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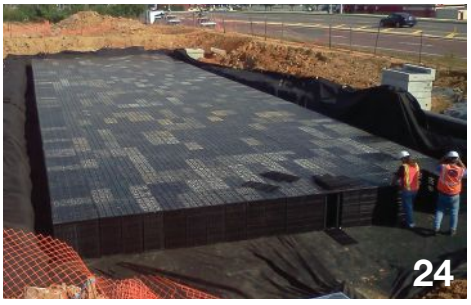

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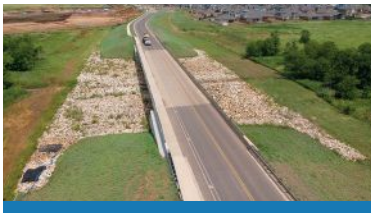

On the Cover

Restoration efforts improve Cottonmouth Creek. **28**

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BPA WORLDWIDE

We Can Do It!

Since joining the SWS team as managing editor, one of my most valuable experiences has been connecting with women in the storm water and erosion control industry. As a young woman professional, I am in the unique position to not only learn from and relate to their stories, but also report on them in ways that may motivate other women professionals.

In February, while attending the International Erosion Control Assn. Annual Conference & Expo in Denver, I joined an intelligent and welcoming group of women at the Women of Water (formerly Women of IECA) networking reception. With a beautiful view of the Rocky Mountains and cocktails in hand, approximately 20 attendees introduced themselves and their roles in the industry, and shared some takeaways. A number of women expressed similar sentiments of watching diversity and inclusivity grow in the industry in recent decades. Several women shared that when they first joined the industry, they could count the women they knew in it on one hand.

More women, young people and people of color are creating change and positivity in the world of storm water and erosion control than ever before. I hope this upward trend continues. The diversity in the industry still is relatively small, but we can encourage growth. We can motivate young women and people of color to join STEM fields; we can create more inclusive work environments; we can develop work clothes and tools better suited for different body types; and we can welcome more diversity in leadership roles.

If you have a story you would like to share, please send it my way. And if you would like to connect with more women in the industry, I hope I can be a resource to you.

Lauren Baltas
Managing Editor
lbaltas@sgcmail.com

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The Big Picture

When complete, the Lakewood Storm Water and Runoff Capture Project in Southern California will cover nearly 14 acre-ft and store 4.5 million gal of water—roughly the same as seven Olympic-size swimming pools. The 307-ft-long-by-180-ft-wide underground structure will be operational in April 2019.

Photo courtesy of Jensen Precast

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The Big Picture

Re-evaluating strategies to meet evolving needs

"Get the water off the streets!"

That was the rallying cry for storm water management through most of the 20th century and certainly the reason for the creation of the Storm Water Management Program (SMP) in Johnson County, Kan., in 1998. Flooding became a major issue for Johnson County cities in the 1970s and 1980s leading to the creation of the SMP. The SMP is funded through a dedicated 1/10-of-one-cent sales tax, and the program's purpose is to provide financial, technical and planning support services for municipalities within Johnson County for storm water management improvements.

Developing the Program

Initially, the SMP was focused on efforts to reduce the impact of flooding. Activities included floodplain boundary mapping; coordinating Federal Emergency Management Agency efforts for municipalities; cost-sharing of flood improvement projects to protect homes, businesses and streets from flooding; and storm water improvement coordination across jurisdictional boundaries. The SMP also provided limited water quality support to the cities, mostly in the form of coordinating and facilitating municipal NPDES permitting activities.

However, in the 2010s, the SMP began to recognize that the "state of the practice" of storm water management was changing and that the needs of the program stakeholders were changing with it. This spurred a strategic planning process that began in 2014 to reassess the current function of the program and determine the best way to move it forward. The SMP engaged Black and Veatch Corp. to lead a comprehensive program update.

The steering committee's ultimate recommendation required key changes to the program. They included moving to a watershed-based organization, refocusing flood mitigation funds toward public safety, including system replacement projects, calling for an asset management program and enhancing focus on alternative funding sources. It envisioned six newly created watershed organizations that would work together to bring projects to the county for funding consideration.

Planning for Change

Johnson County's new approach to storm water management requires a degree of change that is difficult to implement, from a logistical and human acceptance standpoint. Many active stakeholders are involved beyond the professionals working within the program at the county level, but also those in the municipalities that use the program, in downstream municipalities and regulatory agencies, and those who reside in the county. A key step towards overcoming this difficulty is robust implementation.

Through this process, the SMP also found that while formal, long-range strategic plans are commonplace among for-profit and corporate organizations, creating them does not appear to be a commonplace activity for public storm water entities. Strategic planning can take time, needs political backing and may require costs for outside assistance. And simply: change is hard. Organizational inertia can be a difficult obstacle. This can be true for public entities or governments, where it can be easier to stick to what has worked.

Organizations and departments within local governments need to take a critical look at their systems, strategies and structures, to evolve and meet the needs of their stakeholders now and in the future.

Nonetheless, Johnson County's experience represents a compelling example of why and how strategic planning can reap benefits for storm water organizations and their stakeholders. Many of the planning drivers for Johnson County likely are the same for other programs such as an evolving "state of practice," a need to assess the program value provided to stakeholders and an evaluation of the efficient delivery of limited funds.

While the outcomes and strategies in the strategic plan may be unique to Johnson County, the process applied in this effort was not. Organizations and departments within local governments need to take a critical look at their systems, strategies and structures, to evolve and meet the needs of their stakeholders now and in the future.

Heather Schmidt is water quality specialist for Johnson County Public Works. Lee Kellenberger is program manager for the Johnson County Stormwater Management Program. Andrew Smith is national stormwater practice lead for Black & Veatch Corp. Schmidt can be reached at heather.schmidt@jocogov.org.

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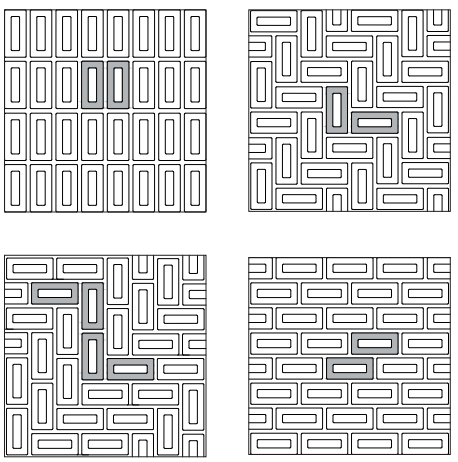

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New York

The city that stretches its storm water plan across five boroughs

The **SWS City Report** is a year-long project, where SWS and a small committee of industry professionals collaborate to assign grades to the storm water infrastructure in some of the nation's largest cities. Modeled after the American Society of Civil Engineer's annual Infrastructure Report Card, the SWS City Report specifically examines storm water infrastructure on a city level. Keeping certain criteria in mind—the condition of the infrastructure, how it will meet future needs, its resilience, how it meets capacity requirements, and its level of innovation—the committee assigns a letter grade, which is followed by a brief, high-level overview of the city's storm water infrastructure. The project will examine one major city in each region of the U.S.: Chicago, New York, Los Angeles, Phoenix and Houston.

The largest city in the U.S. has the storm water management goals to match it. With a population of more than 8.6 million divided among five boroughs, New York City (NYC) has its hands full. Many groups in the city devote resources to improving the city's sewer system, mitigating combined sewer overflows (CSOs) and preventing flooding, ultimately improving storm water management and treatment. Despite these efforts, the city still has a long way to go. Overall, NYC has long-term, big-picture goals, as well as present-day efforts, to manage storm water. However, some of these efforts may be long overdue.

Sewer System

Not all boroughs are created equal, it seems, in NYC. While different areas of the city require different storm water management, basic grey storm water infrastructure is not installed city-wide. For example, some boroughs in NYC do not have storm sewers. To rectify the problem, the NYC Department of Environmental Protection (DEP) is rolling out a long-term plan to install storm sewers in southeastern Queens in addition to the existing sanitary sewers.

In the short term, green infrastructure (GI) can provide some relief, but grey infrastructure ultimately will be necessary. Not only does this lack of storm sewers poorly affect drainage in the area, it also brings up the issue of environmental equality. Demographics vary across the boroughs. This is a trend we see with infrastructure across the U.S., with Flint, Mich., providing a relevant example. That being said, NYC is making an effort to improve the sewer system, even if it is overdue.

Where other grey infrastructure exists in NYC, there are combined sewer systems (CSS). Once the height of technology, CSS now are the bane of many cities' existences. DEP is allocating significant funds to mitigate combined sewer overflows (CSOs) to protect its waterways and ultimately beautify the city, but it has not eliminated them.

According to DEP, the city discharges approximately 20 billion gal per year in CSOs, which is the leading source of pollution in the New York Harbor. However, this number has significantly decreased in recent decades—the CSO capture rate has improved from approximately 30% in 1980 to approximately 80% today, according to DEP. This improvement is noticeable in the harbor. Fewer CSOs has meant improved water quality, leading to increased recreational opportunities and ecological advancement for aquatic life, said OneNYC. Local waterways are still subject to pollution, particularly during heavy rain events, until CSOs are eliminated. Not every waterbody in NYC is fishable or swimmable yet, according to Sri Rangarajan, principal engineer for Boomi Environmental LLC.

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To manage CSOs, NYC takes a multifaceted approach, including efforts to separate CSS where possible, but it relies primarily on its Green Infrastructure Program.

Green Infrastructure

"Our Green Infrastructure Program is the foremost and most extensive, not only in New York City, but I think it's the largest in the nation in the last four years," said Pinar Balci, Ph.D., assistant commissioner, Bureau of Environmental Planning and Analysis, DEP.

To say New York's GI program is far-reaching would be an understatement. DEP has more than 4,500 GI assets across the city, ranging from rain gardens to green roofs to green streets. From 2010 to 2017, it added 467 greened acres. The primary goal of the program is to reduce CSOs into the harbor—and it is a hefty goal. For the overall program, DEP promised a reduction of 1.67 billion gal of CSOs per year, and expects to hit ⅓ of this mark by 2020 by reducing 507 million gal per year. It is too soon to tell if it will accomplish this steep goal.

Source control is a major aspect of the plan. Part of this initiative includes DEP's Rain Barrel Giveaway Program, which began in 2008. In one year, NYC provided more than 5,000 60-gal rain barrels to residents and commercial properties across the city. The harvested rainwater can be used for non-potable activities, such as watering lawns and gardens, thus reducing the strain on NYC's water system, conserving water and diverting storm water from the CSS. However, it may be difficult for the city to monitor the implementation of these rain barrels (e.g., controlling how well and frequently they are used).

Another useful impervious surface is rooftops, which comprise nearly ⅓ of the city's total impervious surface area, according to DEP. NYC is testing the merits of blue—when weirs at drain inlets create ponding—and green—vegetated—roofs. Blue roofs are more affordable, but green roofs offer the added benefits of reducing air and noise pollution and reducing the heat island effect, while blue roofs only minimally counteract it. Until 2018, DEP also offered tax cuts for buildings that incorporated green roofs, which is a powerful incentive. While NYC offers a green roof program as part of its GI program, it is not utilized as much as other features yet.

In addition, DEP implements public right-of-way (ROW) GI, such as rain gardens. According to DEP, ROW space makes up approximately 30% of the impervious cover in NYC. This high percentage of space offers a large opportunity to divert runoff from the CSS. NYC takes advantage of as many spaces as possible to counteract CSOs and incorporate green features, which not only manage storm water, but also ultimately improve the quality of life in NYC.

To help mitigate flooding, the GI plan also incorporates less common features. The Bluebelt Program, for example, uses natural drainage corridors, such as streams and ponds, for filtering and controlling storm water and flooding. Overall, the program covers 14,000 acres and 19 watersheds, and it covers nearly ⅓ of Staten Island.

"The Bluebelt Program is very unique to highly urbanized environments," Balci said.

In 2017, DEP invested $48 million in expanding the Staten Island Bluebelt Program with storm sewers, catch basins, replaced water mains and other expansions. The wetlands will naturally filter storm water from the new sewers and release it into the environment, ultimately welcoming more diverse wildlife in these spaces.

Unfortunately, an expansive GI program like DEP's means maintenance is in high demand during warmer months. Sediment build up may need to be removed, grass may need to be mowed, and vegetation may need upkeep. Although, according to Eric Rosenberg, Ph.D., associate for Hazen & Sawyer, a program similar to "adopt a highway"—"adopt a Bluebelt"—is involving communities in maintaining the bluebelts.

The DEP reached out to the three largest landowners in NYC when developing its GI plan—the parks, the schools and the public housing authority. Then, they reached out to smaller landowners, such as fire departments and public libraries. These partnerships created hundreds of GI projects across the city, but the real work is on private property. DEP started a grant program to incentivize GI on private properties at the point of design.

So far, DEP has successfully secured 35 projects under this program, with another 15 in progress. In order to successfully roll out this program, DEP tapped into community-based organizations, which have more relationships with private landowners in the boroughs. The DEP has committed more than $14.5 million to these projects, strengthening public-private partnerships in the process.

Climate Change

With larger and more frequent storms an imminent threat for an urban coastal environment like NYC, a proactive approach is necessary to mitigate flooding. NYC developed the Climate Resiliency Design Guidelines to provide recommendations to incorporate climate change data in the city's capital projects, Rosenberg said. The plan addresses how climate change will affect NYC and how certain design and construction can be changed to respond to the changing climate.

For storm water, it addresses changes in drainage and design for onsite storm water management systems. In addition, it addresses how sea level rise will affect flood risk for NYC, as well as potential floodplain change. This in-depth and comprehensive plan helps prepare the city for weather-related threats. After Hurricane Sandy devastated the city in 2012, it hopes to proactively prevent another impact of that scale.

Even with an expansive climate change plan, the exact effects of climate change are difficult to predict. While the plan itself is commendable, NYC may find that different design procedures may operate more effectively in the years to come.

NYC's cloudburst management plan may be the effective option they need. Cloudburst management is an aspect of NYC's program for modifying GI to manage storm water above the 5-year storm, which is what the city's storm water system is designed for, said Rosenberg. Cloudburst management intends to use open, dry-weather recreational spaces, such as parks and baseball fields, for storm water management during intense rain events. It maximizes the space available in a congested urban environment by converting them to drainage basins, for example. The city developed two pilots to test how this concept will perform in NYC.

NYC's list of initiatives is long. It juggles short- and long-term priorities to continually provide quality storm water management resources. And while it is not perfect, it manages a lot of programs for a large city.

Lauren Baltas is managing editor of SWS. Baltas can be reached at lbaltas@sgcmail.com or 847.391.1019.

Old Faithful, New Pavement

Walkways at the nation's first national park get a storm water-friendly upgrade

Visitors from across the world come to watch as up to 8,400 gal of boiling water shoot an average of 140 ft into the sky roughly every 60 to 110 minutes from one of the nation's most iconic landmarks: Old Faithful. With more geysers than anywhere else on Earth, more than 4.1 million people visited Yellowstone National Park in 2017 to marvel at the park's unique water features, according to the National Park Service.

However, more visitors inevitably leads to more roads and walkways throughout the delicate ecosystem and fewer permeable surfaces for storm water to infiltrate. Additionally, concrete and asphalt pathways quickly fracture and erode in the freeze-thaw conditions of the park, threatening the careful microbial balance of the geyser basins and hot springs. Yellowstone National Park, Michelin North America, K.B. Ind. (KBI) and nonprofit Yellowstone Forever have worked together to find a more sustainable solution to provide park visitors with safe walkways that protect the ecosystem while also preventing thousands of tires from entering the waste stream. Michelin donated tires that have been repurposed into a permeable pavement, developed by KBI, to withstand the region's harsh weather conditions and filter storm water, all while providing an ergonomic and durable walkway.

Above: The material's design can absorb up to 4,000 cu in. of water per hour.

When Geysers Meet Tires

A partnership started more than 10 years ago when Michelin gave the park technical guidance on tire maintenance and then began providing in-kind donations of $125,000 worth in tires annually for the park's nearly 700-vehicle fleet. As the relationship between the park, Yellowstone Forever and Michelin grew, the partners sought new ways to increase their collaboration and find more sustainable ways to use the tire donations.

"It really evolved over the years and as our relationship grew there was just a desire to do more and more," said Jeff Augustin, senior director of park projects for Yellowstone Forever. "Sustainability has always been a focus for Michelin but it is also a huge focus for Yellowstone National Park."

All parties involved wanted to find a solution that would make the tire donations "not cradle to grave, but cradle to cradle," Augustin said. Michelin, whose North America offices are based in South Carolina, also wanted a way to increase awareness among its own employees regarding the value of the Yellowstone partnership happening across the country. At the same time, Michelin was beginning to develop a relationship with KBI, the manufacturer of Flexi-Pave.

"We like to focus on projects that are around our mission of sustainable mobility, so one of the things that came to mind with them was pathways," said Leesa Owens, director of state, local and community relations for Michelin North America. "As we were exploring that project, we also had the opportunity to have our first project with KBI using this material that was recycling tires."

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Write in 757

1 **Volunteers from Michelin North America collaborated with Yellowstone National Park, Yellowstone Forever and KBI to lay the pavement.**

2 **The completed pathway filters storm water while providing an ergonomic and durable walkway.**

Flexi-Pave is developed out of rubber granules and stone, held together by a polymer binding agent. To create the material, one tire covers approximately 3 sq ft. The material's design can absorb up to 4,000 cu in. of water per hour, allowing storm water and snow melt to percolate through the material. As one of the most visited areas of Yellowstone National Park and one of the most active thermal areas in which the aquifer and groundwater are an integral part of the landscape, the Old Faithful Geyser Basin was selected in 2014 as the initial site to begin replacing walkways with the permeable paving material using recycled tires donated by Michelin.

"What KBI did was take all the service vehicle tires that were used that were getting disposed of and we granulated the tires and brought them back into Yellowstone to go into Flexi-Pave," said Kevin Bagnall, CEO and founder of KBI. "We have achieved a lot more than just a walking surface and actually allowing the water to go back into the geyser basin. We are also making a pavement that does not crack in the sheer freeze-thaw conditions that naturally exist at that level altitude and that location."

However, Bagnall stressed that the material is not designed to be in competition with asphalt or concrete. Rather, it is to be used where asphalt or concrete cannot perform. The material allows water to sink into an aquifer at more than 3,000 gal per sq ft per hour and treats the water as it passes through. The material's pore space, which has 23% emptiness in the dynamic voids within the matrix of the material, naturally grows an anaerobic bacteria, which removes approximately 86% of dissolved nitrates and dissolved orthophosphorus.

Collaboration was essential to make a project of this magnitude a reality. Yellowstone Forever acted as the conduit for Michelin and KBI to work with the park, Augustin said. Michelin Corporate Foundation, headquartered in France, provided the funding. Employees from Michelin, the National Park Service and KBI all came together to install the permeable pavement.

Michelin wanted to strengthen its employee connection with the Yellowstone partnership. For the first phase of installation in 2015, Michelin ran a random employee drawing and selected 10 employees to win a trip to Yellowstone National Park and help install the pavement. The company received overwhelmingly positive feedback on the program and continued a similar drawing for subsequent phases. Many of the employees had never been to the park before, Owens said. The program brought together employees from across the county to collaborate on the project and connect with Michelin's tire recycling initiative.

"It also makes them even more proud to work for a company that would invest in them having this experience, invest in a partnership with the park, and then learn more about

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Write in 758

1 **The material's pore space naturally grows an anaerobic bacteria, which removes approximately 86% of dissolved nitrates and dissolved orthophosphorus.**

2 **Four phases of pavement installation have been completed, beginning in 2015.**

the material and the product and see tires be recycled into a good use," Owens said.

The installation process involves mixing recycled tire chips with a binding material before smoothing the mixture onto the pathway with a board, similar to concrete installation. The mixture needs to cure overnight before it can be walked on, but Owens recalled an occasion when a bison walked across the pathway as the crews were still working on it.

A Winning Partnership

So far, four phases of pavement installation have been completed, beginning in 2015 and continuing annually at different locations throughout the Old Faithful Geyser Basin. The first covered 6,490 sq ft, the second covered 4,610 sq ft, the third covered 8,000 sq ft and the fourth covered 14,000 sq ft, Augustin said. So far, the permeable pavement material has performed well in the challenging ecosystem and received biannual maintenance.

"It's performed well," Augustin said. "You know Yellowstone is unlike any other ecosystem in the world, obviously, and I think that provides an interesting set of challenges whenever you are constructing or building anything inside Yellowstone. Not only do you have incredible temperature swings between summer and winter, but tack on 4 million visitors a year in a thermal influenced ground or base layer and it really creates a challenging environment to construct structures on."

Despite the challenges, all parties involved seem optimistic about the future of the project and potential future phases. Michelin North America has submitted a proposal to Michelin Corporate Foundation for funding to complete an additional phase of the project, though this time the pavement would be located in the park's second most popular area near the Grand Canyon of Yellowstone. Moving forward, Bagnall sees potential for permeable pavement like he creates at KBI to become more prominent as urbanization increases.

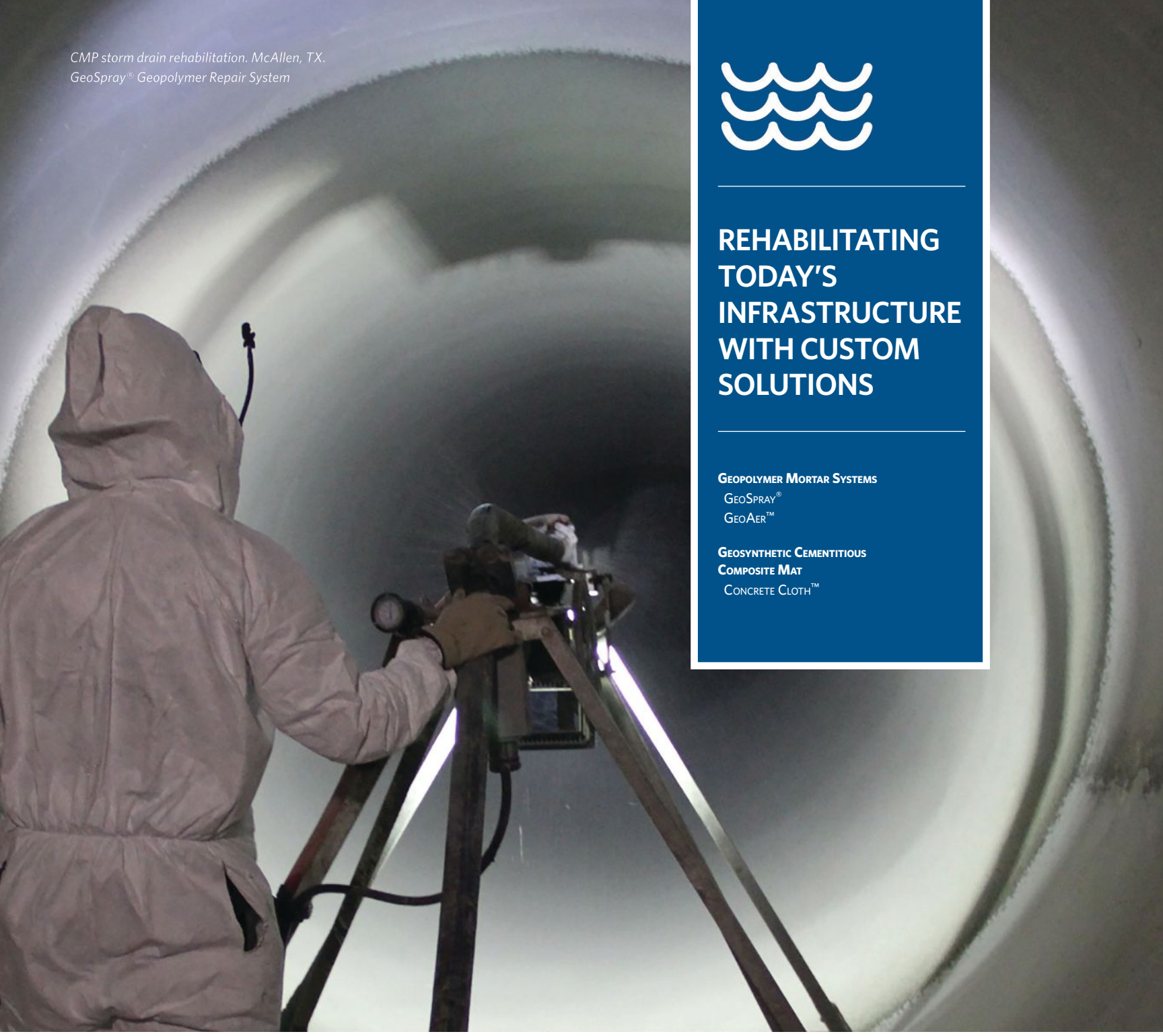
"I think one of the main points here to look at above and beyond the Yellowstone project, which is a phenomenal project, is the urbanization increase or population increase," Bagnall said. "I mean, the only thing that is not increasing is our fresh water, so we better be very careful of how we conduct our expanding urban areas. Water is our next oil."

Augustin agreed that the Yellowstone project could serve as a case study for other applications. "I think that these public-private partnerships are essential in maintaining Yellowstone's ecosystem and protecting and preserving it for the future," Augustin said.

When Owens visited Yellowstone National Park in September 2018 to install the most recent phase of pavement, she took the opportunity to visit previously laid sections of the project. Her view of the storm water-friendly material inspires hope for future phases of the project and perhaps a more widespread use of permeable pavement in the future.

"When you think about laying a pathway material, the word 'beautiful' does not come to mind," Owens said. "I will tell you, when this is laid down it just looks so beautiful. Part of it is the setting that it is in, but the material and the pathway is just very fitting for the natural landscape of Yellowstone and then the benefits on top that it is porous."

Lauren Estes is associate editor for SWS. Estes can be reached at lestes@sgcmail.com.



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 | By Allison Fore & Patrick Thomas

Storm Water Fortress

Chicago's McCook Reservoir Stage I prevents flooding in its inaugural year

Improving water quality in area waterways and protecting homes and businesses from flooding are the two missions of the Metropolitan Water Reclamation District of Greater Chicago (MWRD), and the organization's latest 3.5-billion-gal engineering accomplishment achieved both. Since coming into service in December 2017, MWRD's McCook Reservoir Stage I in Bedford Park, Ill., has captured 27.2 billion gal of water from multiple storms and, combined with the adjoining tunnels that feed into the reservoir, the entire McCook system captured 46.1 billion gal in 2018. Without the reservoir and tunnels, the storm water and wastewater combination could have overwhelmed local sewer systems, causing combined sewer overflows (CSOs) that pollute local waterways and flood streets, homes and communities.

The final piece of MWRD's Tunnel and Reservoir Plan (TARP), the McCook Reservoir will maintain the largest footprint. The reservoir serves central Chicago and 36 suburban communities, covering a 252-sq-mile area with a population of 3.1 million people. Stage I provides an estimated $114 million per year in flood reduction benefits, while also capturing untreated water that formerly overflowed into waterways in rainy weather. After storms subside, the polluted water that was captured in the system is pumped to MWRD's Stickney Water Reclamation Plant (WRP), where it is cleaned before being returned to the Chicago Sanitary and Ship Canal.

In February 2019, the MWRD and project partners at the U.S. Army Corps of Engineers (USACE), who worked together to complete Stage I, entered into an agreement on a federal funding plan to complete Stage II by 2029. This second stage of the reservoir will hold an additional 6.5 billion gal, for a total of 10 billion gal of storage, large enough to fill 200 million rain barrels. The McCook Reservoir in its entirety will be 6,400 ft long by 1,000 ft wide by 300 ft deep.

"McCook Reservoir is helping millions of people in Cook County year round," said MWRD President Kari K. Steele. "It takes on the snowmelt in the winter months and the heavy showers that inundate our communities during warmer months. By relieving us from the burdens of excess water, this engineering marvel is protecting our waterways from pollution and our homes from flooding."

Expanding Capacity

Formally adopted by the MWRD in 1972, TARP was constructed in two phases, beginning with 109 miles of tunnels that are 150 to 300 ft below ground. The tunnels (Phase I) were then connected to three reservoirs (Phase II). When the Phase I tunnels came online in 2006, they cut the number of CSOs in half and prevented an estimated 85% of the CSO pollution. The first two Phase II reservoirs to be completed—Thornton Composite Reservoir to the south and Majewski Reservoir to the north—have nearly eliminated CSOs in those areas. In fact, the Thornton system has captured more than 99% of the volume of CSO discharges since the Thornton Composite Reservoir was placed into service in 2015. When McCook Reservoir Stage II is completed by 2029, TARP's final storage volume will be 17.5 billion gal.

The McCook Reservoir is being mined to its massive dimensions by Vulcan Construction Materials through an agreement with MWRD. Mining of Stage I began in 2003. Vulcan mines rock and sells it through its existing McCook Quarry, which has been in business for more than a century. A 2,000-ft-long conveyance tunnel was constructed beneath the Stevenson Expressway (I-55) and the Des Plaines River to connect the reservoir site with the existing McCook Quarry and transport the rock. The aggregate is used in road and building construction projects in the area. Prior to mining the rock, MWRD had to find a home for more than

Above: The McCook Reservoir Stage I can hold 3.5 billion gal.

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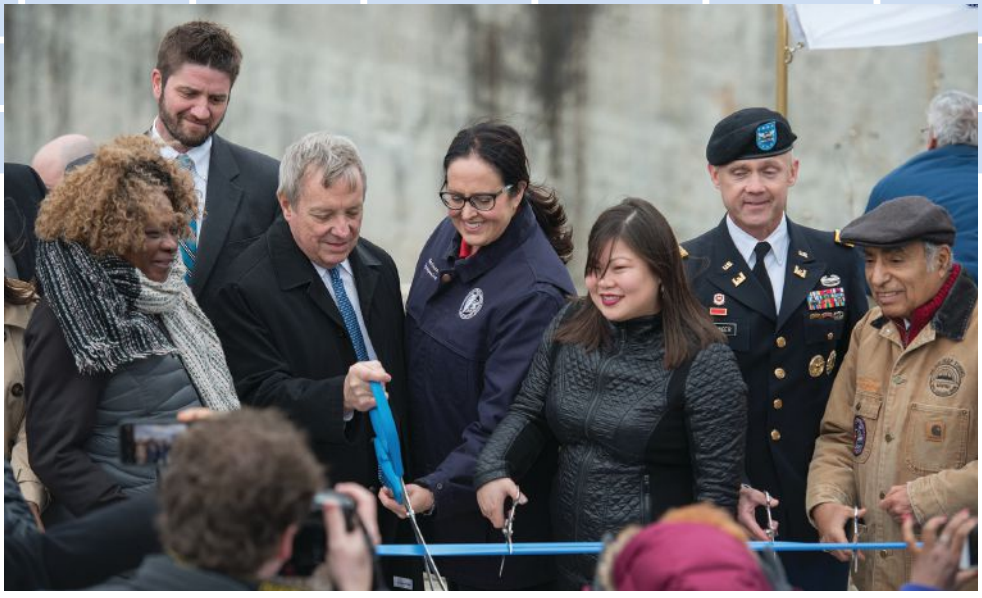
Mining of Stage I began in 2003 and came online in 2017.



MWRD Commissioner Mariyana Spyropoulos and U.S. Sen. Dick Durbin of Illinois (center) cut the ribbon at the Stage I opening ceremony.

9.4 million cu yd of overburden and dirt excavated from the site. As part of that work, two man-made hills were constructed to enhance a nearby forest preserve trail.

In addition to collecting the water, it also is necessary to retain it. Retaining walls were constructed to stabilize the overburdened slope around the reservoir. Along the perimeter, thousands of holes were drilled more than 300 ft deep into the rock, then filled in stages from the bottom up with grout under pressure. The grout migrated into cracks and fissures in the rock mass and reduced the permeability, forming a grout curtain. The holes were drilled every 5 ft around the reservoir's nearly 3-mile perimeter, followed by a second row approximately 15 ft away, angled in the opposite direction to intercept and seal as many cracks as possible. The grout curtain tied into a nearly impermeable natural layer of shale about 325 ft below ground to further prevent water from escaping. A 14,450-ft-long slurry wall was installed around the perimeter of the reservoir between the two rows of grout curtain holes, sealing a roughly 50-ft-deep layer of dirt above the rock to prevent groundwater from entering the reservoir.

Because the reservoir will capture significantly more polluted water, MWRD increased pumping capacity at its Mainstream Pumping Station, conveying the captured water approximately 4.5 miles from the reservoir to the Stickney WRP for treatment. In order to dewater the reservoir to the pumping station, four tunnels were constructed, spanning from a new underground chamber replete with a series of giant gates and valves to control the flow in and out of the reservoir and to and from the pumping station. At 31 ft high, 3 ft thick and 18 ft wide, wheel gates control flow into the reservoir from the 40.5-mile Mainstream Tunnel System. Finally, a solar-powered aeration system was installed to oxygenate the water stored in the reservoir to minimize odors.

Battle Tested

Only weeks into service, the reservoir faced its first test with unseasonable rains in January 2018. Water rushed into the reservoir, demonstrating a fully functioning system. The initial inflow of water entering the reservoir accounted for 263 million gal, but given the reservoir's size, it marked only a fraction of its capacity.

One month later, the Chicago region was hit by a major storm. A sudden spike in the temperature required MWRD to capture and treat heavy rains mixed with snowmelt and runoff from the frozen ground. Approximately 2.77 in. of rain fell at the Stickney WRP over two days in February 2018, and the McCook Reservoir service area took on an estimated 12 billion gal of water. This did not include several billion gallons of snowmelt that came as a result of 60°F weather. The TARP system captured an estimated 9.2 billion gal of water, and the reservoir provided working relief for a 20-hour duration. Because of the reservoir, MWRD was not forced to reverse the flow of the Chicago River into Lake Michigan to prevent flooding downtown Chicago.

In 2018, the McCook Reservoir took on water on 39 occasions, preventing immeasurable flood damage costs while preventing trash, oxygen-depleting organic material, suspended solids, phosphorus, nitrogen and other pollutants from entering the river system and Lake Michigan. As a result of this project and other water quality enhancements made by MWRD, area residents now see the Chicago Area Waterway System (CAWS) as an environmental, economic and social asset. Marinas, riverfront trails and riverside restaurants were developed; river recreation and tourism are on the rise; and game fish have returned to the CAWS. In fact, since the launch of TARP, the amount of fish species has grown from 10 in 1974 to 77 in 2019, including 60 found in the CAWS since 2000.

However, TARP is not the answer for every flooding problem. Sewer backups may occur for a variety of reasons, ranging from limitations to conveyance of water flow in local pipes, the groundwater table, undersized drainage designs, drain blockages, and roof loads and sump pumps attached to house lines. Now, 3.1 million people are better protected from flooding caused by intense rain events.

Allison Fore is public and intergovernmental affairs officer, and Patrick Thomas is public affairs specialist for the Metropolitan Water Reclamation District of Greater Chicago. Fore can be reached at forea@mwrd.org or 312.751.6626.

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The underground storage system makes use of limited land availability.

Thinking Outside the Big Box

A department store combines bioretention & subsurface detention basins

Once a sprawling 636-acre farm, the Spring Ridge Corporate Center now is a beacon of growth in the rural landscape of Berks County, Pa. It spurred rapid development of commercial and residential properties in the area.

Kohl's department store constructed a store on the surrounding area's last remaining, 10-acre location. Once the construction was approved, Kohl's faced an issue. As the complex grew and the design strayed from the original plan, it required the installation of a detention basin to handle the site's runoff.

With a timeline of less than two years and regulatory storm water management requirements to meet, McCarthy Eng. of Reading, Pa., was tasked with developing a plan for building a big-box store on a plot of land originally laid out for two small restaurants. McCarthy Eng. also had to develop a solution for mitigating runoff from the existing corporate center.

A Dual Approach

The designers sketched a standard retail lot that utilized the entire property and included the surrounding landscaping, a parking lot and the store itself. The engineers decided to incorporate aboveground storm water facilities with underground detention to meet NPDES requirements.

The process began by directing a portion of the runoff from the existing site to a neighboring basin capable of handling additional drainage. With this reduced existing requirement and a new site remaining, the team began to

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look for a product that would provide the necessary storage without exceeding the project's budget.

Brentwood's StormTank is a lightweight, polymeric, subsurface storm water storage structure. The designers used the product to mitigate the remaining runoff that the aboveground biofiltration basins could not handle within the tight dimensional constraints.

To meet the regulatory requirements for volume and rate, the project took a dual-solution approach to water quality and quantity, incorporating two bioretention basins with two subsurface detention basins into the design. The first aboveground bioretention basin was to collect offsite runoff and a portion of the new construction, then treat it by using the plant material and an underdrain system before discharging it through the site and to existing infrastructure. Second, a portion of the site was directed to underground detention system A, which was 96 ft long by 45 ft wide by 3 ft tall with approximately 12,500 cu ft of storage capacity, before being discharged into another bioretention basin for treatment, then again discharged to the existing infrastructure. Finally, to handle the portion of the new site that drained away from these bioretention basins and towards a major artery, underground system B, which measured 120 ft long by 21 ft wide by 3 ft tall with approximately 7,300 cu ft of storage capacity was installed separately from the other site drainage networks. Combined, they provided slightly less than 20,000 cu ft of storm water storage while impacting zero buildable land. The strength of the storage structure's classification allowed for the installation of the basins beneath the store's parking facilities, collecting runoff from inlets and rain garden parking islands.

Meeting Regulatory Requirements

The product's design allowed for the easy incorporation of an impermeable liner to prevent infiltration in this heavy hotspot of Karst geography and sinkholes. The liners were used on all four basins and presented a challenge to the bioretention facilities. These facilities typically are

designed to allow runoff to filter through a soil media before infiltrating into the native soils. This process, along with nutrient uptake by the vegetation and evapotranspiration, results in water quality improvements. Because this project was forced to incorporate liners, the runoff that passed through the soil needed a way to be discharged instead of infiltrated. To accomplish this, an underdrain system was connected to discharge structures.

Successfully installed under the parking lot of the Kohl's department store, the system permits the necessary mitigation to meet regulatory needs while also expanding usable land. This design met the needs of the designer, owner, community and regulatory agencies, while introducing a new resident to the area's development.

Jason Bailey, P.E., is product line manager for StormTank. Bailey can be reached at jason.bailey@brentwoodindustries.com.

The system provides nearly 20,000 cu ft of storm water storage.

Taking Root

Restoring the native blackland prairie to Cottonmouth Creek

Like much of the central and southern coast of the U.S., Austin, Texas, is regularly exposed to powerful storms moving inland from the Gulf or overland from the Pacific. Combined with the flat geography and underlying strata of silt and limestone, these meteorological characteristics create an environment that responds to precipitation in a way that often is dramatic, with the scarred hill country terrain serving as a reminder of the forces of erosion.

Austin's growth has not stopped accelerating since the turn of the millennium. Thankfully, Austin leadership has long known that such relentless growth must be coupled with careful forethought as the city limits creep across previously undeveloped terrain. Not only can storm events devastate communities with inadequate infrastructure, but unchecked development can magnify the threats posed by these storms by disrupting the equilibrium of local riparian ecosystems.

A Fragile Ecosystem

Cottonmouth Creek is an ephemeral headwater stream that is fundamental to relieving storm water from the growing number of communities in southeast Austin. Bound by subtly rising ranchland and the slopes of the extinct Pilot Knob volcano, flows collected in the Cottonmouth Creek basin are discharged first to Onion Creek and then the Colorado River.

Brookfield Residential Properties Inc., the developer, has worked to make Easton Park a reality since the early 2000s. Easton Park is a 10,000-unit residential development in southeast Austin that borders the Cottonmouth Creek floodplain immediately upstream of its confluence with Onion Creek. Much of the land in the Cottonmouth Creek basin is representative of the Texas Blackland Prairie Ecoregion, which the state considers a highly threatened ecoregion. Unfortunately, historical agricultural uses have resulted in deteriorated ecological conditions throughout the Easton Park site. Environmental assessments conducted while planning the Easton Park site determined that active restoration and ongoing management practices were necessary for the Blackland Prairie to survive.

Both the city of Austin and Brookfield Residential are committed to minimizing impacts of development on the natural environment. During initial planning discussions, the city and the developer worked together to establish special development conditions that would ensure that the proposed construction activities would not jeopardize the valuable ecoregion or storm water conveyance functions of Cottonmouth Creek. Because of this coordination, the entities agreed to the following two conditions for approving Easton Park's construction: the developer would be responsible for restoring the Cottonmouth Creek ecoregion to that of a healthy headwater Blackland Prairie, and the work in the Cottonmouth Creek riparian corridor would need to provide significant, demonstrable environmental benefit to the creek, riparian area and floodplain.

Starting in 2013, Brookfield Residential retained the services of Lockwood, Andrews & Newnam Inc. (LAN), a national planning, engineering and program management firm, to masterplan, design, permit and construct the major water and wastewater infrastructure. Initially headed by a different team of consultants, the Cottonmouth Creek restoration project had been in permitting for a year and a half when progress came to a standstill because of design disagreements between the design team and the city. To break the deadlock, in mid-2017 Brookfield Residential gave the reins to LAN's Austin team of floodplain experts to bring the permits to fruition. LAN overhauled the design

Above: A six-month regimen of mechanical disking and mowing, coupled with the application of non-selective herbicide and manual removal of invasive vegetation, helped restore native plants.

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A network of seepage berms promotes infiltration and reduces storm water erosion.

packages and diligently worked with the city to rebuild their confidence in the project. The city issued construction permits for the restoration work within six months of LAN taking on the project.

Much like the inherent symbioses that support an ecosystem's equilibrium, the city's conditions are related and mutually beneficial. Renewing the native headwater Blackland Prairie ecoregion to the Cottonmouth Creek basin provides significant, demonstrable environmental benefit to the creek's riparian area because it is a naturally sustainable ecosystem that begets creek resilience and longevity. As such, the essence of LAN's proposed restoration involves planting species that comprise the Blackland Prairie ecoregion. The restoration design improves the Cottonmouth Creek riparian corridor in three ways that are critical to establishing a hospitable environment for the burgeoning ecosystem:

- It promotes an ideal mosaic of distinct vegetative habitats;
- It increases the complexity of hydrologic connectivity in the floodplain; and
- It provides short- and long-term structural streambank protection.

Restoring a Prairie

Many of the Blackland Prairie species require more consistent saturation than could be maintained with the existing vegetation. Through years of agricultural inactivity and proliferation of invasive species, the existing Cottonmouth Creek was overrun by non-native grassland, such as Johnsongrass, sumpweed and Japanese brome in the upland, while the riparian corridor was dense with hackberry and giant ragweed. These invasive plants outcompete the native species for resources, creating an environment that is hostile to many of the essential species of the Blackland Prairie.

Therefore, the first step in ensuring success of the restored headwater Blackland Prairie ecoregion was to implement a rigorous sequence of invasives management and vegetation treatment to cull the woody plants and herbaceous annuals that would otherwise stifle the new growth. This sequence comprised a six-month regimen of mechanical disking and mowing, iterative application of non-selective herbicide, and manual removal of giant ragweed and grubbed vegetation.

Following the vegetation treatment, seeding and planting of three primary vegetation zones was proposed to establish a diverse habitat of structural and native species characteristic of the Blackland Prairie. The vegetation zones included riparian forest (e.g., cedar elm, wax myrtle, etc.); wet meadow (e.g., cottonwood, indigobrush, etc.); and, upland savanna and grassland (e.g., bur oak, redbud, etc.). This arrangement provided a maximum canopy cover of approximately 85% to facilitate herbaceous undergrowth in the riparian corridor and evenly transition to an anticipated 15% canopy density in the upland savanna and grassland.

In addition to reducing resource competition imposed by invasive species, the normal availability of water in the riparian corridor needed to be increased to sustain the newly planted vegetation. A network of seepage berms was designed to provide consistent and abundant water supply to sustain the Blackland Prairie habitats.

The seepage berms will promote infiltration and reduce storm water erosion. A total of five seepage berms will receive flows from storm drain outfalls as they discharge from the residential areas to the floodplain. Each seepage berm is designed as an earthen wall with a reinforced section where overflow is expected

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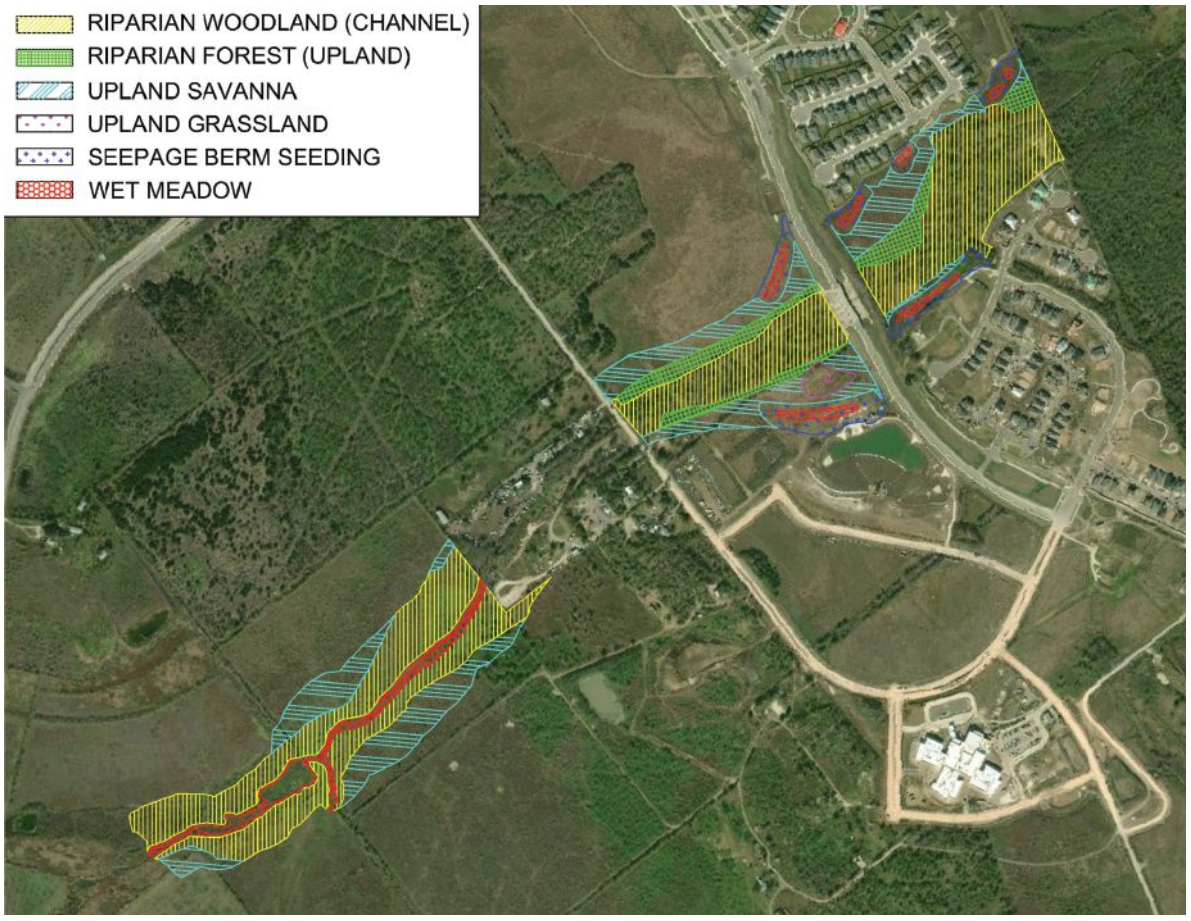

The seepage berms promote recharge of the groundwater by infiltration, which creates a riparian area with a higher degree a of saturation.

to occur. The seepage berms will retain storm water received from the subdivisions during a 100-year storm event.

By collecting and retaining precipitation, the seepage berms promote recharge of the groundwater by infiltration. This increases the complexity and hydrologic connectivity of the floodplain by creating a riparian area with a consistently higher degree of saturation that benefits the hydrophilic plant species of the Blackland Prairie ecoregion. Additionally, by locating the seepage berms in the flow path of the residential storm drain outfalls, the risk of streambank and channel erosion due to scour by overland flow is substantially reduced, thereby further enhancing the structural protection of the streambank.

Channel improvements, comprising cobble riffles and natural structures, will be installed to provide structural protections and increase water retention in the corridor. The primary function of the cobble riffle arrangement is to obstruct flow in the channel to facilitate formation of riffle-pool sequences. Riffle-pool sequences impose control over channel velocities to abate widespread scour in the floodplain and increase streambank resilience.

Large woody debris collected during restoration activities will be installed between cobble riffles to further inhibit channel velocities. Root wads, logs and tree trunks will be partially buried in the creek channel so that localized scouring can deepen the channel and produce pools. In combination with the velocity restrictions imposed by the cobble riffles, these pools increase hydraulic retention time through the creek. Longer hydraulic retention time in the creek directly improves groundwater recharge by extending the opportunity for standing water to saturate the ground. Additionally, these more frequent and resilient pools of water further develop the complexity and hydraulic connectivity in the floodplain by creating protected locations for infiltration.

Meeting Goals

Overall, the restoration improvements will substantially benefit the riparian corridor by increasing frictional resistance on floodwaters. Although the existing vegetation is particularly dense in the channel, the plantings scheme and location of habitat structures are designed in an arrangement that more consistently opposes flow velocity across the floodplain. Similarly, the seepage berms and cobble riffles will reduce peak rates of flow discharged into and through the channel. These design elements obstruct creek flows to reduce streambank erosion and further support a sustainable and structurally stable creek for years to come.

The restoration work was split into three contracts to minimize construction impacts to the creek. Each of the three phases of the work is contracted to be completed within 14 months. Such long construction windows are necessary to allow adequate time for effective implementation of pre-vegetation and invasive species management before the Blackland Prairie species are sown. Having begun at the end of 2018, construction is currently underway and is estimated to be complete by the end of 2020.

William Chandler is project manager for Lockwood, Andrews & Newnam Inc. Chandler can be reached at wcchandler@laninc.com.

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By Tori Durliat

Safety First

Michigan airport rehabilitates drainage pipe with little impact on flight operations

When it was discovered that the 60-in.-diameter storm water drainage pipe under the South Haven Area Regional Airport's (LWA) main runway and taxiway was caving in, a new 300-ft pipeline had to be installed to save the paved area without impacting flight operations. Located near Lake Michigan and 20 miles north of Benton Harbor, Mich., the general aviation municipal airport has an average of 74 flights a day of mostly single-engine aircrafts. The main runway is paved and is 4,800 ft long and 75 ft wide. The other runway is a 3,300-ft-long turf runway.

Underground Obstacles

As with any airport regardless of size, flight operations and safety are the top priorities. Digging up the runway to put in a new culvert pipe not only was impractical but it would have been a major capital undertaking. Answering an invitation to bid, Compton Inc., a third-generation, local land improvement contractor, would slipline the old corrugated metal pipe (CMP) with a thermoplastic pipe.

"I went out and walked the job several times," said Marc Compton, project manager. "We decided to bid and won the job. The old pipe was 60-in.-diameter corrugated metal pipe that ran for 277 ft on a diagonal of about 4 ft under the runway and taxiway. It is part of a county drainage ditch that is associated with a number of surrounding agricultural applications and outlets a little bit further down into Lake Michigan. We did not know when the metal pipe was installed, but our visual inspection revealed that it did not look like it was going to hold up and would continue to deteriorate. That was the purpose of this job—to remediate it and do it quickly because of the potential hazard of a runway collapse. The holes and gaps in the pipe would continue to allow soil to infiltrate and create voids under the runway."

Compton had to finish the job in 12 days. The contractor needed to meet Federal Aviation Administration regulations, and the project had to be rated for under runways. Compton decided to use 48-in.-diameter SaniTite HP pipe from Advanced Drainage Systems Inc. to slip into the old pipe. This smaller diameter would provide the space between the old and new pipe needed for grouting, but because of the new pipe's smooth inner wall, the water flow would not be impacted but actually improved. To start, the crew flushed out and vacuumed the bottom of the pipe to get rid of any debris and sediment. During his original inspection, Compton found several deflections in the pipe's ceiling.

"At first, we thought we might be able to get under them with the new pipe, but if not we had two contingency plans," Compton said. "Number one and our first attempt was to use jacks to push the defections out of our way so we could slip the pipe through. That did not succeed because the bottom of the pipe was so badly rusted we did not have a good platform and the jack would punch through the bottom

Above: A 300-ft pipeline was installed below the South Haven Regional Airport's main runway without impacting flight operations.

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1 **After the new pipe was pushed into the old pipe, the space between them was filled with controlled low-strength material flowable fill grout, and grates were attached at each end.**

2 **The pipe's smooth inner wall improves water flow.**

of the pipe before we could remediate the deflections on the top. We had to resort to taking in our saws and grinders, and we cut out the areas that were about 2 sq ft and picked out the material. We were going to be filling that angular area with grout anyway. After we cut them out, we immediately fed the pipe through in order to prevent any further collapse, and we grouted it a day or two later."

Lessons Learned

The new pipe is made from an engineered grade of polypropylene resin, and is constructed with triple walls that give it the high degree of stiffness and beam strength needed for sliplining projects. The two gaskets and reinforced inline bell provide the watertight joint meeting ASTM D3212 requirements and the pipe meets or exceeds ASTM F2881 and AASHTO M330. For the new pipeline, nine 13-ft-long and eight 20-ft-long lengths were used.

"We thought homing it together was easier than it would have been with any alternative type of pipe, which would have required come-a-longs and chains," Compton said. "We did not have to do that in order to snap it together securely. And because of that, we really picked up on production and exceeded my estimate for the assembly."

After the pipe was pushed into the old CMP, the space between the old and new pipe was filled using controlled low-strength material flowable fill grout. Grates were attached at each end.

"When I bid it I looked at other options," Compton said. "It was not always going to be ADS SaniTite HP pipe from the get-go. It was after we assessed all the options that we knew it would be the best product for this application."

Tori Durliat is director of marketing for Advanced Drainage Systems. Durliat can be reached at tori.durliat@ads-pipe.com or 419.424.8275.

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Write in 768

2019 Ohio Stormwater Conference Promises Networking & Education

Annual event to be held May 8 to 10, 2019, in Sharonville, Ohio

The Ohio Stormwater Conference has grown from 399 attendees to more than 970 in the past 11 years. The 2019 Ohio Stormwater Conference is an annual conference dedicated to advancing the knowledge and understanding of comprehensive storm water management for those dealing in all aspects of planning, design, implementation and regulatory compliance. This year's conference will be held May 8 to 10, 2019, at the Sharonville Convention Center located in Sharonville, Ohio. The conference will provide updates on environmental issues, new technologies, regulatory information and pollution prevention.

The event includes many opportunities for networking and education. These opportunities include Envirocert classes and exams, as well as inspection and maintenance certification for storm water control measures in Ohio. The event also will offer 2019 MS4 training for managing an effective storm water program and overcoming issues in MS4 programs. Three tours will be offered, including a canoe tour, a tour of Lick Run and other best management practices in Cincinnati, and the Bernstein's Batch Bourbon Dinner Cruise.

For more information, visit www.ohstormwaterconference.com.

Oil Separator Cleans Industrial Waste & Protects Thames River

AFL Ind., a division of RGF Environmental Group, recently supplied a vertical tube coalescing (VTC) oil water separator to a long-time energy customer's liquid handling terminal in England. Despite the distance and shipping cost, the customer needed the assurance and reliability provided by the dual-wall, fiberglass VTC design.

A VTC-500A capable of efficiently treating 720,000 gal per day of storm water runoff was delivered to the terminal in Essex, England. Due to the proximity of the customer's facility to the environmentally sensitive waters of the Thames River, efficient separation and removal of hydrocarbons from plant effluent was important.

The VTC model oil separation tank combines a robust one-piece, dual-wall, insulated fiberglass construction with proprietary Delta-Tube oil coalescing media. The tank design provides a long operational life and reliable hydrocarbon removal to less than 10 ppm in a compact footprint. The media attracts small oil globules, which then coalesce with other globules, increasing their size and buoyancy. The globules then break away and rise to the surface where separated oil is automatically removed from the waste stream for collection via the rotary pipe skimmer. The dual-walled fiberglass tank and all PVC fittings are corrosion-resistant, so the separator offers longer useable life than competitive steel constructed tanks.

RGF has purchased and currently is commissioning a new polypropylene extrusion line to manufacture Delta-Tubes in-house. Savings will be passed along to customers and a new design will soon be available, providing twice the inclined surface area and reducing separator footprint and maintenance costs.

AFL Ind., a Div. of RGF Environmental Group | www.rgf.com/afl-industries | 800.842.7771 | Write in 810

Earth Anchoring System Restores Eroded Bank Along Tennessee River

A section of bank on the French Broad River in Del Rio, Tenn., had been severely damaged due to flood conditions as construction of a new bridge over the river was in progress. The bank erosion threatened both the recently installed bridge infrastructure and a railroad line running parallel to the eroded bank slope. Under emergency conditions just after the flood, the Tennessee Department of Transportation (TDOT) placed thousands of tons of class II riprap on the slope for temporary stabilization. Once the bank was temporarily stabilized, TDOT worked with Freese & Nichols Engineering Consultants to develop a fully engineered, permanent vegetated solution to stabilize the bank.

In collaboration with Envirolok, Bryan Dick of Freese & Nichols Inc. created a plan that would restack the existing riprap to the ordinary water level and construct two stone barbs to better stabilize the toe. The area of the riverbank above the ordinary water level then was regraded in preparation for the installation of 4,600 sq ft of Envirolok units. To further reinforce the riverbank during large flood events, the design called for additional reinforcement by placing a geogrid wrap over the bags and connecting and installing earth anchors.

Riverworks Inc. of North Carolina was selected as the contractor for the bank restoration. Upon completing the riprap toe and site preparation, the Envirolok units were filled on site with a mix of sand and topsoil for strength and the ideal growing medium. Once in place, the units were compacted and the Envirolok spike system was installed to provide shear strength and connect the earth anchoring system. A combination of dormant brush material and native grasses were placed between the Envirolok bags to create a lush vegetative buffer. In addition to providing natural habitat along the river's edge, the plant roots will help further stabilize the slope.

Envirolok LLC | www.envirolok.com | 608.223.3571 | Write in 811

Geopolymer Mortar Lining Restores Aging Pipes

In May 2017, the town of Cary, N.C., needed a series of pipes rehabilitated using a centrifugally cast-in-place cementitious lining of 175 ln ft of 52-in. corrugated metal pipe (CMP) and an additional 20 ln ft of 54-in. CMP. In 2016, a section of one of these culverts collapsed, creating a sinkhole on the side of the road. The collapse quickly was repaired with a new section of CMP, but the community was concerned that the remaining CMP sections were showing corrosion in the invert and it would only be a matter of time before a more serious collapse occurred.

There were three side-by-side pipes, so the flow was diverted into a single section and each of the pipes was pressure washed and cleaned. There was little to no infiltration due to the low bury depth of the pipes, but several missing sections of the inverts were filled. A 1-in. coating of GeoSpray geopolymer mortar lining was applied to each of the three pipe sections over a three-day period in a single application.

This was the first time the town of Cary had chosen a GeoSpray geopolymer mortar lining solution and many of the town engineers were onsite to observe the application process. The small footprint of the equipment allowed both lanes of the busy road to remain open during the entire duration of the project. The entire project was completed, including site restoration, in less than a week. After being in service for a year, the geopolymer mortar is performing as intended. Despite the pipes enduring high flows and heavy rains, there is no infiltration, cracking or other observed issues with any of the pipes.

Milliken | www.infrastructure.milliken.com | 855.655.6750 | Write in 812

Rural Water District Limits Water Loss, Saves Time

For nine years, Vivian Shaw has been the operator of Chautauqua County Rural Water District #4 (RWD4) in Kansas. The utility distributes potable water to customers of Chautauqua and Montgomery Counties, as well as the city of Longton, using approximately 275 miles of pipeline. Shaw takes samples, manages water loss, detects leaks and more.

"Before I got Mission RTUs (remote terminal units), I was reading my master meters every day," Shaw said. "I had to go out there and physically read it."

The meters are spread throughout the area and she was traveling more than 40 miles per day on gravel roads to check each of them, a task that sometimes took up to an hour and a half.

RWD4 uses Mission M110 RTUs to monitor the pipeline for leaks. The RTUs monitor three of its master meters, which track how much water is pulled from the water supplier, Public Wholesale #20. The system streamlined Shaw's daily responsibilities, freeing up time and money while providing peace of mind.

Shaw reported that the water loss for RWD4 has been in the 5% to 7% range since the system was installed. Of the total water RWD4 pulls from Public Wholesale #20, only that range is lost in the average year. This is nearly unheard of for rural water districts because of the expansive amount of pipeline, Shaw said. Lower water loss allows RWD4 to keep the water price low, saving money for the utility and customers alike.

Mission Communications | www.123mc.com | 877.993.1911 | Write in 813

Multi-Purpose Street Sweepers Protect Sheep River

Okotoks, AB, Canada, is located on the Sheep River approximately 11 miles south of the city of Calgary. With a population of less than 30,000 residents, it is one of the fastest growing towns in Alberta. There is a strong, community-wide environmental advocacy to protect the Sheep River and its abundant trout population. The municipality leads this effort with source control measures.

The town's storm sewer and drainage system consists of more than 117 kilometers of main lines with approximately 2,000 catch basins and several storm ponds tied to the surface transportation drainage network. This network is monitored and managed at the operations center using GIS software. Crews maintain the system using Schwarze model A7 multi-purpose street sweepers equipped with catch basin cleaners.

When a dispatcher at the operations center receives a complaint of a clogged catch basin from a private citizen or public worker, the location is marked using a nearby address. A repair order with a description of the problem then is entered into the system. When the dispatcher presses send, a notification comes up on the sweeper operator's iPad. The operator and crew then will go to the site to assess the situation. Once the catch basin is flushed, the status is updated on the operator's iPad.

"We purchased the A7 because of the versatility of using it as a street sweeper and a combination flushing unit to maintain our catch basins and our storm sewers," said Peter McDowell, operations superintendent. "Our town council really appreciated that it was a versatile piece of equipment so it is not just tied up for doing street sweeping. When we are not using it as a street sweeper, we are using it for catch basin maintenance so we have no dirt or silt making it into our storm water system and then back into the river."

Schwarze Ind. Inc. | www.schwarze.com | 800.879.7933 | Write in 814

Detention System Meets Storage Needs of Technical College

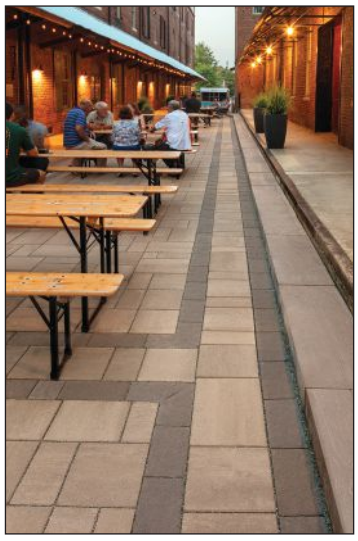
Chattahoochee Technical College recently inaugurated its new health science building at the Marietta, Ga., campus. The project involved the construction of a new building that allows the college to increase student enrollment in health programs, as well as several hardscape and landscape improvements.

However, the project was not without its challenges. The campus had existing ponds on site to handle storm water, but additional storage was needed to meet the Cobb County storm water regulations for volume control and water quality due to the redevelopment and increase of impervious area. There was not sufficient space available for an additional above-ground pond and there were many existing underground utilities on site.

"The site had underground utilities and storm water management had to be provided in a developed area," said Philemon Bannis, P.E., project engineer at Eberly and Associates Inc. In addition to these challenges, a best management practice (BMP) was needed to meet storm water regulations and also augment the existing water quality ponds.

Eberly and Associates Inc. partnered with StormTrap to provide a solution for the site's storm water issues. A 9-ft DoubleTrap system (66 pieces) was designed to fit in the small footprint under the building parking lot. The detention system provided the total 28,033 cu ft of storage needed. As an additional BMP measure, a SiteSaver hydrodynamic separator was installed upstream of the detention system to treat runoff from the site and meet water quality requirements. The device collects trash, sediment and hydrocarbons from storm water before they are discharged into the detention basin and waterways.

StormTrap | www.stormtrap.com | 815.941.4549 | Write in 815



Brewery Solves Drainage Problems With Permeable Pavement

The owners of Ballad Brewing renovated a historic warehouse in Virginia with the vision of creating a community-centered event space and brewery. The remodeled facility now brews 10,000 barrels of beer each year and has a family-friendly taproom. Ballad Brewing offers its guests outdoor private event and community spaces to reserve for parties and other special events. These spaces needed to withstand the high traffic of frequent visitors and the severe rain and weather of the region.

Storm water runoff was an issue for the city and the owners. They needed a way to manage the excessive amount of water that filled the patio area. To compound the situation, the existing roof structure did not include eavestroughs, so they needed a solution that could help with water runoff and keep the area dry and visitor-friendly.

By selecting a permeable paving solution for this project, the designers were able to create a 6,000-sq-ft patio that would not require inconvenient grade changes to direct surface water to a variety of drains. The entire pavement would become a surface drain.

They opted for the Blu collection because of its larger scale modular sizing and smooth texture. The thermodynamically stabilized iron-oxide pigments used in the manufacturing process ensures that the chestnut brown and chocolate brown colors that compliment the historic building remain vibrant.

This system benefits from a consistent ¼-in.-wide joint-spacing that can be filled with ASTM 89 or ASTM 9 stone. For these spaces, the latter, when properly consolidated, offers both high stability and infiltration rates of 570 in. per hour.

By incorporating Techo-Bloc, Ballad Brewing was able to give guests the kind of event space and community feel they wanted, resulting in better guest experiences and providing the brewery owners a product that was 10% more cost-effective than other pavers.

Techo-Bloc | www.techo-bloc.com | 877.832.4625 | Write in 816

Hydro Excavation Equipment Accelerates Pipe Replacement

The city of Milwaukee launched a project to replace approximately 46% of the city's 70,000 lead lateral water service lines, including 18 miles of water mains. The initiative was spurred by tests showing children's elevated lead blood levels reaching 4.6%.

The primary cause was the lead water service lines going into buildings, such as homes, schools and daycare facilities. In 2017, the city began replacing sections of lead service lines, from the cast iron water mains in the streets to the curb stops at property lines. In 2018, the city decided it could expedite the process by purchasing its own hydro excavation equipment.

After examining equipment options, the city purchased a Vacall AllExcavate hydro excavator with a 12-yd debris body mounted on a Freightliner truck chassis, from Serwe Implement.

The service line replacement process typically involves digging down 12 to 15 ft, removing soil, rocks and other material to expose the lead line, then clearing the area where the new copper line can be installed.

"The vacuum system is very powerful because of its design," said Nathan Berk, sales manager for Serwe. "It has an 8-in. tube with a positive displacement vacuum pump and an air flow system that's far better than other machines."

An option that was added to the AllExcavate machine has paid off in terms of productivity dividends. A high dump option makes it easier to raise and tilt the body to empty debris into roll-off containers the city placed around town.

The debris tank can be raised 76 in. above ground level and then shifted back horizontally 21 in. beyond the rear bumper using remote control. The debris tank can be tilted and dumped over the walls of containers without spillage or the need to travel to dumping stations.

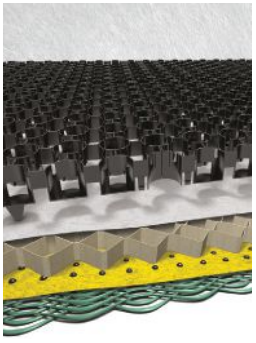
Vacall, a Div. of Gradall Ind. Inc. | www.vacall.com | 800.445.4752 | Write in 817

Pavement Repair

QPR high-performance permanent pavement repair patches potholes, fills utility cuts and repairs damaged asphalt. There is no mixing, tacking or mechanical compaction required. The material is a ready-to-use formula that can go straight from the bag to the repair area. It also works with concrete and steel and can be used in all weather conditions.

QPR
www.qprusa.com | 800.388.4338
Write in 818

Geosynthetics



Developed through 40 years of engineering and construction experience, Typar Geosynthetics provides a trange of geotextile, geocell, porous paving, and grass and ground reinforcement solutions. The products are made in the U.S., for erosion control, slope reinforcement, grass and soil stabilization, drainage, filtration and separation applications.

Typar Geosynthetics
www.typargeosynthetics.com | 800.541.5519
Write in 819

Tanks

These fiberglass storm water tanks are corrosion-resistant and structurally strong. Offering both single and large-capacity tanks, the design flexibility of these watertight tanks makes them ideal for CSO and SSO management; water harvesting; storm water detention, retention and infiltration; and industrial storm water.

ZCL | Xerxes
www.zcl.com | 800.661.8265
Write in 820

Bioretention

Filterra is an engineered high-performance bioretention system. While it operates similar to traditional bioretention, its high flow media allows for a reduction in footprint of up to 95% versus traditional bioretention practices. Filterra provides a LID solution for tight, highly developed sites such as urban development projects, commercial parking lots, residential streets and streetscapes.

Contech Engineered Solutions
www.conteches.com | 800.338.1122
Write in 821

Surface Drains

Skimmer surface drains for sediment basins release the cleanest water instead of draining from the bottom. Eight sizes are available with adjustable orifices to regulate filling and draining. They drain slowly over several days at a constant rate to reduce settling.

J.W. Faircloth & Son Inc.
www.fairclothskimmer.com | 919.732.1244
Write in 822

Sweepers

Developed from more than 50 years of evolution, the V Range is a reliable and dependable truck mounted sweeper. It is environmentally friendly and has a fuel-efficient engine, resulting in a longer on-station time along with low running costs.

Johnston Sweepers
www.johnstonsweepers.us | 704.658.1333
Write in 823

Pavement

Grasspave2 grass pavers enable parking, driving, walking, riding or lounging on a grass surface. It performs the functions of asphalt or concrete pavement, but with the aesthetics of a lawn while enhancing the environment. The pavers have 15,940-psi compressive strength.

Invisible Structures Inc.
www.invisiblestructures.com | 303.233.8383
Write in 824

Water Treatment Media

This granular sorption media efficiently and effectively removes heavy metals from storm water. APTsorb harnesses the sorption capacity of reed-sedge peat, but transforms it into a hardened granule. The media adapts to a variety of applications, from low-tech booms to pressurized tanks. Its capacity and low cost makes it an effective treatment technology.

American Peat Technology LLC
www.americanpeattech.com | 218.927.7888
Write in 825

Midge Control

These products eliminate midge and filter flies from water and waste management facilities without interrupting production. They feature an insect growth regulator, (S)-methoprene, which stops the reproductive cycles of midge and filter flies, eliminating future generations. Strike Midge Control, Strike Ultra Midge Control and Strike Pellets help achieve reduced adult fly populations in 10 days or less.

Central Life Sciences
www.strikeproducts.com | 800.248.7763
Write in 826

Pipe Rehabilitation

The CentriPipe system structurally rehabilitates damaged and failing storm and sanitary sewers without disrupting overhead traffic or activities. The system cost effectively restores deteriorated round, arched, elliptical, and box CMP, brick and RCP culverts. The bi-directional spin-caster and fine aggregate concrete materials ensure long-lasting, high-quality rehabilitation results. It is approved, installed and trusted by departments of transportation and municipalities for proven, cost-effective structural culvert lining.

AP/M Permaform
www.centripipe.com | 800.662.6465
Write in 828

Sewer Cleaner

The Vactor 2100i combination sewer cleaner features a control system, vacuum performance, operator comfort and control, and improved fuel, air routing and filtration efficiency. The cab includes a 7-in. screen with backlit tactile buttons and IntuiTouch one-touch control system. The optional RDB 1015 rapid deployment boom telescopes 10 ft out and extends the debris hose down 15 ft, minimizing the need for additional debris tubes. The water recycling model saves water and provides filtration to 100-µ particle sizes.

Vactor Mfg. Inc. | www.vactor.com | 815.672.3171 | Write in 827

Products & Services

Check Valves

Proco Style 711/731 ProFlex check valves are engineered for installation on pre-existing pipelines where the outfall invert of the pipe is close to the floor of the manhole or outfall. When a new installation is being designed, the valve can be engineered into the pipe layout with little concern for outfall clearance due to its low-slope design. With its sloping bottom, the valve ensures zero potential for standing water. With its all elastomer design, the valve can be installed without concern for future seizing or rusting.

Proco Products Inc.
www.procoproducts.com | 209.943.6088 | Write in 829

Sweeper

The Crosswind1 is a single-engine configuration of the Crosswind regenerative air sweeper. A variable-speed device installed between the chassis engine and transmission allows the engine to simultaneously power both the truck and the sweeper. The operator can switch between modes with a simple push of a button, without the need to stop. The single engine, combined with Quiet Pak sound-dampening technology, helps minimize vibration and noise.

Elgin Sweeper Co.
www.elginsweeper.com | 847.741.5370
Write in 830

Pumps

Super T Series pumps are equipped with the new Eradicator solids management system. The pumps have a patented lightweight inspection cover and a back cover plate incorporating an obstruction-free flow path. They have a self-cleaning wear plate, including laser cut notches and grooves with tooth designed to clear material from the eye of the impeller.

Gorman-Rupp Co.
www.grpumps.com | 419.755.1011 | Write in 831

Trash Racks

StormRax are an alternative to painted and galvanized steel racks for use in storm water management ponds and general water screening. They are structurally sound with a long-lasting quality appearance.

Plastic Solutions Inc.
www.plastic-solution.com
877.877.5727
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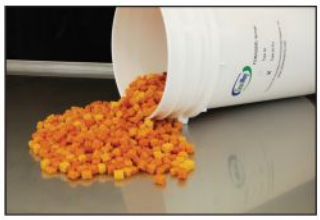
Filtration



MetalZorb is a high-capacity sponge filtration medium that effectively reduces, removes, and recovers dissolved heavy metals found in storm water and industrial process water discharge, including lead, mercury, zinc and gold. With its low impedance to flow, high capacity and light weight, and no backwash required, it is ideal for passive and in-situ applications and helps achieve regulatory compliance.

CleanWay Environmental Partners Inc.
www.cleanwayusa.com | 503.280.5102 | Write in 833

Storage System

StormCapture is a structural precast concrete underground storage system for storm water detention, retention, infiltration and treatment. It can reduce peak flows and provide volume retention through storage and infiltration. Its modular design allows for site-specific configurations, including an option for subsurface infiltration, while providing large storage capacity in a small footprint.

Oldcastle Infrastructure
www.oldcastleinfrastructure.com | 800.579.8819 | Write in 834

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Fire Meets Watershed

Preparing for a hotter, drier future

Last July, after a sweltering stretch of triple-digit heat, I set out to explore a favorite tributary of the Rogue River in southern Oregon. Like most of Oregon, this area was officially in a severe drought condition and the heat wave seemed to be baking all remaining moisture out of the soil and the vegetation. As we neared our destination, dark clouds began to fill the sky. At first, I was glad to see rain on the horizon, anticipating cooling relief and rejuvenation of the landscape, but this was not a gentle summer shower. Soon the winds rose, sprinkles turned to a downpour, hail pelted the car, and great flashes of lightning and booming thunder filled the air. By the time the storm cleared, there had been more than 1,000 lightning strikes across Jackson and Josephine counties, and 68 fires had been confirmed. Unfortunately, this was not an isolated incident.

Storm Water Impacts

Fire is playing an increasingly prominent role in reshaping landscapes in the western U.S., as climate change results in rising temperatures, reduced rainfall and snowpack, and more extreme weather events. In 2017 and 2018, Oregon and California spent more than $2 billion fighting more than 28,000 separate fires that scorched 3.4 million acres. Given the tremendous human and economic losses associated with fire, it is right to focus attention on healing those affected communities. There also are storm water management implications to consider.

The most obvious impact of wildfires on storm water runoff is the reduction of vegetation and a resulting vulnerability of denuded landscapes to erosion. Without plants and a surface litter layer to intercept rainfall, the rain that falls has more power to mobilize soil, and slopes are destabilized. Other soil changes include increased hydrophobicity, organic matter destruction, atmospheric losses of elements, loss of microbial species and destruction of plant roots near the surface. All of these effects also increase runoff rates and erosion potential, and can limit the vegetative recovery rate. The hydrologic impacts range from turbidity increases in local streams to regional slope failure, such as the type experienced in Santa Barbara County, Calif., after the Thomas Fire in 2018.

Less obvious and less well studied are the receiving water impacts resulting from ash fall in areas outside the active burn zone. These may include increased loads of carbon, trace metals and organic compounds like polycyclic aromatic hydrocarbons. The introduction of fire retardant compounds into receiving waters also can be a result of firefighting activities.

Some regions consider fire impacts in their flood control planning requirements. For example, after observations of sediment production in the range of 120,000 cu yd per square mile of watershed in a large storm following a fire, the Los Angeles County sedimentation manual requires that flood protection facilities in susceptible areas be sized to handle the "burned and bulked" 50-year flow rate.

Although fires are unpredictable, they can be planned for.

Planning Ahead

Ultimately, even if its frequency and severity have been boosted by human activity, fire is a force of nature and the natural world is resilient. Although fires are unpredictable, they can be planned for. This includes identifying areas at high risk for erosion and fire damage, responding with slope stabilization measures after a burn, and creating extra capacity in our culverts, bridges and other flood conveyance and storage structures for sediment that inevitably will come with post-fire flows. For storm water program managers, flexibility in meeting water quality standards for already-impaired waters also is critical.

The silver lining of the record-breaking fire activity of the past two years is that we have a new opportunity to investigate the magnitude and duration of fire effects on our receiving waters. We will need this knowledge to build the necessary resiliency and flexibility into our infrastructure and our regulatory frameworks as we prepare for a hotter drier future in the west.

Vaikko Allen is national regulatory director for Contech Engineered Solutions. Allen can be reached at vallen@conteches.com.

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