



## GREEN INFRASTRUCTURE RESEARCH

### What is Green Infrastructure?

Green infrastructure is a general name given to an approach using environmentally friendly techniques to stormwater management. Examples of green infrastructure include: rain gardens, rain barrels, green roofs, cisterns, riparian buffers, daylighted streams, and retention ponds.

### Why Study Green Infrastructure?

Flooding, raw sewage overflows, and nutrient impairment are all real concerns for urban water systems across the United States. Green infrastructure is one tool cities can use to address these issues. Green infrastructure techniques present sustainable options for reducing urban water problems and health risks.

Ultimately, all green infrastructure either retains stormwater runoff—keeping it out of sewers that could potentially overflow—or redirects water into the ground where plants and soil will naturally filter the water. Green infrastructure can also revitalize communities with green spaces.

Although green infrastructure offers a variety of methods by which city managers can address urban water issues, little research has documented the effectiveness or maintenance requirements of these techniques. This is where EPA researchers are taking the lead on research ranging from soil analysis to best-placement modeling.

## CURRENT RESEARCH EFFORTS

### The Urban Soil Assessment

Sewer system overflows can put cities in violation of the Clean Water Act. EPA researchers are helping by developing an Urban Soil Assessment Protocol that shows urban

planners, land managers, and sewer districts when and how to use green infrastructure to be most effective in controlling stormwater and in an economically feasible way.

Research to inform the protocol includes soil assessments from various urban locations to identify how excess stormwater moves through surface and deeper soils.

### Guiding Green Infrastructure in Omaha

Like many older cities across the country, Omaha, Nebraska, is built upon a combined sewer system—a system where stormwater and sewage are directed into one pipe. During heavy rains, this sewage can overflow untreated into nearby water bodies, threatening human and environmental health.



In collaboration with the City of Omaha and the Nebraska Department of Environmental Quality, EPA scientists are analyzing soils and preparing monitoring equipment to provide guidance on how the city can incorporate green infrastructure into their plan to reduce the incidence of combined sewer overflows (CSOs).

Once locations are chosen in Omaha for green infrastructure installations,

EPA will work with the local USGS to monitor water flow before and after installation to determine how well the green infrastructure performs.



Vacant lot before and after transformation to green space and pervious pavement



Monitoring equipment at a rain garden



Entrance of a buried stream

### Transforming Cleveland's Vacant Lots

Based on technical guidance from EPA experts, Cleveland, Ohio has incorporated a green infrastructure pilot program into their CSO control plan. This program takes advantage of the city's excess vacant land, turning that land into green spaces that can soak up stormwater and keep excess water out of the sewer system.

The transformation of urban vacant lots into park-like gardens that catch stormwater runoff not only helps remedy the CSO problem, but also improve the social and economic fabric of neighborhoods lacking green spaces.

### Daylighting Streams to Improve Water Quality

Researchers are comparing the effectiveness of buried streams (streams routed into underground pipes during urban development) with open-air or daylighted streams for removing harmful nitrogen. Early research results show that buried streams are less effective than daylighted streams, suggesting that turning buried streams into daylighted streams could prove a sustainable method for nitrogen removal and improved water quality.

The outcomes of this study and further research will be used to inform a new modeling tool for urban managers to determine where daylighting streams would be most effective.

### Stormwater Calculator to Manage Rainfall Runoff

Researchers are developing a new tool called the National Stormwater Calculator (SWC) to help city planners, developers, and property owners assess how green infrastructure can be used to reduce rainwater runoff before it becomes a problem.

The easy-to-use SWC estimates the annual amount and frequency of stormwater runoff from a specific site based on local soil conditions, land cover, and historical rainfall records. Users can input any U.S. location and select different development and green infrastructure scenarios to see how those changes affect runoff volumes from that location.

### Monitoring Green Infrastructure

Green infrastructure pilot projects in Cincinnati, Ohio, are monitored by EPA scientists in collaboration with the city and local USGS. Rain gardens at the St. Francis Court Apartments and permeable parking lots at Cincinnati State Technical and Community College are among the green infrastructure installations under study. Equipment at each site will track water quality and flow patterns to give researchers a better understanding of the efficiency of each practice.

The Metropolitan Sewer District of Louisville, Kentucky is also working with EPA scientists to develop a monitoring plan to demonstrate the performance of individual green infrastructure controls and the aggregated effectiveness of combined sewer flow control.

### MORE INFORMATION:

#### Water Research

[www.epa.gov/research/waterscience](http://www.epa.gov/research/waterscience)

#### Green Infrastructure Research

[www.epa.gov/research/waterscience/water-green](http://www.epa.gov/research/waterscience/water-green)

#### Green Infrastructure Overview

[water.epa.gov/infrastructure/greeninfrastructure/](http://water.epa.gov/infrastructure/greeninfrastructure/)

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