# COMPOSITE CASE STUDIES

The preceding case studies illustrate that green infrastructure and low-impact development techniques are being applied in a variety of settings and climates, and on a variety of scales, all across the nation. As Nathan Gardner-Andrews of the National Association of Clean Water Agencies observes, "Clearly green infrastructure is the new wave—it's the new thing that all cities are doing, not just because it's trendy but because green infrastructure is actually working." Many cities in the United States beyond those highlighted in this report are successfully incorporating green infrastructure and others are in the process of constructing and implementing their first green infrastructure pilots. Countless additional cities are in the nascent stages of planning for future green infrastructure projects.

This section discusses a number of community efforts that further illustrate the movement toward green infrastructure. The cities differ in how far along they are in their respective programs, but they are alike in doing interesting, innovative projects that warrant recognition.

## INDIANAPOLIS, INDIANA

In 2008 the wastewater treatment and sewer system in Indianapolis, Indiana, was averaging 7.8 billion gallons of overflow annually,[1,2] overflowing 40 to 60 times per year.[3] The city was determined to meet the goals of a 2006 federal consent decree to reduce overflows more than 90 percent, to approximately 642 million gallons annually.[4] Looking for opportunities to incorporate more sustainable solutions, the mayor's office opted to revamp a project to expand the city's wastewater treatment systems. At the time, the project was running $300 million over its $3.5 billion budget and was months behind schedule.[5,6]

In partnership with the city's Public Works Department, the mayor's office transformed the plan for managing wastewater. The new program's chief components include an expansion of the sewer system and an improved sewage treatment facility design (including a 54-million-gallon Deep Rock Tunnel Connector extending between Indianapolis's two wastewater treatment plants), combined with green infrastructure techniques to absorb stormwater runoff before it reaches the enhanced water treatment plants.[7,8] The city's early success in reducing the number and frequency of overflows led to a modification to the consent decree in 2010. Indianapolis must now reduce the volume of total annual overflows to approximately 414 million gallons; even as the project's cost will be reduced by approximately $440 million. This cost reduction, coupled with driving down the original budget overrun, will result in a savings of approximately $740 million. Notably, the incorporation of green infrastructure and sustainable approaches helped achieve these savings.[9]

As part of the effort to enhance green infrastructure in Indianapolis, the mayor's office created the Office of Sustainability, or SustainIndy. SustainIndy works to facilitate and integrate green infrastructure practices across all city agencies and departments. Before the creation of this office, there were few examples of green infrastructure within the city. Today, many projects have been implemented or are in development. These projects include:[10]

- **Tree planting:** In partnership with Keep Indianapolis Beautiful, six thousand trees will be planted in 2011, and a total of 100,000 will be planted by 2017. Stormwater reduction is a key goal: trees in urban areas can significantly reduce runoff by intercepting rainfall before it reaches the pavement. Models show that a mature deciduous tree can intercept 500 to 700 gallons of rain per year and that a mature evergreen can intercept up to 4,000 gallons per year.[11]
- **Rain gardens:** The city promotes rain gardens and native plantings, and the city's Rain Garden Resource Center provides aid in the design and construction of rain gardens. Program participants who register their rain gardens with the city are exempted from a high weeds and grass ordinance. The resource center enables the city to estimate how much stormwater is being diverted from the combined sewer system.

- **The Sustainable Infrastructure Initiative:** This program encourages green infrastructure in private development. Its centerpiece, the Green Supplemental Document, provides guidance on incorporating green infrastructure into stormwater treatment design. Permit review is expedited for plans that meet necessary stormwater requirements and incorporate green infrastructure techniques.
- **The Green Infrastructure Master Plan:** Completed in December 2010, it targets green infrastructure investment to reduce CSOs.
- **The Green Checklist:** As of January 2011, all capital improvement projects in Indianapolis must include this checklist, which requires consideration of green infrastructure elements. The checklist has resulted in the incorporation of green infrastructure in public projects.
- **Pilot projects:** A number of demonstration projects have been conducted throughout the city. For example, the Ohio Street project, located on a two-block CSO location with a history of flooding and overflow problems, replaced old sidewalks with porous pavement and installed rain gardens to improve drainage. The project has the potential to remove an estimated 1.3 million gallons of stormwater from the combined sewer system annually. Although porous concrete often costs more than traditional paving, the material serves a critical drainage function that would otherwise have to be accomplished using drains, pipes, and other structural BMPs. In that respect, the porous pavement is cost-effective: $37,500 was spent on Ohio Street, as opposed to the $85,150 that would have been required for traditional sidewalks plus the required drainage infrastructure.[12]

Although the Office of Sustainability is admittedly on a learning curve and still needs hard data to quantify the benefits of the city's new green infrastructure projects, Indianapolis has been making progress to implement green infrastructure since SustainIndy's inception in 2008.

## CLEVELAND, OHIO

Cleveland is also utilizing green infrastructure as part of the solution to its CSO problems, and now has a federal mandate to implement green infrastructure to help meet the requirements of the region's consent decree.

On December 22, 2010, the EPA and the Department of Justice announced a landmark Clean Water Act (CWA) settlement with the Northeast Ohio Regional Sewer District (NEORSD) to address the flow of untreated sewage into Cleveland waterways and Lake Erie.[13] At the time of the settlement, NEORSD was discharging between 4.5 billion and 5 billion gallons of raw sewage annually from 126 combined sewer overflow locations, with some sites overflowing 70 to 80 times per year.[14]

The settlement requires NEORSD to spend approximately $3 billion on traditional infrastructure to bring total annual discharges down to 537 million gallons. Significantly, the settlement also requires the sewer district to invest at least $42 million in green infrastructure projects to capture an additional 44 million gallons of CSO discharges. The settlement also enables NEORSD to look for opportunities to propose additional green infrastructure in exchange for reducing the scope of conventional, or "gray," infrastructure projects.[15,16] According to Kyle Dreyfuss-Wells, NEORSD's manager of watershed programs, the district "will look across its [$3 billion] gray infrastructure program for opportunities to replace gray with green infrastructure."[17] Environmental justice considerations will play a considerable role in NEORSD's green infrastructure work, which could have significant implications for addressing blight in Cleveland. Currently the city has a significant problem with vacant land and foreclosed properties, and the sewer district has the potential to transform these blighted areas with green infrastructure projects. Concentrating such projects in areas of need will connect the objectives of CSO control with planning and economic development opportunities.[18]

## CINCINNATI, OHIO

Another Ohio city looking to green infrastructure to help address its CSO problems is Cincinnati. A 2004 consent decree with the EPA mandated that the Metropolitan Sewer District (MSD) treat, capture, or remove 85 percent of the annual 14 billion gallons of CSOs in the district's service area, as well as eliminate all sanitary overflows—approximately 100 million gallons per year.[19] In August 2010, the consent decree was amended, providing the sewer district the opportunity to substitute green infrastructure for gray infrastructure on a project-by-project basis; green for gray proposals will likely be submitted in 2012.[20]

To meet EPA mandates, MSD launched Project Groundwork, a multiyear initiative composed of hundreds of sewer improvement and stormwater mitigation projects.[21] Many of the strategies being evaluated for Project Groundwork include green infrastructure techniques; the most significant and large-scale effort is a three-year pilot in the Lick Run watershed. The watershed, located in Lower Mill Creek on Cincinnati's west side, covers about 2,700 acres. The consent decree requires the development of a three-year action plan to determine how to achieve an initial 2-billion-gallon reduction in CSOs within Lower Mill Creek by 2018.[22] The federal government identified a deep tunnel system as

the preferred remedy, but MSD has until December 2012 to an alternative, more sustainable way to achieve this reduction goal. Many subprojects featuring green infrastructure are already showing promise as alternatives to the deep tunnel system.[23]

Importantly, MSD's Communities of the Future initiative seeks to address the CSO problem while combining source control strategies and community revitalization. MaryLynn Lodor, environmental programs manager at MSD, explains that the aim is to "craft a project so that [MSD's] investment can be the seed for further investments in the community to come about." The Lick Run Basin is located in South Fairmount, an underserved community that suffers from a number of social and economic challenges. MSD designed Lick Run as its first "fully integrated effort to develop a sustainable solution for the community based on source control."[24] The Communities of the Future's whole-system approach for Lick Run includes a mix of gray and green infrastructure; it combines the installation of 75,000 linear feet of storm sewer or reconstructed waterways and retention basins for storage with reforestation and downspout disconnections in selected areas.[25] Ideally this watershed-based approach will reduce CSO volume and also bolster the quality of life in South Fairmount by serving as a catalyst for revitalization.

## MINNEAPOLIS, MINNESOTA

Minneapolis, with three streams and the Mississippi River running through it and a multitude of lakes nearby, has carried out projects to improve water quality for more than a decade. Its stormwater ordinance requires public and private redevelopment sites of 1 acre or more to include on-site stormwater management. Since the adoption of the ordinance, approximately 700 structural best management practices (BMPs) have been used at more than 370 sites within Minneapolis. The vast majority of these BMPs are rain gardens (an estimated 1,216 as of December 2010); other techniques include stormwater ponds/wetlands, underground infiltration, bioswales, manufactured BMPs, and green roofs. Additionally, properties in Minneapolis must pay a stormwater utility fee. The utility has a substantial credit program in place: a credit of up to 50 percent is granted to property owners who make water quality improvements, and a credit of up to 50 percent is available for properties designed to retain a 10-year, 24-hour storm event on-site. For retention of a 100-year event, a property is eligible for a credit of up to 100 percent.[26]

Although green infrastructure is not mandated in Minneapolis, the Surface Water and Sewers division of Minneapolis's Public Works Department seeks to include green infrastructure in some of its routine utility and street projects. Current pilots include the implementation of nearly 11,000 Silva cell frames along 24 blocks in downtown Minneapolis as a stormwater mitigation measure. Silva cells are rigid, stackable structures of glass and polystyrene compound with galvanized steel tube frames. Installed as a subsurface under sidewalks or other paved areas, they provide a maximum amount of soil volume for tree root growth in challenging urban environments. They also provide uncompacted soil "reservoirs" for storage of stormwater runoff.[27,28] When Silva cells take in stormwater, the water either is taken up by the trees or infiltrates into the ground. By maximizing root growth, a large canopy of healthy, mature trees will also, in the future, provide stormwater management through significant interception and evapotranspiration. Models predict a 10 percent reduction in peak stormwater flows as a result of Silva cell installation, and research indicates that the filtration offered by the soil within the cells will potentially remove more than 80 percent of phosphorus, 60 percent of nitrogen, and more than 90 percent of lead, copper, zinc, and iron.[29]

The city's 143-acre Heritage Park development illustrates how green infrastructure can be implemented on a large-scale to transform communities. In 1992, the Minnesota Legal Aid Society and the National Association for the Advancement of Colored People brought a lawsuit against Minneapolis and the U.S. Department of Housing and Urban Development regarding segregation and concentration of poverty. An agreement was reached in a 1995 consent decree to demolish four public housing developments and rebuild the area as a mixed-income, mixed-density community now known as Heritage Park. The distressed public housing was originally constructed over filled wetlands and along the former alignment of Bassett Creek, which was rerouted to underground pipes. The project's design accommodated the site's variable soil conditions, using the most developable areas for housing and creating a system of interconnected ponds and trails in the more challenging areas, bringing parklike amenities to a previously underserved part of the city. The project's green infrastructure features use stormwater captured both from the redevelopment area and from pipes that previously carried untreated stormwater toward the Mississippi River from the surrounding neighborhood.[30] The stormwater treatment system is designed to remove 70 percent of suspended solids and also to reduce nutrients and metals, using a "treatment train" approach to remove pollutants. The process uses underground grit chambers, trench forebays or sedimentation basins, grass filter strips, level spreaders, a series of rain gardens planted with native plants, and stormwater ponds.[31]

## JACKSONVILLE, FLORIDA

Jacksonville does not have CSOs, but it does have a number of stormwater-related pollution problems, including sanitary sewer overflows during severe rains and elevated nitrogen and phosphorus levels in multiple area waterways. Jacksonville is tackling the issue of nitrogen and phosphorus pollutant loading with a strategy that includes ordinances regulating fertilizer, irrigation, and pet waste and encouraging "Florida-friendly" landscaping that conserves water and reduces water pollution for all new developments. Additionally, Jacksonville is starting to focus on green infrastructure as an important component of reducing nitrogen and phosphorus pollution and improving the health of the Lower St. Johns River Basin tributaries. Efforts include implementation of a Basin Management Action Plan to meet total maximum daily loads for the river.[32,33,34]

Under the Basin Management Action Plan, governments, stakeholders, and the Florida Department of Environmental Protection regularly work together to develop strategies to address water quality problems in their watersheds. According to Franklin Baker, EPA Region 4 Florida Watershed Coordinator, when local interest groups come together to discuss water quality improvements, "LID and green infrastructure are tools that are regularly identified as being part of the answer."[35]

Jacksonville's public works department has started to incorporate green infrastructure into select road and flood improvement projects, and some private developers have incorporated green infrastructure components in their plans.[36] Additionally, the city is currently developing a low-impact-development procedure manual for the county, slated for completion in early 2012. Outlining green infrastructure practices and benefits, the manual will serve as an important tool for developers, architects, engineers, and government employees while providing clear specifications for those who seek permitting for green infrastructure construction. In a future iteration of the manual, the city plans to include design specifications for underground cisterns, pervious pavement systems, rain barrels, rain gardens, and other green infrastructure techniques.[37]

The EPA has identified Jacksonville as a priority area, partnering with the city to focus resources on its historically underserved downtown urban core. Green infrastructure practices are being concentrated in this area for benefits to the community that extend beyond water quality.[38] "We are doing green infrastructure for water quality improvement," says Maryann Gerber, EPA's Region 4 Green Infrastructure Coordinator, "but we also want to show how the quality of life for communities can be improved as you do these types of projects."[39]

## TUCSON, ARIZONA

Due to Tucson's arid climate and average rainfall of only about 11 inches per year, the city necessarily views rainwater as a valuable resource. Tucson embraces rainwater harvesting to supplement other available water supplies.[40]

The nation's first municipal rainwater harvesting ordinance for commercial projects, Commercial Rainwater Harvesting Ordinance No. 10597, took effect in Tucson on June 1, 2010. Facilities that are subject to the ordinance must meet 50 percent of their landscape demand using harvested rainwater, prepare a site water harvesting plan and budget, meter outdoor water use, and use irrigation controls that respond to soil moisture levels. Facilities have three years to meet the 50 percent requirement, and the rule is waived during periods of drought. In general, commercial sites in Tucson should be able to comply using passive water harvesting systems,[41,42] defined as systems that passively infiltrate rainwater into soil or porous pavement by use of vegetation.[43] A Residential Gray Water Ordinance also took effect on June 1, 2010, requiring all new residential development to have the necessary plumbing to accommodate a gray water system[44,45]

Educating Tucson's residents about how to harvest rainwater is a critical endeavor, and the city is partnering with several nonprofits and organizations to provide technical assistance to individuals, neighborhoods, and businesses undertaking rainwater harvesting projects. A number of incentives are also in place to encourage rainwater harvesting and water conservation on private property. The city offers guidance schematics for Tucson residents who want to install curb cuts for street-runoff harvesting,[46] and grants are made through Tucson's water department for small-scale neighborhood water harvesting. Statewide tax incentives also exist: residents who install a water conservation system may take a one-time tax credit of up to 25 percent of the cost of the system, up to a maximum of $1,000.[47]

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