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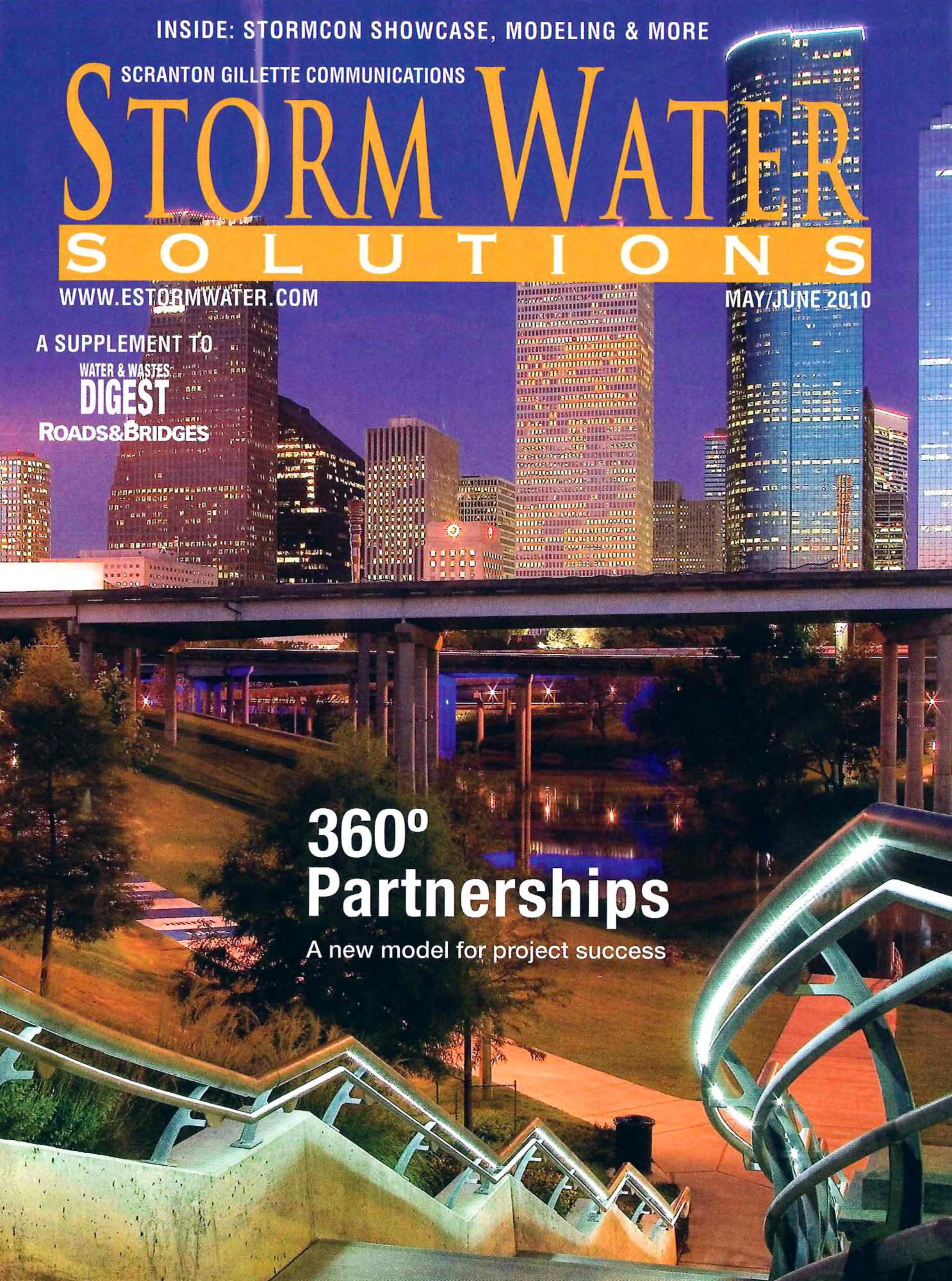

360° Partnerships

A new model for project success

Maximizing Available Resources

Drainage study unites city, university in multiuse basin project

By Michael Clay, P.E. & Brad Davis, P.E.

Drainage infrastructure for the historic Midtown area of Memphis, Tenn., was designed and constructed in the early 1900s. With rapid urbanization and increased impervious area, the city eventually faced numerous flooding issues resulting from over-stressed storm sewers and open channels

As flooding issues persisted in the area, city officials sought a creative solution to alleviate current water detention issues while allowing for future growth. The solution also needed to optimize available resources and provide the least detrimental effects to nearby areas.

Additional factors contributed to the severity of the flooding and complexity of possible solutions, including:

- ***Undersized storm sewers for current runoff.*** Most of the local storm sewers have one-third of the capacity needed to convey the design storm.
- ***Open and closed conduit drainage networks.*** The storm sewers flow from culverts to open channels, and then back into culverts throughout the study area.
- ***Developments in low, flood-prone areas.*** Many houses in the area are built on top of large box culverts.

Inadequate Infrastructure

Based on record grading and drainage plans, culverts in some areas were designed for a capacity of 0.7 cu ft/second/acre. This minimal capacity requirement may have been sufficient for certain culverts with wooded, swampy upstream drainage areas, but these upstream areas had been developed into high-density residential and commercial zones.

Current design standards for high-density zones require some culverts to provide a capacity of up to 4.2 cu ft/second/acre—far greater than the capabilities of the existing infrastructure. As a result, the undersized drainage system surcharges frequently during intense rain events, flooding intersections, underpasses, yards and finished floor elevations.

Because the city's drainage system is severely undersized, existing drainage easements would not provide adequate area for an improved drainage system. Increasing the capacity of one section of the drainage system would necessitate

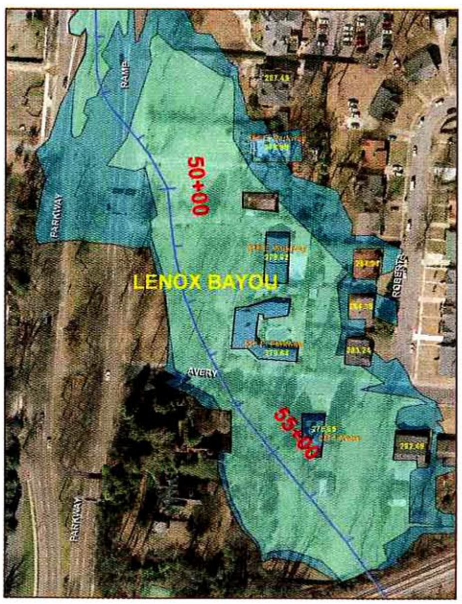

Figure 1. *This preconstruction flood map illustrates the current impact of both a two-year (in green) and a 100-year (in blue) storm.*

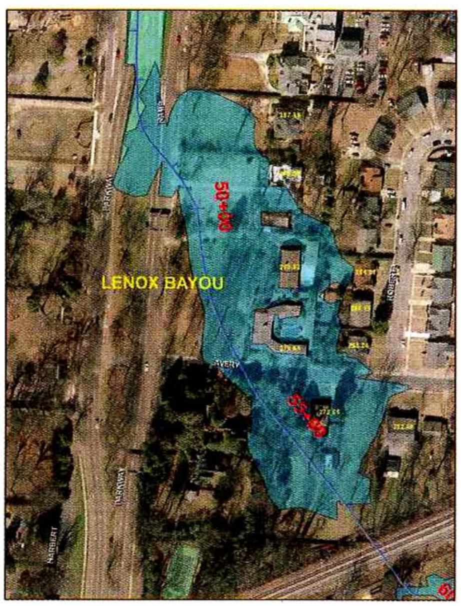

Figure 2. *This postconstruction flood map shows the area that a 100-year storm would flood; no flooding is expected with a two-year storm.*

improvements for miles downstream, otherwise flooding issues simply would be transferred to the location at which improvements cease.

Detention could provide flood relief, but the structure would need to be at least 3 to 5 acres in size to see any substantial benefit. Because the basin is extremely urbanized, it was difficult to find a large, undeveloped piece of property in a location that would benefit the study area hydraulically.

Retaining walls helped minimize the footprint of the CBU soccer field while maintaining the basin's required water retention level.

Drainage Study

Utilizing a regional detention approach, a design team commissioned by the city of Memphis analyzed the entire watershed area through a combination of GIS and a state-of-the-art storm water modeling program. As a result, a highly urbanized 3,800-acre study area, otherwise known as the Lick Creek Drainage Study, was modeled accurately for analysis.

The effort to find a solution was complicated by the lack of open space available for detention. But because the modeling software was able to take into account the finite number of locations available for storm water management, the design team was able to quickly evaluate the impact of possible solutions. Also, the effects of a particular solution could be observed across the entire study area to ensure that recommended improvements would not negatively affect any other location, upstream or down.

Completed in 2006, the study yielded the information the city needed to confidently allocate funds for storm water management for the entire study area. The use of GIS exhibits, urban floodplain mapping and animated drainage profiles helped guide the successful design and implementation of multiple projects, including a regional, multiuse storm water basin. It also enabled the design team to provide the public with a clear understanding of proposed drainage improvements.

Due to a lack of undeveloped land, the NCAA soccer field on the campus of Christian Brothers University (CBU) was cited as the only hydraulically beneficial and spatially feasible construction site for a large detention area. With the use of innovative design techniques, a large-scale storm water detention basin was designed to meet the water detention needs of the floodplain while maintaining all the functionality of the existing soccer complex. With a field design that took into account field inundation frequency, drying time, trash accumulation, stadium seating, aesthetic/architectural improvements and access agreements, construction on the multiuse basin began in November 2008 and is scheduled for completion in Fall 2010.

By comparing Figures 1 and 2 (see page 16), one can see the decrease in flooding that is anticipated after the detention area is constructed. In Figure 1, the two-year storm (shown in green) floods several yards and surrounds some houses, while the 100-year storm (shown in blue) floods some of the homes. Figure 2 shows the improved conditions after construction of the detention area. No flooding occurs during the two-year storm, and while yard flooding still occurs with the 100-year storm, no homes are flooded.

Functional Design Features

Storm water flow onto the field was planned strategically by using an oversized box culvert with a side-discharging weir for storm water to enter and leave the detention basin. The south end of the box culvert is the incoming, and the downstream end of the box culvert is the outlet control structure for the basin.

An opening approximately 3 ft above the invert of the box culvert that runs approximately 150 ft in length allows water to enter and exit the detention basin. This enables flow generated from frequent rain events to flow under the opening and not discharge onto the field. With this feature, the field can remain drier for longer durations and be spared most trash and floatables.

The outlet control structure consists of a junction box, with the oversized box culvert penetrating one wall and a corresponding outlet pipe on an adjacent wall. A steel plate with an 18-in. orifice is mounted to the opening of the outlet pipe, controlling the stage-storage-discharge relationship for the entire detention facility. The outlet structure also features a uniquely enlarged opening to facilitate removal of any large debris that collects at the outlet structure.

Retaining Wall Support

Laying out an NCAA regulation-sized soccer field, player's box, spectator seating and walkways within the project site was no easy feat. To help minimize the footprint of the field without diminishing the required water retention level within the basin, retaining walls were utilized.

Because CBU was concerned

about the appearance of concrete retaining walls, a brick-facade surface treatment was used to match the look of the existing campus. Because brick is susceptible to failure caused by moisture conditions, the project team avoided using it.

In an effort to provide an aesthetically pleasing treatment that would stand up to site conditions better than brick, they opted for concrete formliner—thin, reusable form placed on the exterior surface of poured-in-place concrete formwork. Poured in behind the formliner, the concrete leaves the imprint of the form after curing.

By using a formliner pattern that matched the existing campus brick pattern, a formlined and stained concrete retaining wall was created. It has provided the structural integrity, weather resistance and aesthetic appearance required by CBU and the city.

Mutual Benefits

The implementation of a multiuse basin has, to date, proven to be a success. The city of Memphis has been able to provide regional storm water detention in an area that otherwise would have necessitated the purchase of 4 to 5 acres. Even with the added construction expense associated with turning the facility into a functional soccer complex, the total cost was significantly less than that of a traditional earthen basin on purchased property. Furthermore, the agreement between the city and the university relieves the city of certain maintenance procedures, including mowing.

In turn, CBU has gained a completely renovated soccer field with improved field drainage, spectator seating and intracampus circulation. The new formlined retaining walls and path lighting dramatically improved the aesthetic continuity with the existing campus and provide a safer walkway for pedestrians. While the existing field has no Americans with Disabilities Act (ADA) accessibility routes, a new ramp will provide ADA-compliant slopes. The construction of a regional detention basin on campus also has allowed the university to expand and develop its property without having to lose valuable land to a site detention basin or add to downstream flooding. SWS

Michael Clay, P.E., and Brad Davis, P.E., are civil engineers for Smith Seckman Reid Inc. Clay can be reached by e-mail at mclay@ssr-inc.com. Davis can be reached by e-mail at bdavis@ssr-inc.com.

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