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Green Infrastructure Case Studies For Stormwater

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FORESTERMEDIA

In this special report, we highlight several innovative green infrastructure stormwater projects, including rain gardens, green roofs, and large-scale multi-use projects. Several cities that have faced stiff penalties for combined sewer overflows (CSOs) are using green infrastructure to reduce the total amount of runoff.

Omaha, Nebraska

Like many cities, Omaha is working to correct overflows from its aging combined sewer system (CSS). A ridgeline runs through the middle of the city. The older, eastern section of Omaha has a CSS, while the newer west side has entirely separate storm and sanitary sewers.

"Our CSO program is under consent decree from the state, but not from federal," says Nina Cudahy, environmental quality control manager for the city of Omaha.

Elmwood Park

A major CSO project in which green infrastructure plays an essential part is the stormwater diversion at Elmwood Park. This 2012 project won a Merit Award from the Great Plains Chapter of the American Society of Landscape Architecture.

Big Muddy Workshop was the landscape architecture subconsultant to engineering firm Veenstra & Kimm of West Des Moines, IA. The engineering firm provided civil and water resources engineering and project management.

The stormwater diversion includes concrete weirs, bioretention gardens, areas of native grasses, and detention ponds to slow and treat stormwater in the 29-acre park. Elmwood Park lies within the 169-acre Aksarben Village watershed where the CSS was separated.

The top portion of the watershed was fairly flat, but about half of the water drained down a very steep hill. The bottom of the hill was flat, but it was only about 1/4 mile from the receiving body of water, Elmwood Creek.

Credit: Big Muddy Workshop
Elmwood diversion weirs with flowing water

"Because of that great change in elevation and topography, we needed an incredible amount of storage at the bottom," explains John Royster, FASLA, CEO of Big Muddy Workshop.

The solution was complicated, because stormwater would back up in the pipes during a heavy storm. "We didn't have enough room to put larger pipes under the street."

The land is located where two watersheds met. "We were collecting that water from the Aksarben Village watershed and putting it in the Elmwood Park Creek watershed, which was only a block away," says Royster.

Cover Photo Credit: Aerial Innovations of Tennessee

Elmwood Park has three bioretention gardens where stormwater infiltrates. Originally, the gardens were planted with a palette of 13 or 14 species.

"After three years, we looked at the plants. The Joe Pye weed was doing very well, but we had lost a lot of grasses and wildflower forbs," explains Royster.

Plants from fewer species were used to replace those that had died. This is a trend that Royster sees on other projects.

"We are continually going to simpler plant palettes. The beds are not as colorful, but they're probably lower maintenance, and more plants thrive," he says.

"We've been doing green infrastructure since 2008. When we started, we took a very horticultural approach, arranging plants carefully for height, texture, color. We always lost a large percentage of some species. Now we use a lot fewer species. Our mantra on plants for green infrastructure projects is 'simpler, cheaper, better.'"

Plants that are doing well at Elmwood Park include prairie spiderwort and sneezewort. Native grasses include several varieties of sedges—plains oval, palm, Pennsylvania, and fox—plus Northwind switchgrass.

Royster terms as the project's main challenge "the amount of grade drop in a short distance."

He continues, "We wanted to maintain the natural streambed. We didn't want to armor the stream. We have silty, highly erodible soils that we have to protect from erosion."

The solution was to install a series of weirs and two-stage weirs cascading down the ravine and matched to its geometry. When water first goes over the weir, it hits a concrete apron.

Flexamat was installed below the concrete apron. This permanent erosion control product is made of concrete blocks locked together within a geogrid. It holds the soil in place and allows plants to grow through it. Royster describes the Flexamat (made by Motz Enterprises) as "a slick product."

Credit: Big Muddy Workshop
University of Nebraska at Omaha bioretention gardens

To handle a 100-year storm, the concrete weirs would have had to have wing walls 4 or 5 feet high. This much hardscape would have been intrusive and unattractive. Instead, an underground diversion pipe was installed.

The Elmwood Park stormwater diversion is another CSO project that saved money by using green infrastructure instead of gray—larger pipes. The savings totaled $600,000.

What was a forgotten ravine is now a park amenity where people walk and children play. Wildlife habitat has attracted birds and other animals.

Spokane, Washington

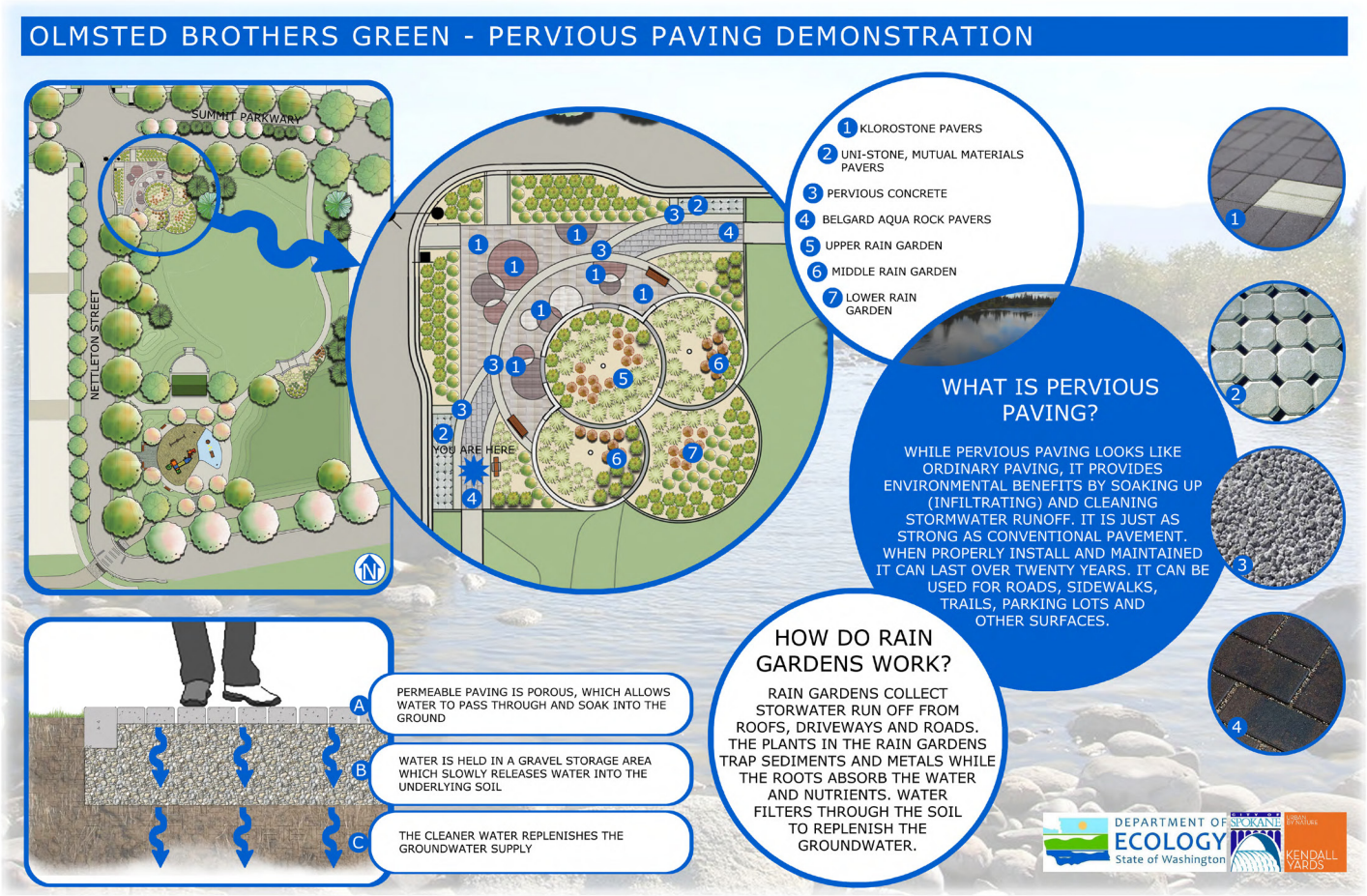
Spokane is yet another American city plagued with CSOs. Its older infrastructure is inadequate to keep up with its growth. During heavy storms, neighborhoods with combined storm and sanitary sewers experience overflows that dump untreated water into the Spokane River.

The Gateway: Lincoln Street

Rick Romero, utilities director for the City of Spokane until his recent retirement, describes Spokane's Lincoln Street as "a gateway to our city—an attractive park-like street."

Eleven blocks of the older residential street were a fine setting for a green stormwater management project that's a good example of Integrated Clean Water Plan projects, even though it was done before the plan was finalized. The street itself was resurfaced, and while that work was being done a stormwater facility was installed.

The Spokane landscape architecture firm of AHBL designed the stormwater project on Lincoln Street in 2009. It was installed in 2010.



Credit: City of Spokane
Signage at Olmsted Green Park

"We moved the curb out seven or eight feet toward the center of the street. There wasn't much need for on-street parking, so we turned that into a storm garden," says Craig Anderson, project manager and landscape architect at AHBL.

Lincoln Street is on a hill. All along the right of way are storm gardens with check dams of recycled plastic timber between them.

"Two years after installation we had a 10-year storm event," says Anderson. "One of our engineers had his wife drive down Lincoln Street during the storm, and he watched out the car window as water entered at the top of the street. It ponded through the first couple of biocells, but at the bottom there was no ponding. All of the water had infiltrated."

The neighborhood has silty clay soil on top of basalt—not favorable for infiltration. Anderson says, "We suspect we tapped into some fissures in the basalt. The project has performed better than expected."

The biofiltration soil added to a depth of 18 inches was the mix developed by the Washington State Department of Ecology, a sandy loam and compost mix. Plants installed included dwarf Oregon grape, dwarf blue fescue, may night salvia, yellow day lilies, and shasta daisies.

"We put in a mix of evergreen plants and plants from a successively flowering palette so that from late spring to early fall something is blooming in the storm gardens," says Anderson.

At the bottom of the hill an underdrain system is beneath part of the installation. It takes runoff to the pond at Cannon Hill Park.

"This was the first project of its type that the city had done. It was a steep learning curve for the engineering and design staff. It was also a learning curve on the public's side. Some people wanted only [traditional] turf and trees," says Anderson.

Residents had to be educated about how the storm gardens would look and be maintained and realize that their earlier perceptions were not accurate. For example, some residents confused species of Oregon grape and thought the species that grows several feet tall would be planted along the street causing major maintenance problems.

Anderson says it took two full growing seasons for the plants to become established. "We've had very positive feedback from the public. The residents like how the curb extension has slowed down traffic."

Indianapolis, Indiana

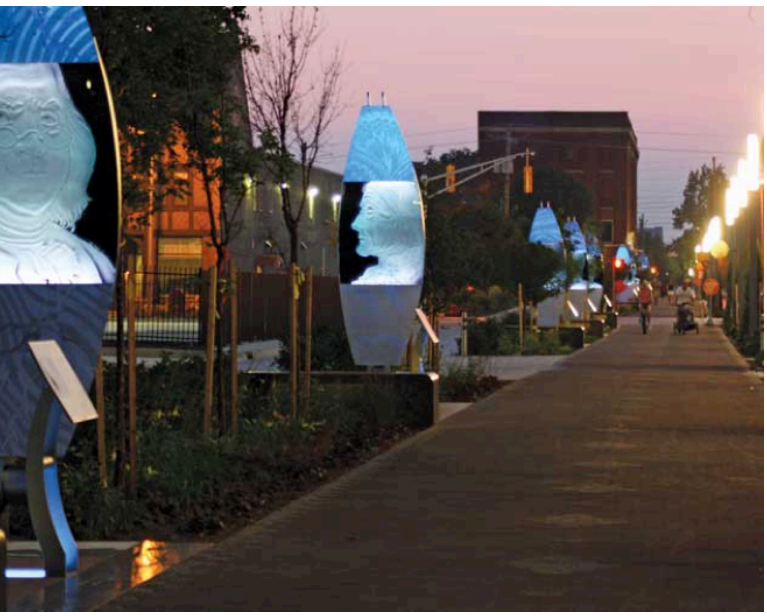
Under a consent decree for CSOs, Indianapolis looks for creative solutions.

Indianapolis Cultural Trail

Many cities have difficulty getting suburban residents to come to the urban downtown area. So did Indianapolis, until May 2013. That's when the final portion of the 8-mile Indianapolis Cultural Trail was dedicated and opened to the public.

"Thousands of people are on the trail every day. People want to be where other people are," says Lauren Day, program manager for the nonprofit organization that manages the trail.

The Cultural Trail connects six areas in and near downtown Indianapolis. They are Fountain Square, Indiana Avenue, Massachusetts Avenue, The Canal and White River State Park, the Wholesale District, and Broad Ripple (the latter via a link to the Monan Trail).



Credit: Rundell Ernstberger Associates
The Indianapolis Cultural Trail includes $2 million worth of outdoor art.

The project is a remarkable result of citizen initiative and generosity, for the city had no money to fund it. It is a popular destination for both tourists and local residents and a model for connecting various segments of the community and encouraging people to be physically active.

"There's an equal split between residents and visitors, as more and more people live and work downtown," says Day. "Indianapolis is a big convention site, and for visitors the trail connects seamlessly to hotels, restaurants, and the convention center."

Indy's Cultural Trail is also a fabulous urban green infrastructure stormwater management project. Videos show dedicated bike riders in spandex, casual cyclists on borrowed BikeShare bikes, joggers, walkers, families pushing strollers, and even older citizens holding on to their walkers, all moving along the trail. Whether they are exploring the heart of Indianapolis, heading for a museum or one of the new shops or restaurants the Cultural Trail has spawned, or out for daily exercise, everyone present travels past some of the 25,400 square feet of stormwater planters and rain gardens.

Regarding the planters and gardens, Kevin Osburn, RLA, ASLA, principal with Rundell Ernstberger Associates, says, "They're working incredibly well. Some have been in place since 2007. We started construction in 2006 and finished in 2012." He also designed this project.

The stormwater planters nearest the streets range from 8 to 9 feet wide. They vary in length from a minimum of 12 or 15 feet to the longest that run the length of a block. The inner planters or rain gardens also vary in size, from 5 to 8 feet wide.

The stormwater planters are placed so that water drops into them. "We've gone as deep as 2 feet. We never wanted them to be deeper than 30 inches so that we had to leave guard rails around the planters," explains Osburn.

The stormwater planters contain beehive overflow structures to send overflow during heavy rains to the sewer system, but they're designed to capture 99% of rain events. They do not have underdrains.

"The soils and subsoils here are very sandy and gravelly," says Osburn. "We're blessed that we have that kind of soil medium to work with."

He notes, "Collecting runoff from the streets into the public right of way—that whole concept was new to the city. We worked closely with DPW [the Department of Public Works] to get them on board. We used five different planter designs in the first phase. The city was still apprehensive. But they worked well beyond what anyone expected, so we replicated them. The first phase covered only a half mile. We used that method of collecting stormwater for the next seven and a half miles."

Credit: Rundell Ernstberger Associates
The trails low planters are curbed with cuts to allow runoff to flow into them.

Wilmington, North Carolina

Another successful green infrastructure project is Wilmington's Wade Park Wetland. It was a $4 million joint project by the city of Wilmington, New Hanover County, and the state of North Carolina. The 17-acre park is on the site of a former wastewater treatment plant. Before the plant was constructed, the area was a natural wetland.

Completed in 2007, the wetland at Wade Park helps clean stormwater before it runs into the Hewletts Creek watershed and also reduces flooding in the area. The largest wetland in the area, it receives runoff from 590 acres, which is about 10% of the Hewletts Creek watershed.

The project began when New Hanover County bought the land in 2005 with money provided by the North Carolina Clean Water Management Trust Fund. Wilmington's Stormwater Services Division installed the 12-acre wetland starting in 2006. The project diverts runoff from two outfalls bordering the property into the wetland before the water enters Hewletts Creek.

The Wade Park Wetland also provides habitat for native and migratory birds and animals. The remaining 5 or so acres of the land were made into a public park after the wetland was completed.

Credit: North Carolina Coastal Federation
Rain garden

The city of Wilmington and its nearby beach towns are fortunate to have the University of North Carolina at Wilmington close. Dr. Michael Mallin, professor of biology and marine biology, works with the city, the North Carolina Coastal Federation, and other entities on stormwater issues.

Mallin led monitoring efforts in 2009 and 2010 to see how well the Wade Park Wetland was handling stormwater volume and pollution. According to a study first published in the November 5, 2012 issue of the *Journal of Environmental Quality*, the results were quite favorable.

The sampling covered eight storms, and showed that the Wade Park Wetland retained and/or removed 50 to 75% of the inflowing volume of runoff. The average load reduction for fecal coliform bacteria was 99%, with an overall concentration reduction of more than 90%.

Credit: City of Wilmington
Wade Park Wetland

Nashville, Tennessee

Music City Center

To many people around the world, Nashville is synonymous with country music. As recording studios and musicians of other types of music moved there, the city acquired its nickname "Music City." This name sings across one of the city's major buildings, the Music City Center. As distinctive a landmark as the old Ryman Auditorium (from where the Grand Ole Opry's country music shows were broadcast to a national radio audience), the Music City Center is Nashville's convention arena.

The Music City Center has 1.2 million square feet of meeting and exhibition space. Certified LEED Gold, the building has solar panels and other measures that allow it to consume on average 20% less energy and 40% less water than similar buildings that are conventionally designed.

Designed to mimic the rolling hills of Tennessee, the green roof above the Music City Center convention arena spans more than 4 acres and is one of the largest green roofs in the Southeast. The 175,000-square-foot roof is composed of 14 different types of vegetation.

The growing medium for that vegetation is rooflite Extensive MCL, from Skyland USA. Because the medium is so shallow—less than 3 inches—prevegetated mats from Sempergreen were installed.

Blended growing media were developed in Germany, which has been at the forefront of the green roof movement. Skyland USA owners knew that such media was proven to work better than using local soils in Germany, so they decided to develop a similar product for the green roof market in the US.

The proprietary blend of rooflite Extensive MCL contains mainly HydRocks, a ceramic material made by calcining clay at high temperatures. The final result of the process is an inert, non-degradable soil that is all natural and very lightweight.

Garick manufactures the rooflite using the HydRocks made by Big River Industries. Because the clay comes from Alabama and Tennessee, it was within a 500-mile radius of Nashville, making the Music City Center project eligible for additional LEED credits for using locally sourced materials.

Credit: Aerial Innovations of Tennessee
The green roof atop Music City Center is one of the largest in the US.

Stormwater runoff and condensation from HVAC equipment are collected in a 360,000-gallon rainwater cistern. This strategy provides water for more than 500 toilets and urinals, irrigates outdoor landscaping, and keeps the runoff out of the municipal sewer system.

Nashville has a significant number of green roofs. They are above the 5th and Main Condominiums, Terrazzo Nashville Condominiums, the Hilton Suites on 4th Avenue South, Werthan Mills Lofts, the Adelicia Condominiums, the AT&T Building/Plaza, Freeman Webb's Green Hills headquarters, Shelby Bottoms Nature Center, Westview Condos, Morgan Park Place Condominiums, and the McCabe Community Center for Nashville Metro Parks.

One reason for the large number of green roofs is that MWS offers a credit for properties with green roofs that are located within the combined sewer systems area. The credit is applied to the monthly sewer charges for a property.

The maximum total credit amount equals $10, multiplied by the square footage of green roof installed. The sewer charges are credited for 60 months or until the maximum total is reached—whichever comes first.

Margaret Buranen *writes on the environment and business.*

Additional Reading

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