



MANAGING
WET WEATHER WITH
GREEN INFRASTRUCTURE
ACTION STRATEGY
2008

This Green Infrastructure Action Strategy is the product of collaboration among many agencies, organizations and individuals. The following organizations are primarily responsible for coordinating the development of this first iteration of the action strategy:

American Rivers
Association of State and Interstate Water Pollution Control Administrators
National Association of Clean Water Agencies
Natural Resources Defense Council
The Low Impact Development Center
U.S. Environmental Protection Agency

For more information on green infrastructure planning and implementation, and partnerships, visit the green infrastructure website at:

www.epa.gov/npdes/greeninfrastructure



January 2008



Front Cover Photos
Top: rain garden; permeable pavers; rain barrel; planter; tree boxes.
Remainder: Green Street in Portland; Mt. Tabor rain garden in Portland; Chicago City Hall green roof; planter inlet in Portland.





Managing Wet Weather with Green Infrastructure Action Strategy 2008

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Introduction

Background

Many communities, ranging from highly developed cities to newly developing towns, are looking for ways to assure that the quality of their rivers, streams, lakes, and estuaries is protected from the impacts of development and urbanization. Traditional development practices cover large areas of the ground with impervious surfaces such as roads, driveways, and buildings. Once such development occurs, rainwater cannot infiltrate into the ground, but rather runs offsite at levels that are much higher than would naturally occur. The collective force of such rainwater scours streams, erodes stream banks, and thereby causes large quantities of sediment and other entrained pollutants to enter the water body each time it rains.

In addition to the problems caused by stormwater and nonpoint source runoff, many older cities (including many of the largest cities in the United States), have combined sewage and stormwater pipes which periodically and in some cases frequently overflow due to precipitation events. In the late 20th century, most cities that attempted to reduce sewer overflows did so by separating combined sewers, expanding treatment capacity or storage within the sewer system, or by replacing broken or decaying pipes. However, these practices can be enormously expensive and take decades to implement. Moreover, piped stormwater and combined sewer overflows (“CSOs”) may also, in some cases, have the adverse effects of upsetting the hydrological balance by moving water out of the watershed, thus bypassing local streams and ground water. Many of these events also have adverse impacts and costs on source water for municipal drinking water utilities.

A set of techniques, technologies, approaches and practices—collectively referred to as “green infrastructure”—can be used to eliminate or reduce the amount of water and pollutants that run off a site and ultimately are discharged into adjacent water bodies. As cities move towards sustainable infrastructure, green infrastructure can be a valuable approach.

“Green infrastructure” is a relatively new and flexible term, and it has been used differently in different contexts. Thus, to date, there is no universally established definition of the term. For example, Benedict and McMahon, in their book *Green Infrastructure* (Island Press, 2006), have defined it broadly as “an interconnected network of natural areas and other open spaces that conserves natural ecosystem values and functions, sustains clean air and water, and provides a wide array of benefits to people and wildlife.” However, for the purposes of our efforts to implement the Green Infrastructure Statement of Intent (discussed below), we intend the term “green infrastructure” to generally refer to systems and practices that use or

mimic natural processes to infiltrate, evapotranspire (the return of water to the atmosphere either through evaporation or by plants), or reuse stormwater or runoff on the site where it is generated.

What is Green Infrastructure?

Green infrastructure is management approaches and technologies that utilize, enhance and/or mimic the natural hydrologic cycle processes of infiltration, evapotranspiration and reuse. Green infrastructure approaches currently in use include green roofs, trees and tree boxes, rain gardens, vegetated swales, pocket wetlands, infiltration planters, porous and permeable pavements, vegetated median strips, reforestation/revegetation, and protection and enhancement of riparian buffers and floodplains. Green infrastructure can be used almost anywhere soil and vegetation can be worked into the urban or suburban landscape. Green infrastructure also includes decentralized harvesting approaches, such as the use of rain barrels and cisterns to capture and re-use rainfall for watering plants or flushing toilets. These approaches can be used to keep rainwater out of the sewer system so that it does not contribute to a sewer overflow and also to reduce the amount of untreated runoff discharging to surface waters. Green infrastructure also allows stormwater to be absorbed and cleansed by soil and vegetation and either re-used or allowed to flow back into groundwater or surface water resources.

In managing wet weather, green infrastructure practices, like all types of practices, need to be implemented at multiple scales: site, neighborhood, and regional or watershed. The most beautifully designed site, even if multiple green infrastructure practices are used, may actually result in an overall increase in impervious surfaces and thus stormwater discharges, if new or expanded roads, parking lots and commercial development are needed to serve it. For that reason, we include approaches such as infill, redevelopment and preserving natural areas in our suite of green infrastructure approaches. For more information on specific green infrastructure practices and how they function, visit:
<http://www.epa.gov/npdes/greeninfrastructure>.

Green Infrastructure Benefits

Green infrastructure has a number of environmental and economic benefits in addition to reducing the volume of sewer overflows and runoff.

- *Cleaner Water* – Vegetation, green space and water reuse reduce the volumes of stormwater runoff and, in combined systems, the volume of combined sewer overflows, as well as reduce concentrations of pollutants in those discharges.
- *Enhanced Water Supplies* – Most green infiltration approaches involve allowing stormwater to percolate through the soil where it recharges the groundwater and the base flow for streams, thus ensuring adequate water supplies for humans and more stable aquatic ecosystems. In addition, capturing and using stormwater conserves water supplies.
- *Cleaner Air* – Trees and vegetation improve air quality by filtering many airborne pollutants and can help reduce the amount of respiratory illness. Transportation and

community planning and design efforts that facilitate shorter commute distances and the ability to walk to destinations will also reduce vehicle emissions.

- *Reduced Urban Temperatures* – Summer city temperatures can average 10°F higher than nearby suburban temperatures. High temperatures are also linked to higher ground level ozone concentrations. Vegetation creates shade, reduces the amount of heat absorbing materials and emits water vapor – all of which cool hot air. Limiting impervious surface and using light colored impervious surfaces (e.g., porous concrete) also mitigate urban temperatures.
- *Moderate the Impacts of Climate Change* – Climate change impacts and effects vary regionally, but green infrastructure techniques provide adaptation benefits for a wide array of circumstances, by conserving and reusing water, promoting groundwater recharge, reducing surface water discharges that could contribute to flooding. In addition, there are mitigation benefits such as reduced energy demands and carbon sequestration by vegetation.
- *Increased Energy Efficiency* – Green space helps lower ambient temperatures and, when incorporated on and around buildings, helps shade and insulate buildings from wide temperature swings, decreasing the energy needed for heating and cooling. Further, diverting stormwater from wastewater collection, conveyance and treatment systems reduces the amount of energy needed to pump and treat the water. Energy efficiency not only reduces costs, but also reduces generation of greenhouse gases.
- *Source Water Protection* – Green infrastructure practices provide pollutant removal benefits, thereby providing some protection for both ground water and surface water sources of drinking water. In addition, green infrastructure provides groundwater recharge benefits.
- *Community Benefits* – Trees and plants improve urban aesthetics and community livability by providing recreational and wildlife areas. Studies show that property values are higher when trees and other vegetation are present.
- *Cost Savings* – Green infrastructure may save capital costs associated with paving, creating curbs and gutters, building large collection and conveyance systems, and digging big tunnels and centralized stormwater ponds; operations and maintenance expenses for treatment plants, pumping stations, pipes, and other hard infrastructure; energy costs for pumping water around; cost of treatment during wet weather; and costs of repairing the damage caused by stormwater, such as streambank restoration.

National Collaboration on Green Infrastructure

On April 19, 2007 the Green Infrastructure Statement of Intent (Appendix B) was entered into and between: the U.S. Environmental Protection Agency (EPA); National Association of Clean Water Agencies; Natural Resources Defense Council; the Low Impact Development Center; and the Association of State and Interstate Water Pollution Control Administrators. The Statement of Intent also recognized the support of all signatories of the Stakeholder

Statement of Support for Green Infrastructure (Appendix C), which continues to garner interest and new signatories.

The objectives of the Statement of Intent are to:

- Affirm the belief by the signatory organizations in the value of green infrastructure as both a cost effective and an environmentally preferable approach to reduce stormwater and other excess flows entering combined or separate sewer systems in combination with, or in lieu of, centralized hard infrastructure solutions;
- Establish a framework for working together to advance an understanding of green infrastructure as a tool for reducing overflows from sewer systems and stormwater discharges and to encourage and promote their wider application;
- Identify partnership opportunities between the signatory organizations;
- Develop strategies to promote the use of green infrastructure by cities and utilities as an effective and feasible means of reducing stormwater pollution and sewer overflows such as:
 - Developing models for all components of green infrastructure and make them available nationwide.
 - Exploring opportunities and incentives for the use of green infrastructure provisions in municipal separate storm sewer system (MS4) permits and CSO Long Term Control Plans (LTCs), including as a component of injunctive relief provisions of enforcement actions;
 - Developing memoranda and guidance materials, including language for the National Pollutant Discharge Elimination System (NPDES) Permit Writer's Manual, that would explain how regulatory and enforcement officials should evaluate and provide appropriate credit for the use of green infrastructure in meeting Clean Water Act requirements;
 - Recognizing the most effective and innovative uses of green infrastructure to meet Clean Water Act goals through EPA awards or recognition programs;
 - Providing technical assistance, training, and outreach to potential users of green infrastructure, including states, cities, counties, utilities, environmental and public health agencies, engineers, architects, landscape architects, planners and nongovernmental organizations;
 - Establishing a web-based green infrastructure resource center at EPA to assist communities in complying with requirements for combined sewer overflows and municipal stormwater permits and evaluating the multiple environmental benefits that green infrastructure can provide; and
 - Developing tools to assist local green infrastructure programs with outreach, training, model development and application, planning and design, monitoring, and plan review.

Purpose of the Action Strategy

The purpose of this action strategy is to set forth a collaborative set of actions among the signatory organizations to both the Statement of Intent and the Statement of Support in order to promote the benefits of using green infrastructure in mitigating overflows from combined and separate sewers and reducing runoff, by encouraging the use of green infrastructure as prominent components of combined and separate sewer overflow (CSO &

SSO) plans, municipal stormwater (MS4) programs, and nonpoint source and watershed planning efforts. This action strategy outlines the efforts that the partners feel are important in bringing green infrastructure technologies and approaches into mainstream wet weather management.

This Green Infrastructure Action Strategy also represents one of the key actions that EPA is undertaking to address projected impacts of climate change. The EPA Office of Water has developed the draft *National Water Program Strategy: Response to Climate Change* which will soon be released for public comment. Green Infrastructure is one strategy that communities can use to adapt water and wastewater management in the face of changing hydrologic cycles.



The Green Infrastructure Action Strategy

This green infrastructure action strategy includes seven major areas for which objectives and tasks are being developed and implemented:

- o Research
- o Outreach and Communications
- o Tools
- o Clean Water Act Regulatory Support
- o Economic Viability and Funding
- o Demonstrations and Recognition
- o Partnerships

Specific project plans for some areas and activities are well defined, and even underway in some cases. In other areas, tasks and activities are only generally laid out, and additional effort will be undertaken to develop the project plan and begin implementation. The core partners group for development of this action strategy preferred this approach, as it made it possible to begin work immediately on efforts with widespread support, rather than waiting for development and finalization of this action strategy document.

In fact, this action strategy is a living document. It will be regularly updated as activities and priorities evolve. In all areas, but especially in areas where action is not well-defined, we welcome input from anyone or any organization with ideas, energy or resources to develop specific tasks. This is truly a collaborative effort, and new partners willing to take leadership in specific areas can only strengthen the outcomes.

The various components of this action strategy have been developed and will be implemented by different partners or combinations of partners. Many of them are collaborative. Some are being undertaken by individual organizations, if particular tasks fall squarely within their provinces. Further, not all tasks will be initiated immediately, but initial priorities have been identified in this action strategy.

The Steering Committee, the core coordinating group of this green infrastructure effort, is comprised of representatives from American Rivers, the Association of State and Interstate Water Pollution Control Administrators (ASIWPCA), the Low Impact Development (LID) Center, the National Association of Clean Water Agencies (NACWA), the Natural Resources Defense Council (NRDC) and U.S. EPA.

I. Research

Because many green infrastructure management practices are relatively new, there is little quantitative data on performance and effectiveness.

Goal: Ensure that potential adopters of green infrastructure approaches have the necessary information to make the transitions on multiple fronts, e.g., technically, administratively, financially.

Objective I.1: Develop protocols to quantify multiple benefits of green infrastructure practices.

Description: Develop standard protocols/methods for co-assessing benefits from green infrastructure practices (energy savings, carbon sequestration, urban heat island reduction, water conservation, air quality, property values, biodiversity) along with water quality and quantity benefits.

Priority: High

Responsible Entities: Co-leads: EPA, Low Impact Development Center

Timeframe: Underway FY07. Complete TBD.

Contact: Jenny Molloy, U.S. EPA
Chris Kloss, Low Impact Development Center

Objective I.2: Assess and quantify multiple benefits of green infrastructure.

Description: Compile existing data. Assess and quantify multiple benefits of green infrastructure (water quality and quantity along with benefits noted above), with side-by-side comparisons to gray infrastructure approaches to managing wet weather. Consider also water quality benefits derived by eliminating or reducing utilization of collection systems that transport pathogens, etc. to receiving waters.

Priority: High

Responsible Entities: Co-leads: EPA, Low Impact Development Center, and other interested parties are encouraged to participate

Timeframe: Dependent upon development of protocols for co-assessment.

Contact: Jenny Molloy, U.S. EPA
Chris Kloss, Low Impact Development Center

Objective I.3: Identify and fill green infrastructure-related research gaps.

Description: Convene a research forum to identify green infrastructure-related research gaps, and identify mechanisms for filling those gaps.

Priority: High

Responsible Entities: Co-leads: U.S. EPA, Water Environment Research Foundation, Low Impact Development Center

Timeframe: Conference in January 2008

Contact: Jenny Molloy, U.S. EPA
Dan Murray, U.S. EPA
Jeff Moeller, Water Environment Research Foundation
Chris Kloss, Low Impact Development Center

II. Outreach and Communication

As is typical of new technological approaches, implementers often need to understand available technologies, benefits and performance of these new mechanisms, and how to design, build, incorporate, implement and maintain new management systems. In addition, it is sometimes necessary to develop or modify administrative, logistical and institutional frameworks for doing things in a new way.

Goal: Ensure that potential implementers of green infrastructure approaches have the necessary information to make the transitions on multiple fronts, e.g., technically, administratively, financially.

Objective II.1: Establish a web-based Green Infrastructure resource center. This resource center will be a clearinghouse for all types of information, e.g., technical, regulatory, funding, research, tools, case studies.

Description: The Green Infrastructure resource center was established in July 2007. (www.epa.gov/npdes/greeninfrastructure). This website serves as an informational clearinghouse for people interested in learning about green infrastructure. The goal is to create a site for people with varying levels of interest and expertise, and will be designed so that visitors can quickly access information that is substantive and up-to-date. The site will be divided into several sub-sections, including:

- **General Information** (background information about the collaborative effort; benefits of green infrastructure; basic definitions)
- **Case Studies** (catalog of green infrastructure initiatives, pilot programs, and demonstration projects that have been completed or are underway)
- **Performance Data** (publications, reports and calculators that quantify the performance capabilities of green infrastructure practices)
- **Funding & Incentives** (links to sources of funding for green infrastructure projects; compilation of incentives that cities/municipalities have adopted to promote green infrastructure)
- **Resources** (links to other sources of information) Additional components will be added, and the website will be kept current.

Priority: High

Responsible Entities: Lead: U.S. EPA. Co-lead: National Association of Clean Water Agencies, Low Impact Development Center, American Rivers.

Timeframe: Underway. Basic framework July 2007; more in-depth information, and sophisticated tools ongoing.

Contact: Greg Voigt, U.S. EPA, ORISE Fellow
Nathan Gardner-Andrews, National Association of Clean Water Agencies

Objective II.2: As noteworthy activities, products or accomplishments, occur, publish a brief periodical newsletter.

Description: Publish a 1 sheet (2 pages) newsletter on a semi-regular basis, of noteworthy activities, production of tools and technical guidebooks, new data, and other accomplishments. The periodical will not be held to a specific publication schedule, but will be used as a primary means to keep all partners updated on progress. The periodical will be distributed to all signatories of the Statement of Support, and placed on the website.

Priority: Medium

Responsible Entities: Lead: U.S. EPA. Associates: all partners who would like to publicize accomplishments

Timeframe: Underway. Ongoing.

Contact: Jenny Molloy, U.S. EPA, Office of Wastewater Management

Objective II.3: Partner with organizations and conference organizers to include green infrastructure on the agendas of major national and regional meetings and forums.

Description: Work with national and regional organizations to include various aspects of green infrastructure on conference agendas.

Priority: High

Responsible Entities: All partners, including American Rivers, Association of State and Interstate Water Pollution Control Administrators, the Low Impact Development Center, National Association of Clean Water Agencies, Natural Resources Defense Council and U.S. EPA

Timeframe: Ongoing.

Contact: Jenny Molloy, U.S. EPA
Neil Weinstein, Low Impact Development Center

III. Tools

One reason for the slow incorporation of green infrastructure practices into mainstream management designs is because the tools—including predictive and design models that would facilitate incorporation into designs, or the protocols for undertaking other analyses—generally do not include green infrastructure layers or modules. Engineers and others use well-established standard models and design paradigms, and until those tools can be updated with standard sets of assumptions and other information, green infrastructure practices are unlikely to move into the realm of standard approaches to managing wet weather.

Goal: Ensure that potential adopters of green infrastructure approaches have the necessary tools to make the transitions on multiple fronts, e.g., technically, administratively, financially.

Objective III.1: Establish models and modeling protocols that quantify discharge volume and pollutant reductions of green infrastructure practices (in combination with each other and gray infrastructure practices) at site, sewershed, and system-wide scales.

Description: This initiative will involve developing a technical support document on integrating green infrastructure technologies into commonly used models and calculators used to plan and design wet weather controls. This effort will consider components that incorporate factors for climate change. Another consideration will be to ensure the availability of the necessary modeling tools for designing green infrastructure solutions. This initiative will involve compiling information on existing models that will fill this need and developing model and calculator components to fill the gaps.

Priority: High

Responsible Entities: Lead: U.S. EPA. Associates: Low Impact Development Center

Timeframe: Underway. Complete by September 2008.

Contact: Robert Goo, U.S. EPA, Office of Wetlands, Oceans & Watersheds
Chris Kloss, Low Impact Development Center

Objective III.2: Develop a guidebook for municipalities on implementing green infrastructure.

Description: Develop a guidebook for municipalities that includes a decision-tree for selecting/applying green infrastructure approaches for new development, redevelopment and retrofits (including performance and cost factors), master planning considerations, site planning and design review specifications, operation and maintenance needs, model codes and ordinances (including removing obstacles in current codes and ordinances), incentives and funding, tracking and evaluation protocols, and marketing. The guidebook will include important aspects of retrofitting and redeveloping in ultra-urban areas, as well as case studies documenting how other local governments have rewritten or created new stormwater codes, regulations or policies to encourage or require the management of stormwater runoff using controls that infiltrate, reuse and evapotranspire. The guidebook will provide lessons learned about barriers, implementation, partnerships and incentives, as well as data on total build out and quantifiable results

Priority: High

Responsible Entities: Co-leads: U.S. EPA; National Association of Clean Water Agencies; American Rivers

Timeframe: Complete 2008-2009.

Contact: Abby Hall, U.S. EPA, ORISE Fellow

Objective III.3: Develop design standards and drawings for homeowners and property owners that can be shared with designers, contractors and builders.

Description: Individuals and organizations choosing to implement green infrastructure technologies often have difficulty conveying the purpose and possibilities for designing site features to manage stormwater runoff. Outreach materials would include simple drawings and images alongside design specifications for managing certain volumes per square feet of imperviousness. Materials should be printed in English and Spanish.

Priority: Medium

Responsible Entities: Co-leads: EPA, and other interested parties are encouraged to participate

Timeframe: Begin in FY08.

Contact: Jamal Kadri, U.S. EPA

Objective III.4: Develop bid specification language for green infrastructure practices, to make it easier for projects to accurately bid construction activities utilizing green infrastructure technologies.

Description: Individuals and organizations choosing to implement green infrastructure technologies often have difficulty accurately bidding the project because of their inexperience with the technology. Model bid specifications will articulate specific provisions, outcomes, etc.

Priority: High

Responsible Entities: Co-leads: EPA; and other interested parties are encouraged to participate

Timeframe: Begin in FY08.

Contact: Greg Voigt, U.S. EPA, ORISE Fellow

IV. Clean Water Act Regulatory Support

There is a misperception by many that regulatory programs do not allow the use of green infrastructure. In actuality, regulatory programs generally allow the use of management practices that will meet the necessary water quality/environmental outcome(s). In practice, regulatory programs often facilitate the proliferation of standard gray infrastructure simply because that is the technology with which the regulated community and the regulators are familiar.

Goal: Clarify for regulators and the regulated community how Clean Water Act provisions can facilitate implementation of green infrastructure approaches. Make specific efforts to use NPDES-related mechanisms to facilitate near-term implementation.

Objective IV.1: Clarify for regions and states that there is nothing in regulations or statutes precluding the use of green infrastructure solutions in various regulatory programs, and provide direction to promote utilization of green infrastructure approaches in lieu of, or in combination with, gray infrastructure approaches.

Description: Issue joint memo from Water Permits Division and Water Enforcement Division, to regional and state NPDES permit and enforcement program managers clarifying that green infrastructure approaches are acceptable controls for CSOs, stormwater and other discharges within the Clean Water Act frameworks, subject to the same frameworks and requirements.

Priority: High

Responsible Entities: EPA Water Permits Division and Water Enforcement Division

Timeframe: Completed. Memo issued August 16, 2007.

Contact: Gary Hudiburgh, U.S. EPA

Objective IV.2: Develop model permit language for MS4 permits that will specifically incorporate green infrastructure management practices into municipal stormwater programs. Conduct pilot tests of the model language in permits, as appropriate.

Description: Draft language that can be incorporated into MS4 permits to focus stormwater management on processes of infiltration, reuse and evapotranspiration, and simultaneously consider both site design and community design/regional issues. Develop accompanying justification for permit fact sheets and accompanying guidance for permittees. Conduct pilots with select states and regions, including providing direct permit writing technical assistance, as necessary.

Priority: High

Responsible Entities: U.S EPA and relevant states as pilots are initiated.

Timeframe: Underway. Pilots with West Virginia and Tennessee 2007 and 2008.

Contact: Jenny Molloy, U.S. EPA
Lynn Richards, U.S. EPA
Robert Goo, U.S. EPA

Objective IV.3: Develop a guidebook for state and regional NPDES programs (permitting and enforcement) on facilitating the use of green infrastructure via regulatory programs.

Description: This guidebook will discuss considerations for evaluating green infrastructure approaches as part of a regulatory program. The guidebook will provide information about how to incorporate green infrastructure approaches for wet weather programs in permits, long term control plans (LTCP), and settlements (Supplemental Environmental Programs (SEPs) and injunctive relief). The guidebook will describe the elements of these documents and provide examples of existing permits, LTCPs and settlements with relevant provisions. The guidebook will articulate review criteria to help ensure that the feasibility of green infrastructure approaches is always considered during design and review stages.

Priority: High

Responsible Entities: U.S. EPA, NACWA, NRDC, ASIWPCA, LID Center, American Rivers

Timeframe: Complete by summer 2008.

Contact: Gary Hudiburgh, U.S. EPA

Objective IV.4: Provide guidance on green infrastructure stormwater technologies and the interface with underground injection control (UIC) regulations for class V wells.

Description: Clarify which infiltration measures are classified as class V wells, and therefore subject to underground injection control requirements to protect groundwater quality. Provide guidance to EPA and state regulatory programs. Provide guidance to adopters of infiltration techniques regarding their regulatory obligations, where appropriate.

Priority: High

Responsible Entities: U.S. EPA

Timeframe: Spring 2008.

Contact: Jeff Jollie, U.S. EPA
Greg Voigt, U.S. EPA, ORISE Fellow

Objective IV.5: Continue training to municipal officials and others who operate MS4s, combined sewers and other wet weather programs.

Description: A one-day training on using green infrastructure to help manage wet weather regulatory programs was piloted in northern Kentucky in September 2007 for about 100 people. The training program included technology and policy components. This training will be provided in other municipalities as requested.

Priority: High

Responsible Entities: U.S. EPA, Low Impact Development Center

Timeframe: Ongoing.

Contact: Gary Hudiburgh, U.S. EPA
Chris Kloss, Low Impact Development Center

Objective IV.6: Collaborate on development of a CSO long term control plan (LTCP).

Description: There are currently several communities in the process of developing LTCPs that may be good candidates for a model 'green' plan. Identify one or two good candidates and provide tools and assistance necessary to incorporate green infrastructure controls into the LTCP.

Priority: High

Responsible Entities: U.S. EPA, and interested state NPDES programs and municipal operators are encouraged to participate

Timeframe: Commence FY08.

Contact: Gary Hudiburgh, U.S. EPA

V. Economic Viability and Funding

Practitioners are often reticent to adopt new approaches without adequate documentation that these approaches are economically viable and demonstration of the economic advantages of employing approaches that provide multiple benefits. In addition, municipalities and other entities interested in green infrastructure are often dissuaded from pursuing projects because of lack of available funds. This can be particularly true for smaller communities that are already struggling with a lack of resources to meet ever increasing municipal demands.

Goal: Document and/or quantify the multiple benefits of using green infrastructure. Ease the financial burden on municipalities that are interested in implementing green infrastructure practices and technology but lack the necessary financial resources

Objective V.1: Document capital expenditures, administrative and life cycle costs; compare to traditional gray-infrastructure costs. Consider new construction versus retrofits. Consider regional averages and ranges. Consider individual practices as well as combinations of practices.

Description: Develop protocols for making standard cost evaluations of green infrastructure practices. Compile information on capital and life cycle costs and include cost savings derived from reducing curb, gutter, paving materials, O&M, dredging, channel restoration, drinking water treatment costs, etc.

Priority: High

Responsible Entities: U.S. EPA and interested parties are encouraged to participate

Timeframe: Begin FY08

Contact: Robert Goo, U.S. EPA

Objective V.2: Document types of incentives and financing mechanisms that communities can use through a review of strategies used by municipalities with well-established green infrastructure policies.

Description: Compile information on the types of incentives that communities are and can use to facilitate and encourage the use of green infrastructure approaches. Compile case studies from institutionalized green infrastructure programs, including examples of stormwater fee structures, taxes, interagency contributions, etc.

Priority: High

Responsible Entities: Co-leads: U.S. EPA, American Rivers, Environmental Finance Center

Timeframe: Underway. Complete FY08.

Contact: Abby Hall, U.S. EPA , ORISE Fellow

Objective V.3: Clarify those existing grant and loan programs that local governments and other entities can use to help fund green infrastructure projects. Work to make green infrastructure a priority.

Description: Create a list of those existing grant programs that could be used to fund green infrastructure projects and work with those programs to make green infrastructure projects a high priority for funding. Work especially to enhance use of State Revolving Fund (SRF) funds for green infrastructure solutions to wet weather problems.

Priority: Medium

Responsible Entities: U.S. EPA (Lead) and other partners as grant opportunities become known

Timeframe: Begin Summer 2007 and ongoing

Contact: Greg Voigt, U.S. EPA, ORISE Fellow

VI. Demonstrations and Recognition

Publicizing projects, robust data, experiences, and lessons learned and other information will begin to help familiarize potential adopters with green infrastructure practices that have successful track records. Recognizing exceptional and successful projects will provide an incentive for adopters to use more green infrastructure. Existing and new projects provide great opportunities to gather additional data and information for demonstration and recognition projects.

Goal: Use existing projects and develop several new green infrastructure pilot projects to carefully design studies to answer many of the questions outlined in this action strategy (e.g., documenting costs, quantifying other benefits, developing models, gathering performance data).

Objective VI.1: Develop a catalog of green infrastructure case studies.

Description: This web-based catalog will build on the Natural Resources Defense Council's *Rooftops to Rivers* (June 2006, <http://www.nrdc.org/water/pollution/rooftops/rooftops.pdf>) and include documented costs (capital and operation and maintenance), benefits/performance and other relevant information. This catalog will be broken out by regional, neighborhood, and site-specific scales and may include examples from Leadership in Energy and Environmental Design (LEED) for Neighborhood Development and municipalities included in the policy development handbook. A Stormwater on Brownfields fact sheet may also elicit case studies of green infrastructure on brownfield sites and in ultra-urban settings.

Priority: Medium

Responsible Entities: Co-leads: U.S. EPA, Low Impact Development Center, Natural Resources Defense Council

Timeframe: Begin developing case studies during FY07 and continue in FY08.

Contact: Greg Voigt, U.S. EPA, ORISE Fellow

Objective VI.2: Expand the Washington, D.C., green build-out model to include other green infrastructure practices, and make publicly available.

Description: Expand the model to include use of pervious or permeable pavement, rain gardens and other vegetated solutions for volume and pollution reduction estimates, specifically those practices that infiltrate, reuse and evapotranspire stormwater. This work involves research, method development and application. Methodology will be transferable.

Priority: High

Responsible Entities: U.S. EPA; District of Columbia Washington Area Sewer and Water Authority (WASA); Limno-Tech

Timeframe: Commence August 2007. Complete spring 2008.

Contact: Jenny Molloy, U.S. EPA

Objective VI.3: Using the expanded Washington, D.C., green build-out model, reconvene the advisory team to develop an implementation strategy.

Description: Reconvene the D.C. Green Build-Out Advisory Team to develop a strategy for implementing a full-scale demonstration in a pilot sewershed.

Priority: Medium

Responsible Entities: D.C. Washington Area Sewer and Water Authority, D.C. Department of Environment

Timeframe: Following completion of Objective V.2

Contact: Nancy Stoner, Natural Resources Defense Council

Objective VI.4: Recognize innovative green infrastructure through awards or recognition programs.

Description: Develop a framework for a national recognition program for quality green infrastructure efforts. The development of this framework will be based on existing recognition programs.

Priority: Medium

Responsible Entities: Lead: American Rivers, and other interested parties are encouraged to participate

Timeframe: Begin 2008; ongoing

Contact: Gary Belan, American Rivers
Jenny Molloy, U.S. EPA

Objective VI.5: Seek green infrastructure projects in the early stages to create opportunities for documenting costs, performance and other data.

Description: Identify green infrastructure projects in the concept or planning stages. Depending on the type of project, partner in order to gather information, influence design, and other objectives outlined in this action strategy.

Priority: High

Responsible Entities: All partners, including American Rivers, Association of State and Interstate Water Pollution Control Administrators, the Low Impact Development Center, National Association of Clean Water Agencies, Natural Resources Defense Council and U.S. EPA

Timeframe: Ongoing

Contact: Jenny Molloy, U.S. EPA
Nathan Gardner-Andrews, National Association of Clean Water Agencies

VII. Partnerships

A broad and intensive effort to expand the partnership and promote green infrastructure approaches is needed to expedite efforts and gain more widespread acceptance.

Goal: Expand the partnership via the Statement of Support and other mechanisms. Use a variety of venues and approaches to promote the use of green infrastructure, and disseminate data, tools, guidance and other useful information.

Objective VII.1: Work with large retailers to develop agreement on implementing green infrastructure at retail and warehousing establishments

Description: Collaborate with EPA programs already promoting “green” practices with large (“big box”) retailers to include a green infrastructure wet weather management component. This initiative will focus on promoting standards and specifications for new and redeveloped facilities, as well as operation and management practices. The second phase of this effort will involve expanding to malls and strip malls.

Priority: High

Responsible Entities: U.S. EPA, Low Impact Development Center, and interested commercial partners are encouraged to participate

Timeframe: Underway.

Contact: Jenny Biddle, U.S. EPA, ORISE Fellow
Katherine Telleen, U.S. EPA, ORISE Fellow
Neil Weinstein, Low Impact Development Center

Objective VII.2: Leverage existing EPA and federal government wide efforts to lead by example in green infrastructure.

Description: Participate in EPA’s Green Building Working Group, EPA’s Innovation Action Council’s Green Building Program, the Interagency Sustainability Working Group, U.S. General Services Administration and U.S. Department of Defense to increase emphasis on use of green infrastructure/stormwater management issues. Work with the EPA’s Office of Administration and Resources Management to add green infrastructure requirements to their facility specifications and complete demonstration retrofit projects and new projects.

Priority: High

Responsible Entities: U.S. EPA

Timeframe: Ongoing.

Contact: Robert Goo, U.S. EPA

Objective VII.3: Promote existing, and develop new green infrastructure training and certification for green infrastructure installers.

Description: Individuals and organizations choosing to implement green infrastructure technologies often have difficulty finding qualified installers. This effort will promote training and certification programs that already exist (e.g., porous concrete, green roofs). Where gaps are identified, we will work with relevant industries to develop training and certification criteria/programs. Specific priority areas will be determined.

Priority: Medium

Responsible Entities: Lead: EPA, and other interested parties are encouraged to participate

Timeframe: Underway. Existing programs identified and recognized on the web, summer 2007.

Contact: Greg Voigt, U.S. EPA, ORISE Fellow

Objective VII.4: Continue to expand the partnership through the Statement of Support for Green Infrastructure.

Description: Continue to solicit and accept new partners through the Statement of Support for Green Infrastructure. Add an electronic component to the Green Infrastructure website for organizations to electronically add their organizations as signatories to the Statement of Support.

Priority: High

Responsible Entities: Co-leads: National Association of Clean Water Agencies, National Resources Defense Council; Associates: U.S. EPA (e-signatory feature on the website)

Timeframe: Ongoing. Website feature completed.

Contact: Nathan Gardner-Andrews, National Association of Clean Water Agencies
Nancy Stoner, Natural Resources Defense Council

Objective VII.5: Develop targeted partnerships for pivotal areas of implementation—for example, with the U.S. Department of Transportation, U.S. Green Building Council, American Society of Landscape Architects and American Institute of Architects.

Description: Other agencies and organizations have missions and resources that are relevant to the goals of this action strategy. On a case-by-case basis, partnerships will be developed to help further mutual goals.

Priority: High

Responsible Entities: All partners, including American Rivers, Association of State and Interstate Water Pollution Control Administrators, the Low Impact Development Center, National Association of Clean Water Agencies, Natural Resources Defense Council and U.S. EPA

Timeframe: Case-by-case.

Objective VII.6: Work with other federal agencies to build partnerships and implementation opportunities around green infrastructure.

Description: Explore possibilities for including relevant green infrastructure-related technologies and approaches in all federal activities.

Priority: High

Responsible Entities: U.S. EPA, Federal Highway Administration, U.S. Forest Service, U.S. Department of Agriculture, and other interested parties are encouraged to participate.

Timeframe: Begin FY08

Contact: Robert Goo, U.S. EPA



Implementation Framework

Coordination and Communication

To date, representatives from the six organizations that signed the Statement of Intent, including American Rivers, Association of State and Interstate Water Pollution Control Administrators, the Low Impact Development Center, National Association of Clean Water Agencies, Natural Resources Defense Council and U.S. EPA, have served as a Steering Committee for this green infrastructure effort. Coordination and communication among the partners on specific topics has been relatively frequent, largely via conference calls and e-mails. Conference calls and e-mails are likely going to continue to be the primary means of communication for the Steering Committee, as well as the signatories of the Statement of Support, but a more formal coordination framework is currently being developed to ensure that everyone who is interested can participate.

Current plans include maintaining the existing steering committee as the core coordinating group, perhaps with a few membership additions. However, formalizing our networks to communicate with other parties is very important. To that end, U.S. EPA is developing a network of contacts for each of its D.C. and regional offices; these contacts are being included on the green infrastructure website contacts page as they are identified. These individuals will be responsible for communicating relevant information within their offices, and bringing important information to the attention of the green infrastructure collaborative. U.S. EPA is also appointing a green infrastructure coordinator to track efforts and facilitate ongoing activity.

At the same time, the partners are discussing development of an electronic means of communication among the larger partnership (all signatories to the Statement of Support), which continues to grow. In addition, discussions are underway about whether communication tools will include an e-mail distribution list, a listserv, or some other mechanism. The website will also be used to keep interested parties informed about ongoing activities.

Project-specific teams will manage their own efforts and create project-specific communication networks. Participation in any effort or discussion will be open to the extent legal restrictions (e.g., enforcement negotiations) do not preclude it.

Determining Success

The success of individual projects and tasks will depend on the objectives of each project. In some cases producing stipulated projects within reasonable timeframes will accomplish relevant objectives. However, there are several major milestones that will indicate that green infrastructure is attaining status as a mainstream approach to managing wet weather:

- o Notable numbers of MS4 permits, injunctive relief portions of enforcement settlements, and long-term control plans (enforceable documents) include provisions that facilitate or require green infrastructure approaches.
- o EPA regional offices will set and annually evaluate goals for incorporating green infrastructure in the MS4 and CSO permitting and enforcement programs.
- o Increasing numbers of communities embrace green infrastructure as a key component of ongoing upgrades to their critical water infrastructure, as evidenced by adoption of progressive ordinances, and implementation of cutting-edge projects.
- o Increasing implementation of green infrastructure technologies as tracked by relevant industries and commercial vendors (e.g., acres of pervious pavement, square feet of green roofs, numbers of rain barrels and cisterns in use).
- o Research data indicate positive outcomes in terms of technology performance on multiple fronts and water quality improvements.
- o Increasing number of SRF applications proposing to utilize green infrastructure approaches.

The steering committee agrees to develop a tracking system to compile this information, and will also refine measures of success as more useful data become obtainable.

Keeping the Action Strategy Updated and Efforts Underway

The steering committee will convene on a regular basis (e.g., quarterly) to discuss progress, projects, and needs. Where new action is deemed necessary, decisions will be made about who will be involved and how and when the action will be implemented.

U.S. EPA commits to keeping the website and the action strategy document up to date, as those are important communication tools for this effort. U.S. EPA also commits to convening steering committee forums, compiling activities and accomplishments reported to or through the committee, and communicating other important information to the larger partnership as long as those efforts are within the purview of the agency.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

MAR 5 2007

OFFICE OF
WATER

MEMORANDUM

SUBJECT: Using Green Infrastructure to Protect Water Quality in Stormwater, CSO, Nonpoint Source and other Water Programs

FROM: Benjamin H. Grumbles
Assistant Administrator

A handwritten signature in black ink, appearing to read "B. H. Grumbles", is written over the printed name and title of the Assistant Administrator.

TO: EPA Regional Administrators

Green infrastructure can be both a cost effective and an environmentally preferable approach to reduce stormwater and other excess flows entering combined or separate sewer systems in combination with, or in lieu of, centralized hard infrastructure solutions. EPA Water Programs are in a pivotal position to exert leadership in the consistent and reliable implementation of green infrastructure approaches. This memo is to highlight opportunities for the Regions, States, and Headquarters efforts to increase the development and use of green infrastructure in water program implementation.

Several cities, searching for alternatives to traditional hardscape solutions to wet weather discharge problems, have initiated some green infrastructure approaches. The Natural Resources Defense Council (NRDC) has recently published a document with information and case studies on these efforts. I strongly support the use of green infrastructure approaches described in the NRDC report and I suggest you share the report with States and promote other tools for green infrastructure. *Rooftops to Rivers: Green strategies for controlling stormwater and combined sewer overflows* (NRDC, June 2006) is available at:

<http://www.nrdc.org/water/pollution/rooftops/contents.asp>

Green infrastructure approaches essentially infiltrate, evapotranspire or reuse stormwater, with significant utilization of soils and vegetation rather than traditional hardscape collection, conveyance and storage structures. Common green infrastructure approaches include green roofs, trees and tree boxes, rain gardens, vegetated swales, pocket wetlands, infiltration planters, vegetated median strips, reforestation, and protection and enhancement of riparian buffers and floodplains. Green infrastructure can be used where soil and vegetation can be worked into the landscape. It is most effective when supplemented with other decentralized storage and infiltration approaches, such as the use of permeable pavement, and rain barrels and cisterns to capture and re-use rainfall for watering plants or flushing toilets. These approaches can be used to keep rainwater out of the sewer system to reduce sewer overflows and to reduce the amount of untreated stormwater discharging to surface waters. Green infrastructure

facilitates or mimics natural processes that also recharge groundwater, preserve baseflows, moderate temperature impacts, and protect hydrologic and hydraulic stability.

Green infrastructure has a number of benefits:

- *Cleaner Water* – Vegetation and green space reduce the amount of stormwater runoff and, in combined systems, the volume of combined sewer overflows.
- *Enhanced Water Supplies* – Most green infiltration approaches result in stormwater percolation through the soil to recharge the groundwater and the base flow for streams.
- *Cleaner Air* – Trees and vegetation improve air quality by filtering many airborne pollutants and can help reduce the amount of respiratory illness.
- *Reduced Urban Temperatures* – Summer city temperatures can average 10°F higher than nearby suburban temperatures. High temperatures are linked to higher ground level ozone concentrations. Vegetation creates shade, reduces the amount of heat absorbing materials and emits water vapor – all of which cool hot air.
- *Increased Energy Efficiency* – Green space helps lower ambient temperatures and helps shade and insulate buildings, decreasing energy needed for heating and cooling.
- *Community Benefits* – Trees and plants improve urban aesthetics and community livability by providing recreational and wildlife areas and can raise property values.
- *Cost Savings* - Green infrastructure may save capital costs on digging big tunnels and stormwater ponds, operations and maintenance expenses for treatment plants, pipes, and other hard infrastructure; energy costs for pumping water; and costs of wet weather treatment and of repairing stormwater and sewage pollution impacts, such as streambank restoration.

The Office of Water is working with a coalition of organizations, including the Natural Resources Defense Council, the National Association of Clean Water Agencies, and the Low Impact Development Center, to develop additional strategies for green infrastructure approaches to water quality challenges. As those strategies take shape, we will send you additional tools and information on implementing green infrastructure in our water programs.

I am pleased that EPA Regions and States are looking for opportunities to incorporate green infrastructure. We would be very interested in hearing about your efforts, and to the extent they can be applied elsewhere, assist in disseminating information and tools. If you have any questions, please contact me or have your staff call Jenny Molloy at (202) 564-1939 with any questions, comments, ideas or information on green infrastructure approaches.

cc: Water Division Directors
OW Office Directors

Green Infrastructure Statement of Intent

U.S. Environmental Protection Agency (EPA)
and
National Association of Clean Water Agencies (NACWA)
Natural Resources Defense Council (NRDC)
Low Impact Development Center (LID)
Association of State and Interstate Water Pollution Control Administrators
(ASIWPCA)

April 19, 2007

Introduction

This Statement of Intent is entered into and between the U.S. Environmental Protection Agency (EPA) and the following organizations in recognition of the Statement of Support for Green Infrastructure (attached) and the efforts of all supporting organizations thereto: National Association of Clean Water Agencies, Washington, DC; Natural Resources Defense Council, Washington, DC; the Low Impact Development Center, Beltsville, MD; and the Association of State and Interstate Water Pollution Control Administrators, Washington, DC.

Purpose

The purpose of this Statement is to formalize a collaborative effort among the signatory organizations in order to promote the benefits of using green infrastructure in protecting drinking water supplies and public health, mitigating overflows from combined and separate sewers and reducing stormwater pollution, and to encourage the use of green infrastructure by cities and wastewater treatment plants as a prominent component of their Combined and Separate Sewer Overflow (CSO & SSO) and municipal stormwater (MS4) programs. The Statement is intended to describe and facilitate cooperation, collaboration, coordination, and effective communication among the signatory organizations. We encourage other organizations that support green infrastructure to join us in this initiative.

Background

Many communities in the United States are looking for ways to reduce overflows from sewer systems and stormwater discharges. Overflows occur when separate sewage and/or combined sewage and stormwater pipes overflow due to rainfall, other wet

weather events, or system deterioration. In the late 20th century, most cities that attempted to reduce sewer overflows did so by separating combined sewers, expanding treatment capacity or storage within the sewer system, or by replacing broken or decaying pipes. More recently, a number of cities and utilities have recognized that sewer overflows can also be reduced effectively by diverting stormwater from the sewer system and directing it to areas where it can be infiltrated, evapotranspired or re-used. These approaches are often referred to as “green infrastructure” because soil and vegetation are used instead of, or in addition to, pipes, pumps, storage tunnels, and other “hard infrastructure” that is traditionally used to store and treat the combined sewage and stormwater. Green infrastructure can also be used to reduce stormwater discharges and help to restore the natural hydrology, water quality and habitat of urban and suburban watersheds.

Green infrastructure approaches currently in use include green roofs, trees and tree boxes, rain gardens, vegetated swales, pocket wetlands, infiltration planters, vegetated median strips, reforestation, and protection and enhancement of riparian buffers and floodplains. Green infrastructure can be used almost anywhere where soil and vegetation can be worked into the urban or suburban landscape. Green infrastructure is most effective when supplemented with other decentralized storage and infiltration approaches, such as the use of permeable pavement and rain barrels and cisterns to capture and re-use rainfall for watering plants or flushing toilets. These approaches can be used to keep rainwater out of the sewer system so that it does not contribute to a sewer overflow and also to reduce the amount of untreated stormwater discharging to surface waters. Green infrastructure also allows stormwater to be absorbed and cleansed by soil and vegetation and either re-used or allowed to flow back into groundwater or surface water resources.

Objectives

The objectives of this Statement are to:

- Affirm the belief by the signatory organizations in the value of green infrastructure as both a cost effective and an environmentally preferable approach to reduce stormwater and other excess flows entering combined or separate sewer systems in combination with, or in lieu of, centralized hard infrastructure solutions;
- Establish a framework for working together to advance an understanding of green infrastructure as a tool for reducing overflows from sewer systems and stormwater discharges and to encourage and promote their wider application;
- Identify partnership opportunities between the signatory organizations; and
- Develop strategies to promote the use of green infrastructure by cities and utilities as an effective and feasible means of reducing stormwater pollution and sewer overflows such as:

- o Developing models for all components of green infrastructure and make them available nationwide.
- o Exploring opportunities and incentives for the use of green infrastructure provisions in MS4 permits and CSO Long Term Control Plans (LTCPs), including as a component of injunctive relief provisions of enforcement actions;
- o Developing memoranda and guidance materials, including language for the NPDES permit writer's manual, that would explain how regulatory and enforcement officials should evaluate and provide appropriate credit for the use of green infrastructure in meeting Clean Water Act requirements;
- o Recognizing the most effective and innovative uses of green infrastructure to meet Clean Water Act goals through EPA awards or recognition programs;
- o Providing technical assistance, training, and outreach to potential users of green infrastructure, including states, cities, counties, utilities, environmental and public health agencies, engineers, architects, landscape architects, planners and nongovernmental organizations;
- o Establishing a web-based green infrastructure resource center at EPA to assist communities in complying with requirements for combined sewer overflows and municipal stormwater permits and evaluating the multiple environmental benefits that green infrastructure can provide; and
- o Developing tools to assist local green infrastructure programs with outreach, training, model development and application, planning and design, monitoring, and plan review.

Recognition: The signatory organizations intend to develop strategies to identify, encourage, and recognize innovative and effective use of green infrastructure.

Communication: The signatory organizations intend to communicate widely about this Statement with their constituencies and encourage them to focus increased attention to green infrastructure development.

Note: All actions that EPA may take in furtherance of this statement are subject to the availability of appropriated funds and the parties to this agreement will not submit a claim to EPA for compensation solely on the basis of this agreement. In signing this statement, none of the organizations listed above, including EPA, are obligating funds nor making any commitment to provide funding to any organization or individuals in the future. Further, EPA cannot endorse the sale or purchase of products or services developed by the participating organizations. This Statement does not create any right or benefit, substantive or procedural, enforceable by law or in equity against the other Signatory organizations or EPA, their officers or employees, or any other

person. This Statement does not apply to any person outside of the other Signatory Organizations and EPA. Nothing in this Statement of Intent creates an exception to EPA policies on competition for assistance agreements or procurement contracts.

STEPHEN L. JOHNSON

Administrator

U.S. Environmental Protection Agency

Date

DICK CHAMPION

National Association of Clean Water Agencies

Date

NANCY STONER

Natural Resources Defense Council

Date

NEIL WEINSTEIN

Low Impact Development Center

Date

DANA AUNKST

Association of State and Interstate
Water Pollution Control Administrators

Date

Stakeholder Statement of Support for Green Infrastructure

Purpose

To bring together organizations that recognize the benefits of using green infrastructure in mitigating overflows from combined and separate sewers and reducing stormwater pollution and to encourage the use of green infrastructure by cities and wastewater treatment plants as a prominent component of their Combined and Separate Sewer Overflow (CSO & SSO) and municipal stormwater (MS4) programs.

Goals

Green infrastructure can be both a cost effective and an environmentally preferable approach to reduce stormwater and other excess flows entering combined or separate sewer systems in combination with, or in lieu of, centralized hard infrastructure solutions. The undersigned organizations support:

- Use of green infrastructure by cities and utilities where it is an effective and feasible means of reducing stormwater pollution and sewer overflows;
- Development of models to quantify stormwater detention, retention, and filtration potential of green infrastructure to better identify opportunities to successfully use green infrastructure in CSO, SSO, MS4 and nonpoint source programs;
- Monitoring to verify the amount of CSO, SSO, and stormwater discharge reduction that cities obtain through using green infrastructure;
- Measurement of economic and environmental benefits realized from the use of green infrastructure in sewer systems and quantification of its life-cycle costs;
- Increased federal, state, and local funding for green infrastructure initiatives;
- Elimination of barriers to the incorporation of green infrastructure in stormwater and sewer system programs;
- Development and funding of a plan to identify research needs to further green infrastructure;
- Preparation of guidance documents to assist cities and wastewater treatment plants in developing green infrastructure initiatives in their CSO, SSO, and MS4 programs; and
- Development of model provisions to incorporate green infrastructure into CSO and MS4 permits; SSO capacity, management, operations, and maintenance plans; and consent decrees and other enforcement vehicles.

Background

Many communities in the United States are looking for ways to reduce overflows from sewer systems and stormwater discharges. Overflows occur when combined sewage and stormwater pipes overflow due to rainfall or other wet weather events. In the late 20th century, most cities that attempted to reduce sewer overflows did so by separating combined sewers, expanding treatment capacity or storage within the sewer system, or by replacing broken or decaying pipes. More recently, a number of cities and utilities have recognized that sewer overflows can also be reduced effectively by diverting stormwater from the sewer system and directing it to areas where it can be infiltrated, evapotranspired or re-used. These approaches are often referred to as “green infrastructure” because soil and vegetation are used instead of, or in addition to, pipes, pumps, storage tunnels, and other “hard infrastructure” that is traditionally used to store and treat the combined sewage and stormwater. Green infrastructure can also be used to reduce stormwater discharges and help to restore the natural hydrology, water quality and habitat of urban and suburban watersheds.

Green Infrastructure Benefits

Green infrastructure approaches currently in use include green roofs, trees and tree boxes, rain gardens, vegetated swales, pocket wetlands, infiltration planters, vegetated median strips, reforestation, and protection and enhancement of riparian buffers and floodplains. Green infrastructure can be used almost anywhere where soil and vegetation can be worked into the urban or suburban landscape. Green infrastructure is most effective when supplemented with other decentralized storage and infiltration approaches, such as the use of permeable pavement and rain barrels and cisterns to capture and re-use rainfall for watering plants or flushing toilets. These approaches can be used to keep rainwater out of the sewer system so that it does not contribute to a sewer overflow and also to reduce the amount of untreated stormwater discharging to surface waters. Green infrastructure also allows stormwater to be absorbed and cleansed by soil and vegetation and either re-used or allowed to flow back into groundwater or surface water resources.

Green infrastructure has a number of other environmental and economic benefits in addition to reducing the volume of sewer overflows and stormwater discharges.

- *Cleaner Water* – Vegetation and green space reduce the amount of stormwater runoff and, in combined systems, the volume of combined sewer overflows.
- *Enhanced Water Supplies* – Most green infiltration approaches involve allowing stormwater to percolate through the soil where it recharges the groundwater and the base flow for streams, thus ensuring adequate water supplies for humans and more stable aquatic ecosystems.
- *Cleaner Air* – Trees and vegetation improve air quality by filtering many airborne pollutants and can help reduce the amount of respiratory illness.
- *Reduced Urban Temperatures* – Summer city temperatures can average 10°F higher than nearby suburban temperatures. High temperatures are linked to higher ground

level ozone concentrations. Vegetation creates shade, reduces the amount of heat absorbing materials and emits water vapor – all of which cool hot air.

- *Increased Energy Efficiency* – Green space helps lower ambient temperatures and, when incorporated on and around buildings, helps shade and insulate buildings from wide temperature swings, decreasing the energy needed for heating and cooling.
- *Community Benefits* – Trees and plants improve urban aesthetics and community livability by providing recreational and wildlife areas. Studies show that property values are higher when trees and other vegetation are present.
- *Cost Savings* - Green infrastructure may save capital costs associated with digging big tunnels and centralized stormwater ponds, operations and maintenance expenses for treatment plants, pumping stations, pipes, and other hard infrastructure; energy costs for pumping water around; cost of treatment during wet weather; and costs of repairing the damage caused by stormwater and sewage pollution, such as streambank restoration.