and construction process for projects in the right-of-way, answers frequently asked questions, and describes the co-benefits of green infrastructure. Similarly, **Seattle Public Utilities** (SPU) used parking surveys to better understand and meet the needs of the community for its Street Edge Alternatives Program. The surveys revealed community concerns about reductions in parking due to reductions in street width caused by the installation of green infrastructure projects. SPU responded to this concern by installing occasional angled parking clustered along the street.

***Inter-Agency Partnerships*:** Creating partnerships between agencies can help to implement green infrastructure practices both efficiently and effectively. By pooling the resources, expertise, and knowledge of different agencies, inter-agency partnerships can be crucial to successful pilot programs. These partnerships can exist to aid in any stage of the process, including planning, installation, maintenance, and monitoring. For example, in New York City, the **Departments of Environmental Protection and Parks and Recreation** have worked together to develop the Green Infrastructure Maintenance Program in order to allocate appropriate resources for the long-term maintenance of DEP's green infrastructure projects.

Equity and Environmental Justice

Many local governments are incorporating principles of equity, environmental justice, and social vulnerability into their climate adaptation planning. This section highlights some tools for addressing social vulnerability, engaging overburdened communities, and incorporating equity principles into planning and implementation, with a focus on green infrastructure.

Image Credit: Jessica Grannis, Georgetown Climate Center. Green infrastructure in Washington D.C.'s Ward 7, one of the areas of the city facing disproportionate risks from climate impacts relative to other parts of the District due to physical and socioeconomic factors.

Tools

Equitable Planning

This section highlights city and regional plans that center equity and green infrastructure and community-driven plans with a focus on green infrastructure. It also includes tools that planners can use to help them consider socioeconomic and other risk factors in green infrastructure planning.

Learn more at https://www.georgetownclimate.org/adaptation/toolkits/green-infrastructure-toolkit/equitable-planning.html

Equitable Investment

This section highlights how policymakers can design green infrastructure programs to prioritize environmental justice communities facing disproportionate climate-risk and pollution burden and resources that can be used to help fund projects in disadvantaged communities.

Learn more at https://www.georgetownclimate.org/adaptation/toolkits/green-infrastructure-toolkit/equitable-investment.html

Equitable Planning

Planning is one way to ensure that equity is centered in how cities are deploying green infrastructure solutions. This section includes examples of city, county, regional, and community-driven plans that address equity in making decisions about green infrastructure solutions to climate threats. Truly equitable approaches will be developed through diverse and inclusive planning processes; this section also highlights how planners are engaging with communities in the design and development of plans. Community-driven plans can ensure that residents have power in determining how green infrastructure solutions are deployed in their neighborhoods. This section also includes tools to help planners consider socioeconomic and other risk factors when developing plans and identifying potential neighborhoods for green infrastructure investments.

Related Resources

Planning for Equity in Parks with Green Infrastructure

From the Natural Recreation and Park Association, this report summarizes research on the social and health outcomes related to the implementation of green infrastructure and parks in traditionally underserved communities. Findings suggest that while green infrastructure and green space can buffer climate impacts, they also enhance social equity by building social capital, improving health outcomes, and increasing economic opportunities. This resource can help users communicate the benefits of making investments in green infrastructure in underserved communities and ways that green infrastructure projects can be designed and implemented to maximize the socioeconomic benefits of projects (e.g., by incorporating a training and local hiring component)

View Resource at https://www.adaptationclearinghouse.org/resources/planning-for-equity-in-parks-with-green-infrastructure.html

NYC Climate Justice Agenda 2016: Strengthening the Mayor's OneNYC Plan

This NYC Environmental Justice Alliance (NYC-EJA) report is an example of how community-based organizations can hold cities accountable and ensure that city plans are facilitating equitable outcomes. This report analyzed Mayor Bill de Blasio's 2015 OneNYC Plan and provided recommendations about how the city can strengthen its initiatives to address equity and climate justice, including through investments in green infrastructure. The report encourages the city to prioritize communities facing disproportionate risks from climate change, provide greater funding for green initiatives, and develop partnerships with local grassroots groups to support local initiatives and promote genuine community engagement. Specifically, the report calls on the city to reassess and prioritize green infrastructure investments to build new parks and community gardens to create open spaces in low-income communities, and funding for coastal resiliency projects (i.e., living shorelines and other natural barriers to storm surge) in low-income communities and communities of color.

View Resource at https://www.adaptationclearinghouse.org/resources/nyc-climate-justice-agenda-2016-strengthening-the-mayor-s-onenyc-plan.html

Equity Foundations: USDN Capacity Building Program

This resource provides general professional development training for city sustainability directors and their staff on how to integrate racial equity in sustainable development and planning. Although this resource is not specific to green infrastructure, it can city staff address equity considerations in the planning and design of a range of sustainability projects and programs, including green infrastructure investments. The program is available online and includes a curriculum of five webinars, videos and worksheets. The program was developed by the Urban Sustainability Director's Network in partnership with the Government Alliance on Race and Equity and the Center for Social Inclusion.

View Resource at https://www.adaptationclearinghouse.org/resources/equity-foundations-usdn-capacity-building-program.html

South Ironbound Resiliency Action Plan (Newark, New Jersey)

This plan, developed by the Ironbound Community Corporation, presents an example of how community-based organizations can lead community-driven planning initiatives and develop recommendations to inform city decisionmaking on green infrastructure and resilience. In 2015, the Ironbound Community Corporation developed this Resiliency Action Plan to build climate resiliency in the South Ironbound neighborhood and to inform policymaking in the city of Newark, New Jersey. The South Ironbound neighborhood is particularly susceptible to flooding and extreme weather impacts due to storm surge and sewer back-ups. The plan includes a green infrastructure component to address anticipated heavy rain events and combined sewer overflow events. It recommends the development of a Green Infrastructure Strategic Plan, implementation of specific demonstration green infrastructure projects; public workshops to educate business owners and residents about the benefits of green infrastructure; training for residents in the installation of green infrastructure to create job opportunities; among other recommendations. The plan also recommends that a Greening Vacant Lots Program be created to facilitate adaptive reuse of brownfield, vacant, and underutilized sites for purposes of green infrastructure and other climate resiliency uses. Detailed action plans provide a schedule for implementation, responsible parties, potential partners, and potential sources of funding and financing.

View Resource at https://www.adaptationclearinghouse.org/resources/south-ironbound-resiliency-action-plan-newark-new-jersey.html

Resilient New Orleans: Strategic Action to Shape Our Future City

The Resilient New Orleans plan, adopted in 2015, presents an example of how cities can use planning to address equity and water resilience. More than a decade after Hurricane Katrina, New Orleans still faces combined threats from severe storms, sea-level rise, subsidence, aging infrastructure and economic inequality. The report is framed with equity at the forefront, acknowledging the disparate impacts of flooding and extreme weather on communities of color. The plan presents the city's vision for enhancing resilience to climate impacts and other stressors and includes a detailed focus on green infrastructure and other nature-based approaches to enhancing resilience. The plan recommends that the city utilize local vegetation to promote more effective soil drainage, transition vacant lots into rain gardens to collect and detain water from heavy rainfall events, incorporate green infrastructure in city redevelopment projects, create training for jobs in green infrastructure installation, and support workshops and trainings to facilitate small-scale green infrastructure projects on homes and businesses.

View Resource at https://www.adaptationclearinghouse.org/resources/resilient-new-orleans-strategic-action-to-shape-our-future-city.html

EJSCREEN: EPA Environmental Justice Screening and Mapping Tool

The Environmental Justice Screening and Mapping tool (EJ SCREEN), developed by the U.S. Environmental Protection Agency (EPA) can help users target investments in green infrastructure to communities based upon environmental and demographic indicators. The tool combines environmental and demographic data to provide maps that highlight specific environmental issues and especially susceptible areas. Environmental indicators include air quality, traffic proximity and volume, wastewater discharges, and proximity to hazardous waste facilities. Demographic data helps users map census tracts based upon income, education, race, linguistic isolation, and age (under 5 or older than 64). The tool provides a low-cost, accessible way to help users develop green infrastructure approaches that can benefit communities facing environmental and socioeconomic challenges.

View Resource at https://www.adaptationclearinghouse.org/resources/ejscreen-epa-environmental-justice-screening-and-mapping-tool.html

City of Portland and Multnomah County, Oregon Climate Action Plan 2015

This City of Portland and Multnomah County Climate Action Plan, released in 2014, shows how local government plans can address emissions reductions and climate adaptation while centering social equity, and the plan includes specific recommendations about directing investments in green infrastructure to frontline communities. The plan discusses climate threats to the region including increasing temperatures and high-heat days, recurring droughts, and increasing intense rainfall events. It recommends the use of green infrastructure and a substantial increase in the city's urban forest canopy cover, to reduce the urban heat island effect, and improve water and air quality. For example, the plan calls for an increase in forest canopy cover throughout the city (at least to 25% in residential areas and 15% of the central city) to provide shade and sequester carbon, while creating root systems that will prevent erosion and landslides during heavy rainfall events. Specifically, the plan acknowledges the need to deploy green infrastructure in underserved communities where disparities in access to green space and age, asthma, and income levels leave populations particularly susceptible to the impacts of heat and pollution. The city advocates for equitable implementation, prioritizing populations with the greatest need. The plan specifically highlights the diverse community of East Portland as an area where investments are needed, where transportation concerns are greatest, and lower-income residents are increasingly concentrated due to rising housing costs in the city. The city convened an Equity Working Group with representatives from community-based organizations serving low-income communities and communities of color to inform the development of the plan.

View Resource at https://www.adaptationclearinghouse.org/resources/city-of-portland-and-multnomah-county-oregon-climate-action-plan-2015.html

One New York: The Plan for a Strong and Just City (One NYC)

The 2015 OneNYC plan for New York City lays out strategies for dealing with income inequality along with plans for managing climate change impacts, while establishing the platform for another century of economic growth and vitality. The plan includes recommendations for using green infrastructure as a strategy for addressing increasing risks of flooding and urban heat. The plan recommends that the city provide job training and increase the number of government jobs to install and maintain green infrastructure projects; that green infrastructure be deployed in environmental justice communities to address flooding and water quality, with a focus on communities prone to flooding and drainage problems (such as Southeast Queens); and that the city invest in parks and green space in underserved communities and integrate enhancements that improve stormwater management, reduce pollution, and enhance flood resiliency.

View Resource at https://www.adaptationclearinghouse.org/resources/one-new-york-the-plan-for-a-strong-and-just-city-one-nyc.html

Memphis, Tennessee Mid-South Regional GreenPrint

The Mid-South Regional Greenprint plan, released in 2015, is an example of a plan that utilizes open spaces and green infrastructure as the foundation for improving social equity, transportation, and public health across a large metropolitan region. The 25-year plan seeks to connect the four counties within the region using a "Greenprint Network" of trails, greenways, parks and other natural spaces to mitigate flooding and promote community growth, among other benefits. The plan includes a Greenprint map of proposed "connected green infrastructure projects" that were strategically selected by considering the region's population densities, transportation networks, social and economic disparities, and employment levels. The plan articulates a goal of creating 448 miles of new greenway trails and providing safe, environmentally-friendly transportation options and a network of greenspace for all citizens, with a focus on underserved and disadvantaged communities. The plan centers equity-driven throughout addressing socioeconomic disparities, public safety, and job creation. Equitable participation in the process and community ownership throughout implementation were also a focus of the planning process. The plan was developed by a consortium of municipalities, nonprofits, businesses, and residents representing the geographic and racial diversity of the area.

View Resource at https://www.adaptationclearinghouse.org/resources/memphis-tennessee-mid-south-regional-greenprint.html

NAACP Equity in Building Resilience in Adaptation Planning

From the National Association for the Advancement of Colored People (NAACP), this report contains a list of indicators as measures of vulnerability and resilience to help policymakers design and assess the equity and effectiveness of adaptation measures. Indicators include measures of pre-existing vulnerability and risk factors (e.g., age, race, health, income) and process and outcome indicators for demonstrating successful adaptation. The aim of this resource is for city planners, community organizations, elected officials, and other decision-makers to consider these equity based indicators as they design climate adaptation plans, programs, and policies. Although not specific to green infrastructure, these indicators could be used by policymakers as a starting point for considering equity in the development, design and evaluation of plans and programs focused on green infrastructure.

View Resource at https://www.adaptationclearinghouse.org/resources/naacp-equity-in-building-resilience-in-adaptation-planning.html

Equitable Investment

In determining how to deploy green infrastructure projects, policymakers can use socioeconomic indicators to prioritize green infrastructure investments in communities facing disproportionate risk and in environmental justice communities facing disproportionate burden from pollution. This section includes examples of how cities are using socioeconomic criteria and other factors to direct green infrastructure investments to underserved communities.

Related Resources

City of Berkeley, California 2016 Measure T1 - Bonds to Improve Existing City Infrastructure and Facilities

Voter passed **Measure TI** authorized the City of Berkeley to sell $100 million of General Obligation Bonds to improve the City's aging infrastructure and $1 million in funding was dedicated to development of green infrastructure criteria. To select projects for funding, City Staff applied criteria including considerations of how the project meets community needs (benefits to the greatest number of residents and address demographic changes), advances equity (considers geographic and economic equity), advances sustainability, and improves preparedness. Funding has been used to incorporate green infrastructure in parks in lower-income neighborhoods and to add green infrastructure improvements to bus stops.

View Resource at https://www.adaptationclearinghouse.org/resources/city-of-berkeley-california-2016-measure-t1-bonds-to-improve-existing-city-infrastructure-and-facilities.html

RainReady’s Residential Flood Assistance Program Case Study - Chicago, Illinois

Chicago's RainReady Residential Flood Assistance Program (FRAP) presents a model for how city's can partner with nonprofit agencies to provide technical assistance and funding to homeowners to help them implement green infrastructure solutions to reduce flood risks to private homes. In 2015-2016, the Chicago Department of Planning and Development partnered with the e Center for Neighborhood Technology’s (CNET), which provided a one-stop-shop to homeowners offering free flood mitigation assistance, including assistance verifying program eligibility, conducting home assessments, developing construction scopes of work, supporting contractor selection, and administering grant funding to pay for mitigation measures. The provided up to $50,000 in **Community Development Block Grant-Disaster Recovery** funding to pay for a range of flood mitigation measures and repairs, including green infrastructure improvements. The homes were located throughout the city, but predominantly in neighborhoods where more than 30% of households have income below the federal poverty line.

View Resource at https://www.adaptationclearinghouse.org/resources/rainready-eys-residential-flood-assistance-program-case-study-chicago-illinois.html

Baltimore, Maryland Growing Green Initiative

Baltimore’s **Growing Green Initiative (GGI)** is an example of a city grant program designed to facilitate reuse of vacant lands for urban greening projects, such as green stormwater infrastructure, urban gardens, tree planting, and community gathering spaces (e.g., pocket parks). Introduced in 2014, the initiative was created to help the city address the 14,000 vacant lots and 16,000 abandoned houses that were identified by the city in 2013. To support the initiative, the city developed a “**Green Pattern Book**” to help community groups, nonprofit organizations, and others develop plans for reutilizing vacant lands to enhance green space, strengthen neighborhoods, and improve health and environmental quality in Baltimore neighborhoods. The Green Pattern Book provides a useful guide for helping project proponents identify vacant land types and potential green uses including parks, urban forests, urban agriculture, and green stormwater management. GGI projects help the city reduce concerns raised by vacant lots and buildings (public health threats, increased crime, public safety concerns, etc.) and can also deliver broader resilience benefits in underserved communities by creating new jobs, increasing access to parks and community gardens, and improving water and air quality. Grants were awarded in 2015 and 2016 to facilitate implementation of GGI projects.

View Resource at https://www.adaptationclearinghouse.org/resources/baltimore-maryland-growing-green-initiative.html

EPA Urban Waters Small Grants

EPA's Urban Waters Small Grant Program is a potential source of funding for green infrastructure and other resilience projects that highlight equity and environmental justice. The program offers small grants (up to $60,000) for water projects that encourage the growth of local business, promote public education, or otherwise create recreational, social, and employment opportunities in local communities. For example, the Ciudad Soil and Water Conservation District (Albuquerque, New Mexico), in its efforts to improve the water quality of the Rio Grande watershed areas, received a grant to educate middle school students about water protection and stormwater runoff. Grants are competed and awarded every two years and are accessible to a wide range of entities, including state and local governments, Native American tribes, universities and colleges, nonprofits, and interstate agencies.

View Resource at https://www.adaptationclearinghouse.org/resources/epa-urban-waters-small-grants.html

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101. U.S. EPA, Nonpoint Source Program and Grants Guidelines for States and Territories, 25 (2013), http://www.epa.gov/sites/production/files/2015-09/documents/319-guidelines-fy14.pdf.

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112. https://www.swbno.org/work_greeninfrastructure_federalfunding.asp

113. http://portal.hud.gov/hudportal/documents/huddoc?id=Pittsburghcasestudy.pdf

114. http://www.detroitmi.gov/News/ArticleID/419/Preparing-For-the-Next-Storm

115. http://maps.semcog.org/tap/

116. http://www.fema.gov/media-library-data/1464899521902-b2d31bbf89cc089c3cd43851a33d4aee/PolicyClarification_BCA(Drought-EcosystemServices-Wildfire)_508.pdf

117. American Rivers, "Funding Green Infrastructure in Pennsylvania" at 21.

118. American Planning Association, Community-Based Conservation in Tucson's Rincon Heights Neighborhood, http://www.azplanning.org/newsltr/visiondecember2009/visiondecember2009.pdf.

119. EPA "Green Infrastructure Opportunities that Arise During Municipal Operations" (January 2015)

120. Mid-South Regional Greenprint, available at http://midsouthgreenprint.org/greenprint-20152040/

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123. California State Water Resources Control Board, Green Infrastructure for Los Angeles, available at http://www.swrcb.ca.gov/water_issues/programs/climate/docs/resources/la_green_infrastructure.pdf

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125. See American Rivers, "Staying Green: Strategies to Improve Operations and Maintenance of Green Infrastructure in the Chesapeake Bay Watershed" at 17, available at http://americanrivers.org/wp-content/uploads/2016/05/staying-green-strategies-improve-operations-and-maintenance.pdf.

126. The multi-phase project is primarily funded by a district-wide ad valorem tax. The Ramsey-Washington Metro Watershed District received approximately 3 percent of the total property tax assessed to each parcel. See U.S. EPA, Getting to Green: Paying for Green Infrastructure Financing Options and Resources for Local Decision-Makers (2014) at 8.

127. The project received additional support from Minnesota's Clean Water Fund. The Clean Water Fund receives 33 percent of revenues from a three-eighths of one percent state property tax increase passed in 2008.[6] http://www.rwmwd.org/index.asp?Type=B_BASIC&SEC=%7BDB475310-069F-4230-9E97-01E92FD50527%7D

128. City of Portland, Oregon, % for Green, available at https://www.portlandoregon.gov/bes/article/341452

129. EPA "Green Infrastructure Opportunities that Arise During Municipal Operations" (January 2015) at 9.

130. US EPA, "Getting to Green: Paying for Green Infrastructure" at 8-9.

131. In a 2013 study, Western Kentucky University identified 71 legal challenges to stormwater utilities. National Association of Clean Water Administrators, Navigating Litigation Floodwaters: Legal Considerations for Funding Municipal Stormwater Programs (2014) at 3.

132. National Association of Clean Water Administrators, Navigating Litigation Floodwaters: Legal Considerations for Funding Municipal Stormwater Programs (2014) at 5-6.

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134. Water Environment Research Foundation, Orlando, Florida: Using Retrofits and Redevelopment to Turn Back the Clock on Stormwater Impacts, http://www.werf.org/liveablecommunities/studies_orlando_fl.htm

135. U.S. EPA, CWSRF 101: An Introduction to EPA's Clean Water State Revolving Fund (2015).

136. U.S. EPA, Learn about the Clean Water State Revolving Fund, http://www.epa.gov/cwsrf/learn-about-clean-water-state-revolving-fund-cwsrf#how

137. U.S. EPA Office of Water, Green Infrastructure Approaches to Managing Wet Weather with Clean Water State Revolving Funds, 3 (2008), http://www.epa.gov/green-infrastructure/green-infrastructure-approaches-managing-wet-weather-clean-water-state

138. The four Green Project Reserve priority categories are 1) water efficiency improvements, 2) energy efficiency improvements, 3) green infrastructure, and 4) environmentally innovative activities. U.S. EPA, Green Project Reserve Guidance for the Clean Water State Revolving Fund (CWSRF), http://www.epa.gov/cwsrf/green-project-reserve-guidance-clean-water-state-revolving-fund-cwsrf

139. Generally, investors purchase bonds (providing the bond issuer with capital) in exchange for regular interest payments to the investors by the issuer and the return of principal. The maturity date of a bond is the date on which the issuer repays the principal.

140. U.S. Securities and Exchange Commission, Fast Answers: Municipal Bonds, available at http://www.sec.gov/answers/bondmun.htm.

141. Municipal bond offerings can be issued at lower interest rates because municipal bonds are tax exempt – interest income from bonds is generally exempt from federal income tax (and potentially from state and local tax). Id.

142. EPA Region III at 43, available at https://www.epa.gov/sites/production/files/2014-10/documents/green-infrastructure.pdf.

143. City of Los Angeles, Green Infrastructure for Los Angeles: Addressing Urban Runoff and Water Supply Through Low Impact Development (2009) at 60-61.

144. In New York, for example, municipal securities are regulated by both Article VIII of the state constitution[12] and by the New York Local Finance Law. See NYS Department of State, "Local Government Handbook" at 108.

145. Moody's Investor Service, Green Bonds Start to Bloom, 5 (May 27, 2015).

146. See, e.g., Climate Bonds Green Bond Principles (2014) http://www.climatebonds.net/files/uploads/2014/01/Green-Bond-Principles-FINAL.pdf; World Bank Green Bond Program http://treasury.worldbank.org/cmd/htm/WorldBankGreenBonds.html

147. Moody's Investors Service, "Green Bonds Start to Bloom" (May 27, 2015)

148. Smart Growth of America, U.S. PIRG Education Fund, "Tax-Increment Financing: The Need for Increased Transparency and Accountability in Local Economic Development Subsidies" (2011).

149. Pennsylvania Environmental Council, "Implementing Green Infrastructure: Developing a Winning Strategy to Fund Philadelphia's Ambitious Visions" (2009) at 19.

150. See also Sustainable Chicago, "Green Building and Climate in Chicago," http://www.sustainable-chicago.com/2008/04/23/green-building-and-climate-in-chicago/

151. Pennsylvania Environmental Council, "Implementing Green Infrastructure: Developing a Winning Strategy to Fund Philadelphia's Ambitious Visions" (2009) at 15.

152. Madison, Catherine and John Kovari, "Impact of Green Infrastructure on Property Values within the Milwaukee Metropolitan Sewerage District Planning Area: Case Studies," The University of Wisconsin-Milwaukee Center for Economic Development (May 2013), available at https://www4.uwm.edu/ced/publications/MMSD_GreenInfrastructure_Final.pdf.

153. Johnson, Craig L., Indiana University School of Public and Environmental Affairs, prepared for National Association of Realtors, "Tax Increment Financing" (2002).

154. See, e.g. City of Austin, Tax Increment Financing (TIFs) presentation (June 25,2013) http://www.austintexas.gov/edims/document.cfm?id=191785 ; Camoin Associates, Connecticut Overhauls Tax-Increment-Financing (TIF): New Legislation Opens the Door to More TIF Projects" (October 1, 2015) http://www.camoinassociates.com/connecticut-overhauls-tax-increment-financing-tif-new-legislation-opens-door-more-tif-projects

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156. For example, the New Jersey TIF enabling statute, the Revenue Allocation District Financing Act, requires local governments who seek to finance a project with a TIF to pass an ordinance designating the proposed TIF district as a Revenue Allocation District. N.J. STAT. ANN. § 52:27D-459 et seq. The New Jersey Act also requires approval of TIF planning documents by the state Department of Community Affairs, only authorizes TIFs for specific purposes, and includes requirements on the geographic boundaries of a TIF district and the effect of related borrowing on the credit of a municipality.

157. See, e.g., New York General Municipal Article 18-C - (970-A).

158. Chicago Policy Review, To Divert or Not to Divert: The Impact of TIFs on Chicago Public Schools, March 29, 2012, available at http://chicagopolicyreview.org/2012/03/29/to-divert-or-not-to-divert-the-impact-of-tifs-on-chicago-public-schools/.

159. For a discussion of Chicago's Green Roof Improvement Fund see http://www.sustainable-chicago.com/2008/04/23/green-building-and-climate-in-chicago/

160. EPA Region III at 12, available at https://www.epa.gov/sites/production/files/2014-10/documents/green-infrastructure.pdf.

161. Bipartisan Policy Center, Public-Private Partnership (P3) Model State Legislation (2015). http://bipartisanpolicy.org/wp-content/uploads/2015/12/BPC-P3-Enabling-Model-Legislation.pdf

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