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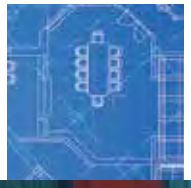
GREAT PRESERVATION
IOWA CITIES PROVE PERMEABLE PAVEMENT IS A SUSTAINABLE SOLUTION FOR INFRASTRUCTURE REHABILITATION



By Elizabeth Bandy

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IOWA CITIES PROVE PERMEABLE PAVEMENT IS A SUSTAINABLE SOLUTION FOR INFRASTRUCTURE REHABILITATION

Across Iowa, cities and towns are using permeable pavement in infrastructure rehabilitation. They are exploiting the multiplier effects (and benefits) that result from combining stormwater management with pavement rehabilitation using permeable interlocking concrete pavement (PICP). These projects not only reduce local flooding and stormwater pollution, they support road rehabilitation and historic preservation.

A permeable paver parking lot in Dubuque along Washington Street between 17th and 18th Streets is adjacent to one of Dubuque's many green alleys, which utilize permeable pavers to reduce stormwater runoff and improve water quality.

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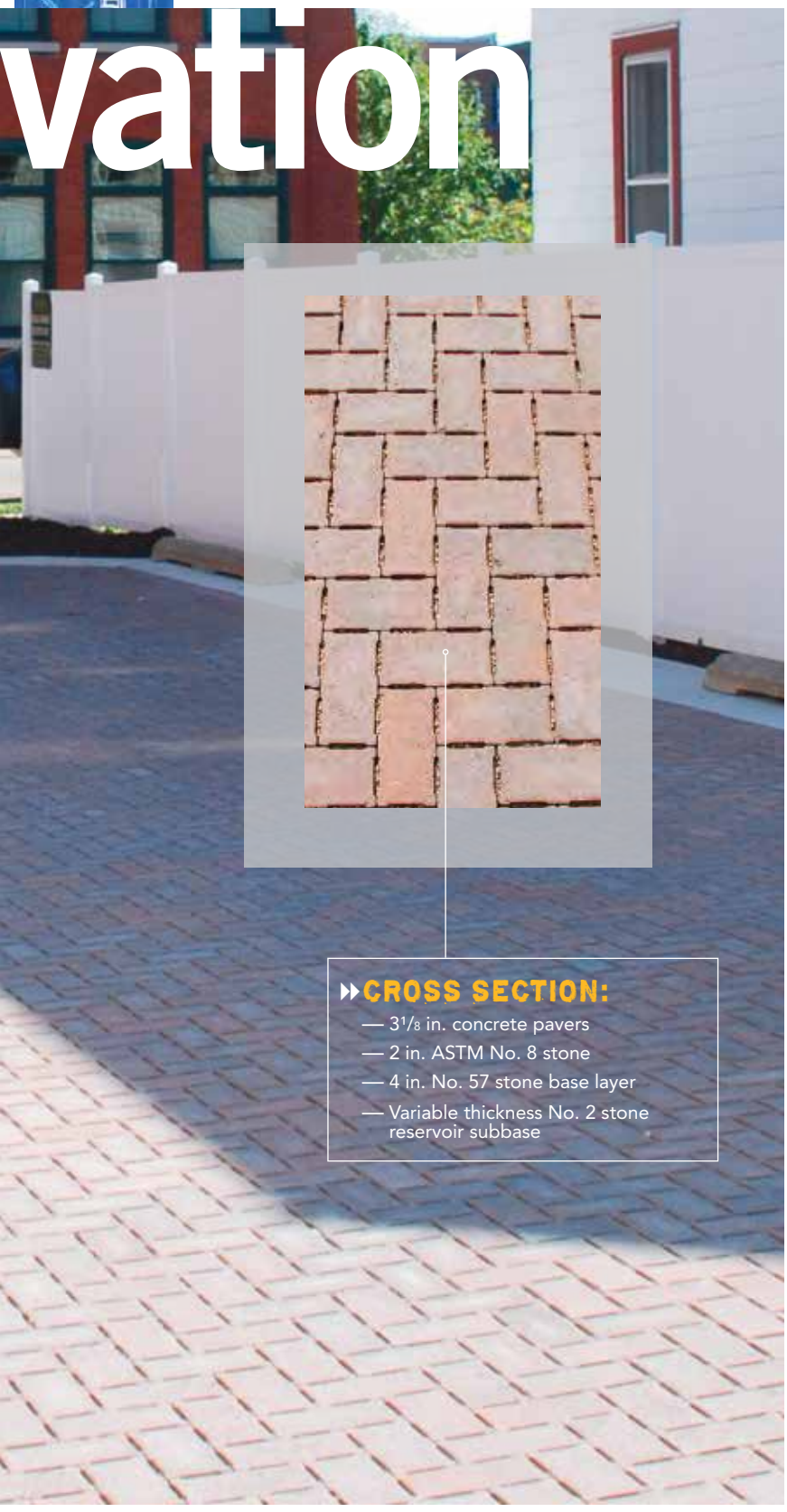

Three Iowa cities recently completed multi-million dollar PICP projects with local, state and federal government funding. A primary funding source comes from the diversification of Iowa's State Revolving Fund (SRF). The low-interest loans, normally used for wastewater treatment projects, are now additionally directed toward infrastructure projects that reduce stormwater runoff, specifically flows into wastewater treatment plants and combined sewer overflows (CSOs).

PICP has been deemed an eligible project element for infiltration in projects intended to reduce CSOs. Other municipalities, including those in Washington, Oregon, Michigan, California and Washington, D.C. are conducting similar projects with more on the way.

GREEN ALLEY PROJECT: DUBUQUE

Situated on the Mississippi River and chartered in 1837, Dubuque lays claim to being Iowa's oldest city. Its location and topography make it prone to damage from stormwater runoff and flooding. In 2011, the city experienced over 13 in. (325 mm) of rainfall in 12 hours, resulting in severe flooding of over 1,300 households. The event was a major impetus for the installation of nine green alleys to reduce flooding and CSOs, which led to planning for another 80 alleys, all built from PICP.

"We're a very sustainable city, and it's a mantra that resonates with City staff," says Jon Dienst, civil engineer for the City of Dubuque. "The pavers were a natural fit for clean water and city design."

City officials took cues from Chicago, now home to more than 100 green alleys under a program targeting four initiatives:

1. Stormwater management (CSO reduction)
2. Urban heat island reduction
3. Material recycling
4. Energy conservation

Dubuque's first two alleys were piloted in 2009 using porous asphalt and PICP; funding was through the federal Community Development Block Grant program. "The City council, without even talking about the performance, just liked the look of the concrete pavers in the alleys," Mr. Dienst recalls of the initial decision.

After the launch, the City decided to take advantage of the state's low-interest loan funds to borrow $64 million for a major overhaul of Dubuque's wastewater treatment plant. The alley financing comprised $9.4 million in State Revolving Funds designated by the Iowa Department of Natural Resources for wastewater and clean water projects. The alleys qualified.

The catch: the funding had to be spent within three years. "That's a lot of alleys," Mr. Dienst says. Forty-eight

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alleys will be constructed this year with an additional 25 next summer. The 25 alleys next year will have sewer and water mains and services replaced at City cost with the SRFs used for the alley pavement and stone.

The alleys are roughly 300 ft (90 m) long and 12 and 14 ft (3.6 to 4.2 m) wide. Each costs about $100,000, depending on topography. The City uses modeling software to determine the reservoir capacity and resulting thickness for open-graded aggregate subbase in each alley. A range of rain events are modeled and the subbase thicknesses determined by extensively testing the soil subgrades for infiltration.

Each alley uses 3 1/8 in. (80 mm) thick concrete pavers over 2 in. (50 mm) of ASTM No. 8 stone. That sits on a 4-in. (100 mm) thick base layer of No. 57 stone. Under this layer is a No. 2 stone reservoir subbase. The project team employed geotextile on the soil subgrade of each alley to help keep the stone clean.

Some of the alleys are next to buildings with foundations over 100 years old. Those installations included new waterproofing to prevent water infiltration. From a cost standpoint, this was well worth the expense, Mr. Dienst says, to prevent water in basements or worse.

"We didn't have experience in Dubuque," Mr. Dienst says. "We had to talk with others and learn from their mistakes." Suppliers and contractors were hard to come by at first, but now are abundant in the area, with pricing around $3.75 to $4/sf ($40 to $43/m^2). "It's almost cheaper to put in the pavers than concrete or asphalt," he says.

The alleys are being monitored for water quality performance and are expected to reduce nitrates by 25 percent and phosphorous by 60 to 70 percent, achievements supporting the City's clean water initiative. An 80 percent reduction of stormwater runoff volume is expected as well. Maintenance costs are low, and the City has invested in a vacuum cleaning truck to help in that effort.

Aesthetically, pavers are well suited for a city heavily rooted in its past. "They are historically appropriate," Mr. Dienst says. "A lot of them are downtown. We are a historic city, recently celebrating 175 years. Historic preservationists are excited about this."

PERMEABLE STREETS: CHARLES CITY

About 130 miles (78 km) northwest of Dubuque sits Charles City with a history of flooding and runoff problems. Federal and state funding provided resources to install 27 blocks of PICP in a residential neighborhood slated for street rehabilitation.

Through the help of now-retired City Administrator Tom Brownlow, Charles City received $3.6 million in 2010 from the American Reinvestment and Recovery Act to install the initial phase of the project. At $2 million, phase two utilized Iowa's State Revolving Fund and 30 percent forgiveness of the eligible costs, essentially paying for the paving portion of the project. The remaining funding paid for sanitary, sewer and water line improvements.

Both projects involved city street renovations with the second phase having learned several lessons from the first. "The first time was a hard sell," recalls Dirk Uetz, Charles City's superintendent of streets. "People were a lot more open-minded after they had seen the first project."

The City commissioned the Conservation Design Forum (CDF) to design the permeable streets. The designers modeled the system to capture runoff from streets, yards and alleys and infiltrate the runoff. Peak discharges for the 10-year storm were reduced by more than 90 percent, according to CDF. This reduction prevented the necessity and expense of upsizing many existing storm sewers. The design took advantage of the sandy soil subgrade by infiltrating much of the runoff rather than directing it to inlets and into storm sewers. Also, the permeable streets were narrowed by 5 ft (1.5 m), thereby increasing the tree lawns and the graceful appearance of the old neighborhood.

Phase one spanned 16 blocks and included permeable areas at intersection corners covered with large stones surrounding raised beehive intakes. These areas ultimately proved difficult for the local homeowners and for the city's maintenance staff to clean. They also presented some risk to children playing nearby. The phase two design of six-and-a-half additional blocks reverted to regular storm drainage intakes, which were easier to maintain and presented no risks to children. Additionally, phase one used slightly depressed retention areas with amended soils in the tree lawns behind the curbs. These proved inconvenient for pedestrians and were replaced by an improved, raised design in the second phase.

While response to the new streets has been positive, the real success lies in the runoff reduction, Mr. Uetz says. "If we have a heavy rain now, you don't see any water going down to the river," he says. "In phase one, we opened the hydrants onto the street and let the water run. The spectators couldn't believe it."

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> —Dirk Uetz, Superintendent of Streets, Charles City

The concrete paver installation at the intersection of Spriggs and Iowa Streets in Charles City features new ADA-compliant pedestrian curbs where the sidewalks meet the street.

DOWNTOWN RESTORATION: WEST UNION

A farming hamlet about an hour's drive west of Dubuque, West Union had its share of stormwater flooding problems including contamination of nearby Charles Stream. Moreover, its aged and worn downtown needed an update.

West Union took the opportunity to implement its Clean Green Climate Action Plan in six downtown blocks. The U.S. National Renewable Energy Laboratory weighed in on the project, which included energy conservation, greenhouse gas reduction and pedestrian infrastructure improvements. Geothermal heating and cooling systems were also built as an incentive for businesses to fill the downtown storefront vacancies, and these systems included snowmelt capabilities.

Completed in 2013, the project totaled $10 million and used state stimulus money, funding from the Iowa Department of Transportation, the U.S. Department of Energy, the Environmental Protection Agency and others. Both the Iowa Department of Agriculture and Land Stewardship and Watershed Improvement Review Board contributed $500,000 each towards the project, with the majority going towards PICP.

"Prior to the project, there was nothing for storm drainage in the downtown area," says Jon Biederman, branch manager for Fehr Graham, an engineering and environmental firm that worked on the project design. "We were looking for a way to clean and cool water [before it runs] into Charles Stream. An easy way to accomplish this was with permeable pavers."

The infiltration system filters runoff through an open-graded stone base to cool it and clean it, accomplishing both goals at once. It also slowed the stormwater runoff substantially. "It can take a few days versus a few minutes," Mr. Biederman says.

West Union's PICP design differed from the norm. While typical PICP installations include a stone subbase storage layer no more than 1- to 2-ft (0.3- to 0.6-m) thick, West Union needed much more storage. In most areas, the subbase is 3- to 5-ft (0.9 - to 1.5-m) thick to store, infiltrate water into the clay soil subgrade, and release any excess slowly to the downstream waterway. The subbase storage layer was topped with a 6-in (150-mm) layer of clean, crushed stone as a base for the bedding layer of 1½ to 2 in. (40 to 50 mm) limestone chips. The concrete pavers rest on this bedding layer, their joints filled with small permeable aggregate.

The clay soil subgrade demonstrated that PICP can be designed to infiltrate into low infiltration soils. The City purchased a vacuum truck for the main thoroughfare and a smaller unit for the sidewalks and to clean the joints twice a year. Ultimately, the design met the project goals for infrastructure restoration, positive environmental impacts and historic preservation.

The street previously had been paved with asphalt over brick pavers placed in 1914. The contractor retrieved the old bricks and incorporated them into decorative strips in the intersection centers. They are installed on the same stone base as the concrete pavers with permeable, stone-filled joints.

"We've had very positive responses," Mr. Biederman says, noting the initial skepticism of the local residents and business owners who were not initially keen on the change. "They look good."

As demonstrated by West Union, as well as by Charles City and Dubuque, Iowa presents some groundbreaking examples of creatively funding infrastructure renovation projects with PICP.

West Union's East Elm Street permeable paver installation included not only the street but also the sidewalks and crosswalks. Brick pavers from the city's first surfacing of its downtown, dating back to 1914, were reinstalled at the center of the intersection.