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STORMWATER

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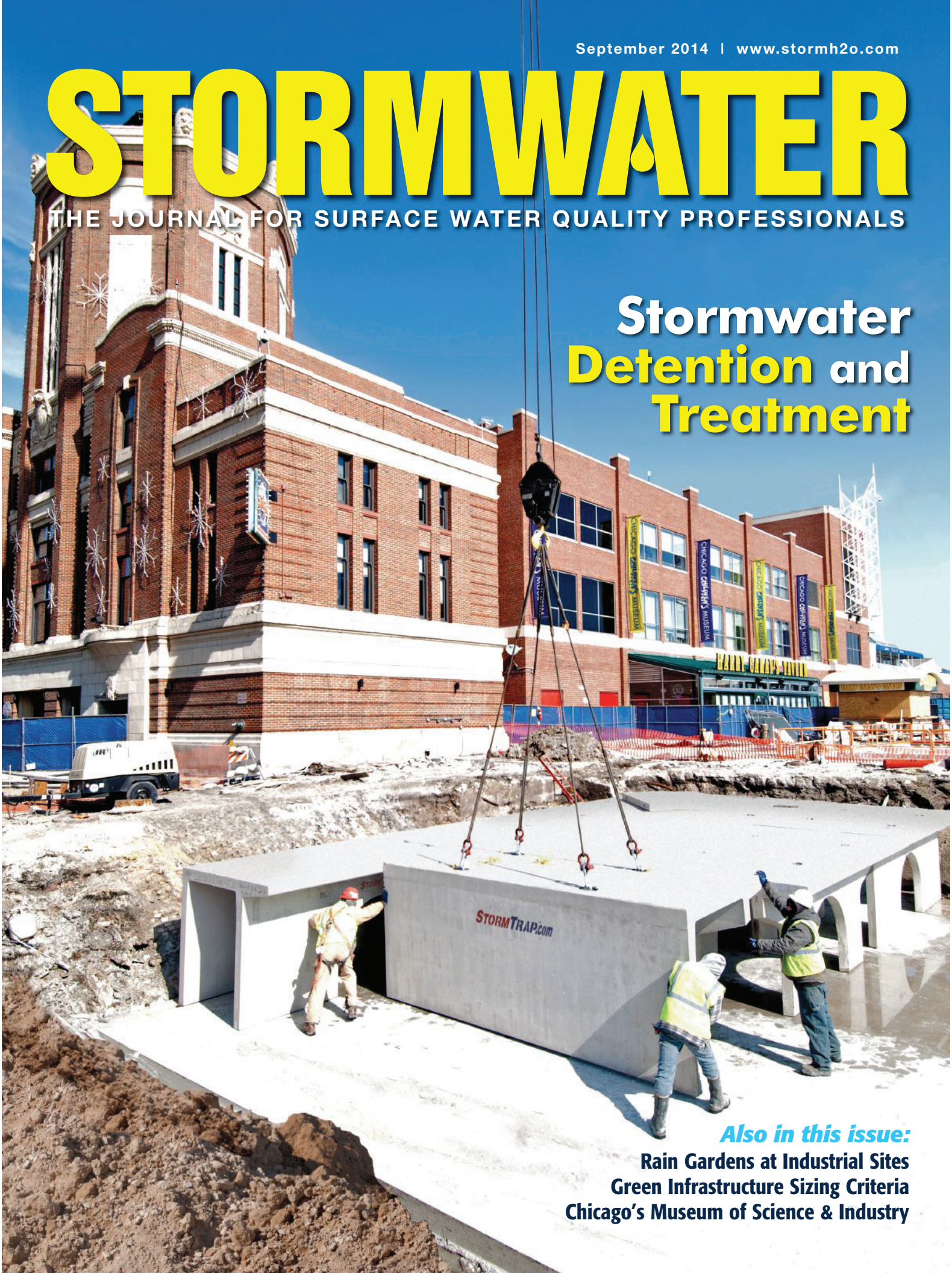
Stormwater Detention and Treatment



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When the Snow Melts

Chicago's Museum of Science and Industry permeable paver parking lot

It might be summer now, but the nation experienced a particularly harsh winter this past year and Chicago, IL, was certainly no exception. The city reached a near-record 80 inches of snowfall for the 2013–2014 winter season and recorded the most days at or below zero of any Chicago winter on record, according to the National Weather Service.

When snow melts it becomes stormwater runoff, an increasing problem for many municipalities across the country. Many of these cities are responding to the issue by implementing green infrastructure into new and existing sites.

Chicago has been at the forefront of this trend with its Green Stormwater Infrastructure Strategy Initiative, which will devote $50 million of water infrastructure spending to improve stormwater management. The initiative calls for the implementation of an interagency government process to review projects for the potential to use green infrastructure, such as permeable pavement and bioswales, during construction.

Last fall, the Chicago's Museum of Science and Industry (MSI) decided to reconstruct and expand its west parking lot, located off South Cornell Avenue. The largest science center in the Western hemisphere, MSI opened in 1933 and has had more than 180 million visitors from around the world. It is housed in the former Palace of Fine Arts from the 1893 World's Columbian Exposition and is a National Historic Landmark.

As federal funding was used for the design and construction of the project, it had to be administered and approved by the Chicago Department of Transportation (CDOT) and Illinois Department of Transportation (IDOT) Bureau of Local Roads to ensure it would meet all applicable federal, state, and local requirements.

Stanley Consultants Inc. was contracted to provide the project engineering design for the CDOT and worked closely with CYLA Design Associates Inc. on the landscape and hardscape design elements. "CDOT played a key role in helping manage the project, providing coordination with the client, assisting with permit approvals, and securing IDOT approvals," says Stanley Consultants.

Chicago's newly adopted stormwater ordinance requirements for new and existing developments encourage applicants to obtain Leadership in Energy and Environmental Design (LEED) certification and incorporate best management practices (BMPs) into design plans with the goal of reducing impacts to the storm sewers.

"While this project did not have

specific LEED requirements that had to be met, it did have to meet strict BMP requirements for rate and volume control for stormwater discharge into the city's existing storm sewer system," says Stanley Consultants. "The specific issue we encountered during design was that the existing storm sewer system the parking lot drained to was already at capacity, and since we were expanding the size of the lot, we had to come up with an economical solution for detaining stormwater onsite that would meet the city's requirements."

It was soon determined that it was not economically or technically feasible to provide onsite detention through the use of detention vaults or oversized pipes, as there wasn't enough space for these systems. Stanley Consultants notes that it also is the city's preference for parking lots to incorporate BMPs such as biofiltration and permeable pavements into the design to reduce the amount of pollutants discharging from the site. "It became clear to us that the best solution would be the use of permeable pavers."

The Eco-Optiloc and Eco-Priora permeable concrete pavers and Optiloc traditional concrete pavers used in the project were supplied by UNI-GROUP USA manufacturer Unilock Chicago of Aurora, IL. Unilock's commercial product representatives Brad Swanson and Auggie Rodriguez worked with Stanley Consultants on the engineering aspects of the project and coordinated the paver styles, finishes, and color selection with Carol Yetken and Karen Heller of CYLA Design Associates and representatives from the museum.

The museum's vision is "to inspire and motivate children to achieve their full potential in the fields of science, technology, medicine, and engineering," and MSI welcomes approximately 340,000 school children on field trips each year. The parking lot was built to improve traffic circulation for the bus drop-off area that accommodates these student groups. The lot needed to have safe areas for children to disembark from the buses and cross the travel lane to get to the museum's group entrance.

The lot has six drop-off bays that feature 7,633 square feet of Optiloc traditional pavers, 40,380 square feet of drive aisles and employee parking with Eco-Optiloc permeable pavers, and 7,384 square feet of Eco-Priora permeable pavers for pedestrian sidewalks and crosswalks. Both the traditional and permeable pavers offer a slip-resistant durable pavement surface, ideal for both pedestrian and vehicular traffic. The Eco-Priora pavers used in the crosswalks feature Unilock's exposed granite face with Onyx Black Series 3000 finish that adds a visual contrast from the field of Eco-Optiloc drive aisles and helps guide the children to the building's entrance. Unilock's Endura Color finish was chosen for the Eco-Priora pavers in the sidewalk areas. Landscaping for the project consists of native plantings that are adapted for the area's climate and beautifully enhance the site.

"It was helpful that we were able to seamlessly match the Optiloc traditional pavers and the Eco-Optiloc permeable pavers so that the whole palette was compatible in color and design," says Yetken.

The Eco-Optiloc and Eco-Priora permeable vehicular cross section is composed of a 1-1/2-inch-thick aggregate setting bed (CA-16 ASTM No. 8), a 4-inch-thick aggregate base (CA-7 ASTM No. 57), and an 18-inch-thick aggregate subbase (CA-1 ASTM No. 2). Stanley Consultants chose to use Optiloc traditional pavers in the bus lanes to accommodate the heavy loading and used a 9-inch-thick Portland Cement Concrete base course over a 4-inch-thick aggregate base (CA-7), and reduced the 18-inch-thick aggregate subbase (CA-1) to 9 inches so the total pavement thickness matched that of the permeable sections. The Eco-Priora sidewalks, which feature both 5- by 10-inch rectangular and 10- by 10-inch square units, are designed with a 1-1/2-inch-thick aggregate setting bed (CA-16) and an 8-inch-thick aggregate base (CA-7) as they do not have to support vehicular loading. A geotechnical fabric also was used under all the sub-bases.

The Eco-Priora pavers used in the crosswalks feature Unilock's Onyx Black Series 3000 to provide visual contrast and help direct children to the museum's entrance.

The total parking lot and bus drop-off area surface of the project encompasses just under two and a half acres, or 103,647 square feet, of which 43,256 square feet has permeable pavers. In keeping with Chicago's stormwater ordinance requirements for rate and volume control for stormwater discharge, the intent of the permeable pavement system is to reduce runoff and its impact on the city's sewer systems. The engineers used a total base depth of 22 inches in the trafficked areas to accommodate bus loading, and the aggregate materials used in the design provide a void space of approximately 40%, which would result in a total water storage capacity of 34,311 cubic feet or 256,646 gallons of water. In a 1-inch rainfall event, approximately 64,600 gallons of water would be captured, which would use less than 26% of the total system's capacity. The aggregate under the pedestrian areas would provide additional storage capacity. Other factors that Stanley Consultant's engineering

team considered in the hydrological design of the system were outflow and the infiltration into the subgrade soils on the site. The existing subgrade soils consisted of black topsoil (OL-FILL), clayey sand fill (SC-FILL), fine to medium sand (SP), poorly graded sand with silt (SP-SM), and silty sands (SM). Permeability tests were done and because the soil permeability was less than the required 0.5 inches per hour, an underdrain system was required to adequately drain the base.

On an annual basis, Chicago's average rainfall is about 35 inches and the majority of these rainfall events are fairly small. In fact, 98% of Chicago storms are less than 2 inches and 95% are less than 1 inch. If the 80 inches of snow that Chicago received this year melted all at once, it would be equivalent to 8 inches of rain, and even with the subgrade soil still frozen due to the extremely cold temperatures, the project would still only use about 74% of the total capacity of the permeable pavement system.

The site was observed a number of times over the winter to see how the Eco-Optiloc and Eco-Priora permeable pavements were performing. On February 17, the site received 4 to 5 inches of snow that was immediately plowed from the paver surface. On February 18, the site was photographed while the temperature remained below freezing. Two days later, the temperature increased to 45 degrees and a storm dropped nearly 1 inch of rain. The next day, the temperature once again dropped below freezing. The permeable paver surfaces remained clear of snow and ice.

Chicago's stormwater permit submittal required an operations and maintenance plan for the permeable parking lot to maintain its functionality. The plan stipulates that sand should not be used on the permeable pavement during the winter months as this can reduce infiltration capabilities. In addition, the landscaped areas should be maintained to prevent soil from being transported onto the pavement surface. The paving surface is to be monitored regularly to ensure proper drainage after storms and that the surface is free of sediment and vegetation. In addition, the pavement is to be vacuum swept twice per year and joint aggregate material replenished after cleaning, and the surface is to be inspected annually for signs of deterioration or settling.

Using permeable pavers and an aggregate base course provided a cost-effective green solution for the Museum of Science and Industry site. The pavement system provided detention for the additional pavement area, maintained the design release rate, met the design volume requirements, and satisfied the recently implemented Chicago ordinance requirements for stormwater management.

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