ACEC
American Council of Engineering Companies of Texas

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ENGINEERING TEXAS

2022 ENGINEERING EXCELLENCE AWARDS ★

BUILDING A MORE RESILIENT TEXAS

How the Flood Infrastructure Fund is Helping Communities Statewide Develop Collaborative Regional Flood-Control Solutions

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ENGINEERING TEXAS

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ACEC Texas is the business association of Texas engineering firms. The organization is committed to advancing the private practice of consulting engineering, enhancing markets for private engineering services, educating the public on the importance of infrastructure investment, and promoting sound business practices within the industry and across its client base. We are committed to aggressive involvement in legislative and public sector decision making, with a focus on the protection of qualifications-based selection of engineering services, transportation and water resources investment, expanded project delivery options, and appropriate legal and liability systems affecting the industry.

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COVER IMAGE: Central Texas Regional Water Supply, Vista Ridge Regional Water Supply; photo courtesy of Pape-Dawson.

BACK COVER IMAGE: Houston Botanic Garden, photo courtesy of Walter P Moore.

Publication photography courtesy of ACEC Texas.

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We are pleased to present the spring 2022 issue of *Engineering Texas*, a publication of the American Council of Engineering Companies of Texas (ACEC Texas).

In this edition, we feature the award-winning projects from the 2022 ACEC Texas Engineering Excellence Awards (EEA). In March, ACEC Texas hosted the first EEA Gala since the onset of the COVID-19 pandemic in 2020, welcoming member firms together to celebrate industry excellence. Projects recognized this year included essential water, wastewater, and flood infrastructure; historical building renovations; expanding solid waste options beyond disposal; structural work on a professional sports stadium; roadway and traffic designs; and repurposing land into a botanic garden.

This edition will also focus on flood infrastructure and funding demands in the state of Texas. In 2019, the 86th Texas Legislature overwhelmingly passed landmark legislation that approved over $1.4 billion to fund flood related mitigation projects and planning, of which $793 million was allocated to the newly created and constitutionally dedicated Flood Infrastructure Fund (FIF). The Texas Water Development Board has been instrumental in delivering FIF funding to cities, counties, and certain districts and authorities to move these critical projects forward. Funding, however, is critically short of the overall need.

We take a deep dive on the Flood Infrastructure Fund, a handful of projects it has funded, and the continued gap between demand for and availability of its dollars.

Thank you for your interest in this issue of *Engineering Texas* and for your support for ACEC Texas, the voice of engineering firms in the Lone Star State.

ACEC
TEXAS

2022
ENGINEERING EXCELLENCE AWARDS

TEXAS GOLD

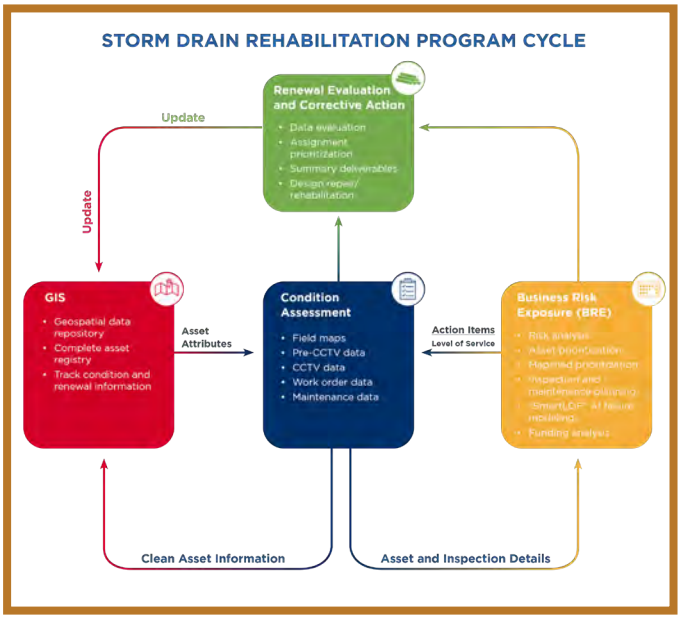
Studies, Research, and Consulting Engineering Services

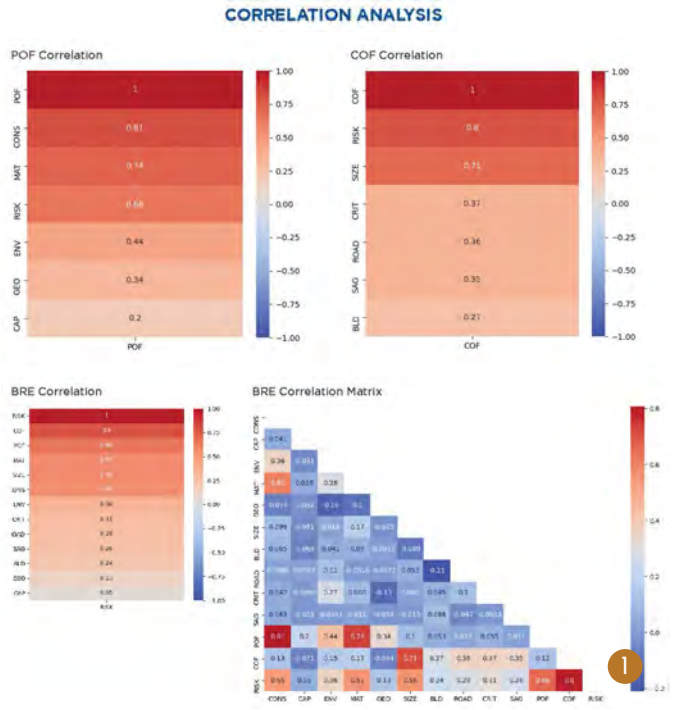
City of Fort Worth Storm Drain Rehabilitation Program

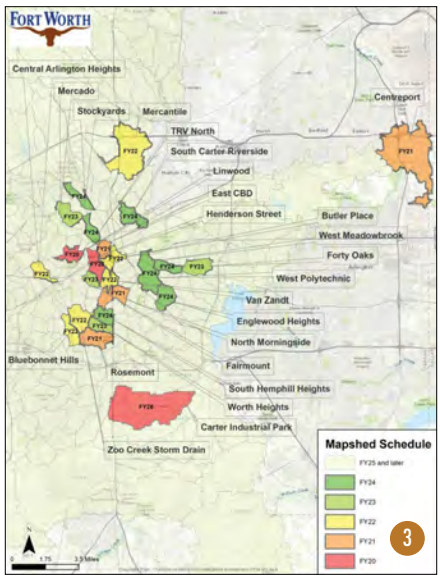
Halff Associates

A key challenge faced by the City of Fort Worth is the maintenance of 1,000 miles of storm drain with limited resources for inspection and rehabilitation. The Transportation and Public Works Department sought consulting engineering assistance from Halff Associates to develop a comprehensive program with these key goals: Enhance safety, improve level of service, reduce long-term costs and provide cost-sharing opportunities.

The development and implementation of the Storm Drain Rehabilitation Program provides a strategic, long-term framework to scale the City's stormwater pipe condition assessment data and inform future decisions about system maintenance and renewal.







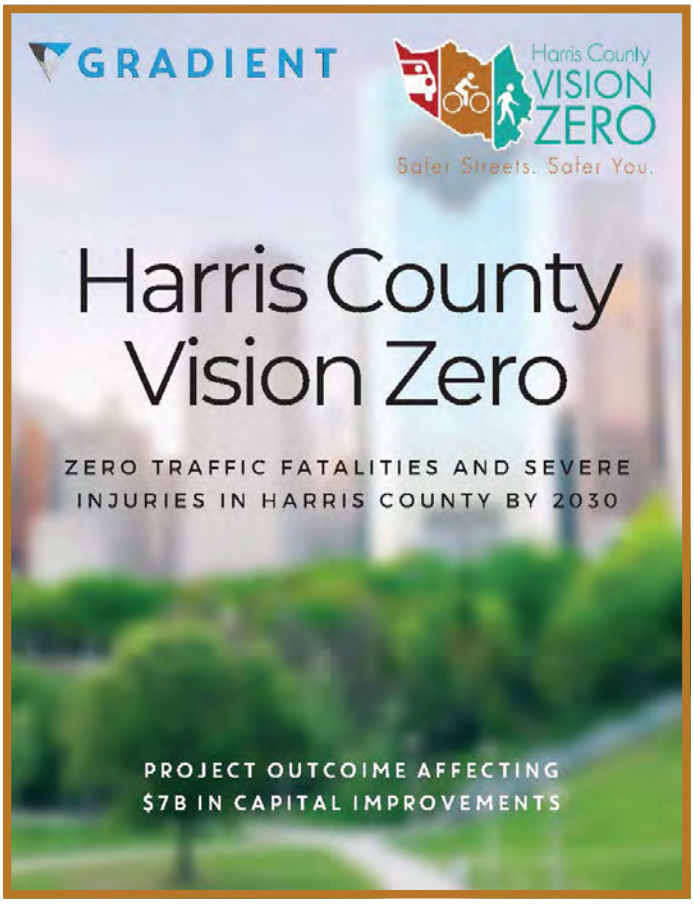
1: A correlation analysis evaluates the refined prioritization inputs against the City of Fort Worth's baseline prioritization inputs. Correlation analysis is used as a tool in data preprocessing and exploration to highlight possible relationships between variables. The correlation analysis for the Fort Worth Storm Drain Rehabilitation Program helped validate the prioritization approach and confirm that no single input was biasing the results. **2**: Halff Associates developed a web-accessible data platform—the Storm Drain Rehabilitation Program Tracker—to enable collaboration by internal city stakeholder groups. The tracker is used by the City of Fort Worth's Transportation and Public Works Department to prioritize system inspection and capital improvement projects and to monitor the SDRP performance metrics. **3**: The spreadsheet-based, High-Risk Mapshed Prioritization Tool was prepared to manage and schedule the city's storm drain inspections by drainage areas, known as mapsheds.

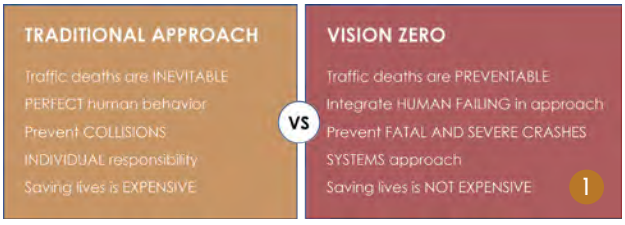
Harris County Vision Zero Action and Implementation Plan

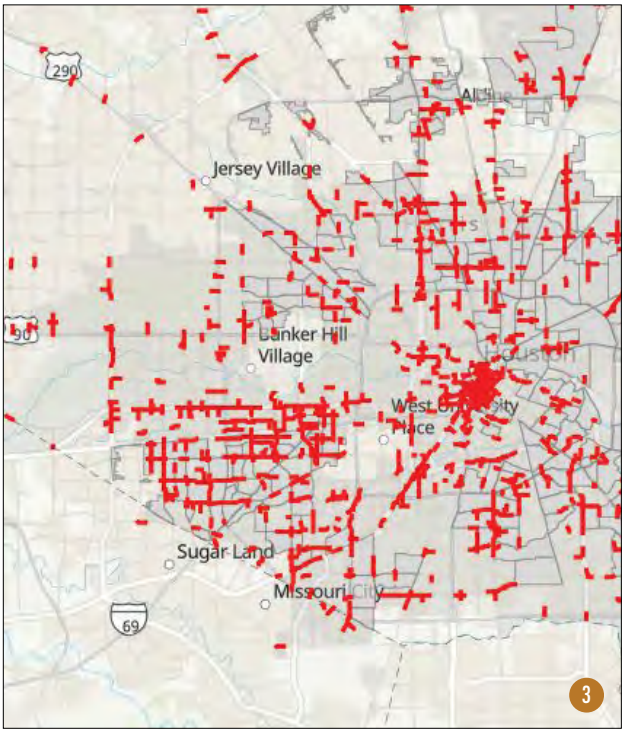
Gradient Group

More than 39,000 people lost their lives on the Harris County roadway system in 2020—that's the equivalent of 130 commercial plane crashes a year. This number doesn't even include the four and a half million people seriously injured in roadway crashes.

Vision Zero is an effort to improve roadway safety by changing our collective mindset. Started in Sweden around 1995, this multi-national program aims to reshape the casual way in which the public thinks about roadway crashes and help improve roadway safety for all users—regardless of their mode of travel.







1: VISION ZERO changes the mindset on how we view safety on our roadway system. **2**. The plan initiated the Safer Streets Study, which included pedestrian crossings, to save lives. **3**: The High Injury Network represents 6% of Houston streets which account for 60% of traffic deaths and serious injuries.

TEXAS GOLD

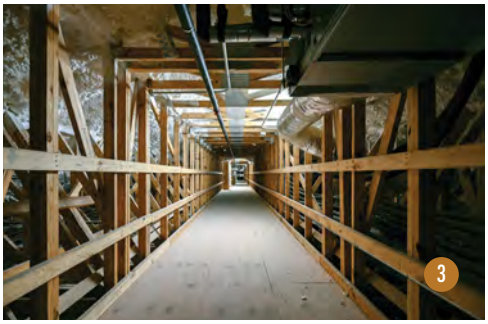
Studies, Research, and Consulting Engineering Services

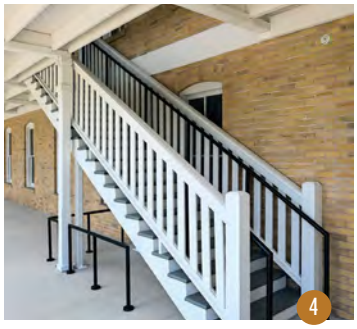
Texas Military Department, Camp Mabry Building 1 Historical Renovation

Freese and Nichols

Established in the 1890s in Austin, Camp Mabry serves as headquarters for the Texas National Guard. Building 1 is one of the oldest structures on the campus. The two-story building is a contributing structure within the Camp Mabry Historic District and the State Antiquities Landmark Listing.

Renovating and restoring a registered Texas Historical Landmark presented its challenges. Modernizing the structure with contemporary systems, including energy efficiencies, proved to be the solution for the engineering, construction, and other project phases. The Camp Mabry Building 1 Historical Renovation demonstrates antiquity married with efficient, modern engineering and design.





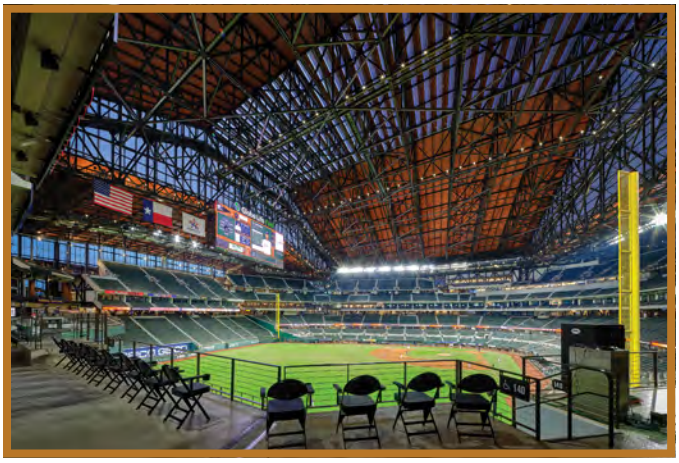
1: The first-floor lobby was transformed into welcoming entryway. The original entry felt cramped and bland. The renovation created a more open space, and new doors replicated the appearance of the previous doors. The articulated ceilings and wood flooring creates a more dynamic feel. **2**: A complex shoring system protected the integrity of the historical brick walls. During construction, diaphragms were demolished and replaced with the new structural systems. To protect the walls from becoming overstressed while they were unsupported during construction, the shoring system was attached to the walls using through bolts located in the mortar joints of the exterior wythe of brick. This preserved the historical brick while supporting the walls. **3**: A catwalk system enables access to the new, energy-efficient HVAC system installed in the attic. **4**: A more substantial connection between the first- and second-floor columns to meet the required current codes. This was achieved using a mechanical strap. **5**: Restored exterior back porches.

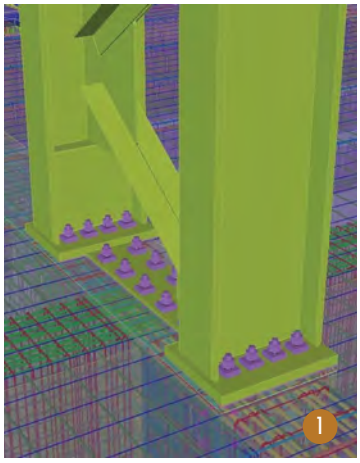
Texas Rangers Globe Life Field and HKS

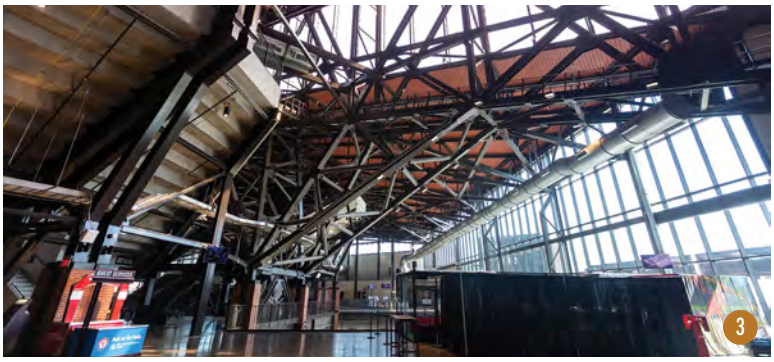
Walter P Moore

Globe Life Field—home of Major League Baseball's (MLB) Texas Rangers—caters to baseball fans of all ages. The Rangers had two goals: providing protection from the elements while maintaining the feel of an outdoor ballpark and bringing fans closer to the action than ever before.

The stadium has a distinctive 300,000-square-foot, single-panel operable roof with a "racing stripe" of ETFE to protect fans from the elements while allowing natural light to flood the ballpark. The seating bowl features seven distinctive "front-row experiences," with the closest MLB suites to home plate a mere 20 rows from the field.







1: Walter P Moore's Construction Engineering specialists provided fabrication-level modeling for 1,500 tons of reinforcing steel and the highly congested interface between this rebar and the embedded anchor rods. **2**: A striking feature of the ballpark is its 300,000-square-foot, 420-foot by 680-foot single-panel, operable roof that takes a mere 12 minutes to travel over 400 feet to open and close. **3**: To create a distinctive fan experience in the southeast corner, a series of large floor openings from the Upper Concourse down to the Main Concourse combined with a discontinuity in the upper seating bowl creates a sizeable open area. **4**: The design team created an asymmetrical seating bowl offering a variety of seating options, each having a unique sightline. In the bowl, fans are drawn into the game by seven distinctive front-row experiences. **5**: Globe Life Field's exterior design blends a historic brick façade with structural steel accents and extensive glazing throughout to bring natural light into the stadium.

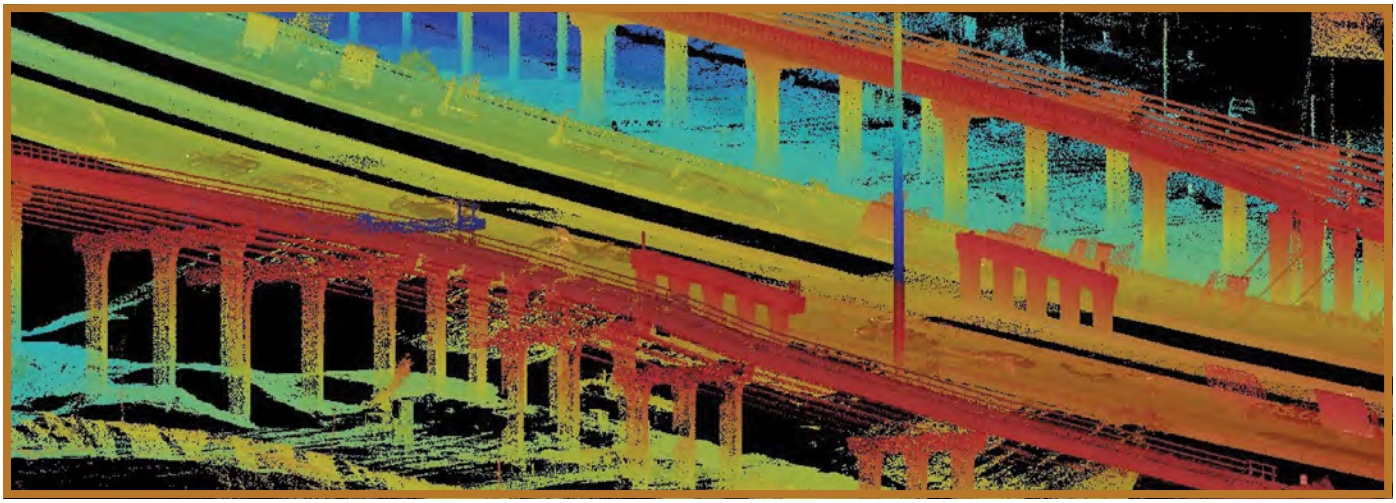
TEXAS GOLD

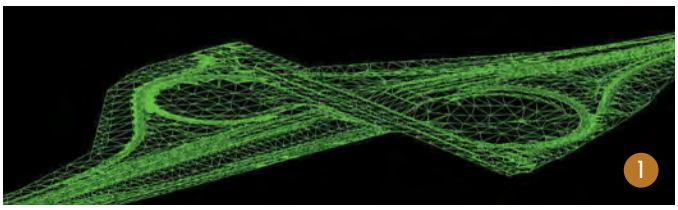
Surveying & Mapping

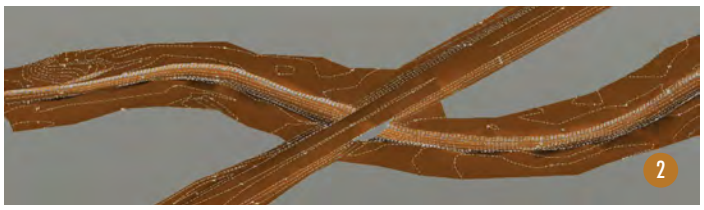
TxDOT El Paso, I-10 Bridge Modeling and Construction Verification

Halff Associates

Significant population growth trends in El Paso, Texas, necessitated improvements to alleviate congestion along the I-10 corridor. The Texas Department of Transportation (TxDOT) El Paso District selected Halff Associates, Inc. (Halff) for the I-10 Bridge Modeling and Construction Verification project, a multi-phase roadway transportation project in the corridor. Halff was tasked with collecting geospatial and survey data across three roadway sections and at an interchange to verify that its bridge columns were placed properly. Surveyors used geospatial technology to collect complete datasets efficiently and accurately using lidar, data fusion and hybrid mapping processes.







1: The mobile lidar unit produced data collections that were then modeled for analysis. The team also collected terrestrial-based lidar data and unmanned aerial data to generate a wireframe digital terrain model (DTM). **2**: The data was vectorized to create a contextualized DTM. All datasets from the aerial mapping, mobile and terrestrial lidar, and conventional surveying collections were merged, creating a comprehensive view of the bridge structures. **3**: Halff Associate's has invested heavily in geospatial technologies including manned and unmanned aerial photogrammetry, light detection and ranging (lidar), mobile lidar systems, and terrestrial-based lidar services. Halff uses the Trimble MX9 mobile lidar system as its mobile lidar unit to rapidly capture laser scans and images while driving. Using Global Navigation Satellite System (GNSS) technology, a laser scanner, cameras and browser-based operation, the technology reduces collection time and increases staff safety.

City of Big Spring, Big Sandy Municipal Solid Waste Landfill

Parkhill

Big Spring has served their community with solid waste services at a site with limited expansion opportunities and an expected closure by 2025. To continue this service, Big Spring teamed with Parkhill to identify, permit, design, and oversee construction before the deadline. The newly opened facility on 242 acres provides over 12.7 million cubic yards of disposal capacity with a life expectancy of 106 years.

Big Spring desires to expand its solid waste options beyond disposal. The new site allows space for material recycling while improving methods of leachate disposal, expanding groundwater protection, and enhancing landfill gas monitoring programs. Citizens using the facility will be directed away from the work zone to drop off waste, providing a safer means of disposal.

1: Scalehouse with inbound and outbound scales. **2**: Cell liner installation. **3**: Stormwater detention basin. **4**: Maintenance building.

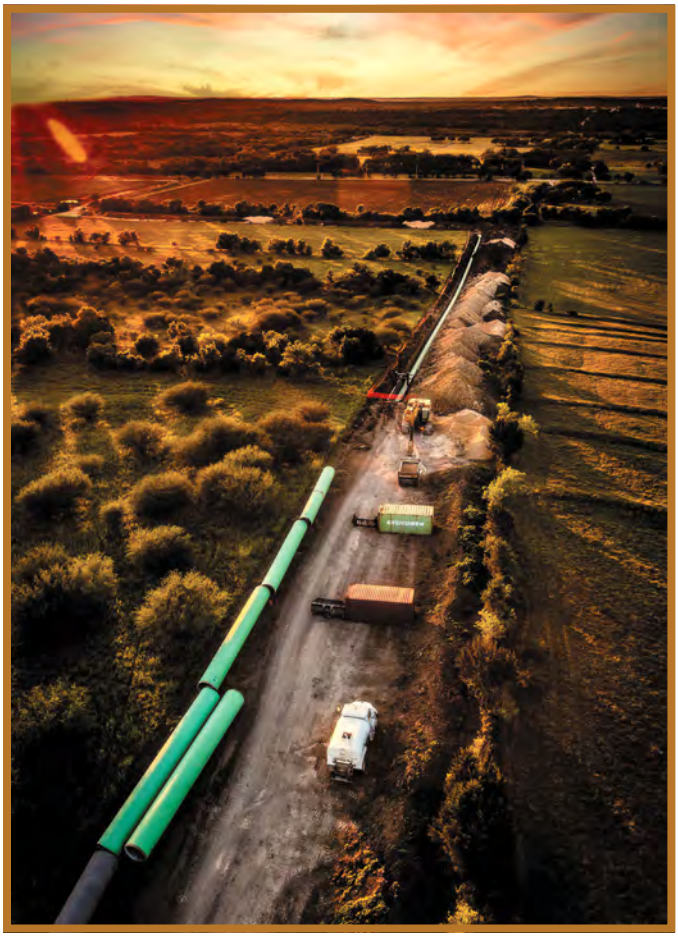
TEXAS GOLD

Water and Wastewater

Central Texas Regional Water Supply Corp., Vista Ridge Regional Water Supply

Pape-Dawson

Due to San Antonio's explosive growth, the San Antonio Water System (SAWS) needed a major source of water to complement the Edwards Aquifer in ensuring sustainable and reliable water supply. The Vista Ridge Regional Water Supply Project met this objective through a public-private partnership to supply the SAWS service area with 16.3 billion gallons annually for the next 30 years. Vista Ridge was monumental in size, timeframe, material procurement, and design restrictions that necessitated a unique approach for concurrent construction while land acquisition was still in its infancy, allowing the project team to remarkably deliver water production within four and a half years.

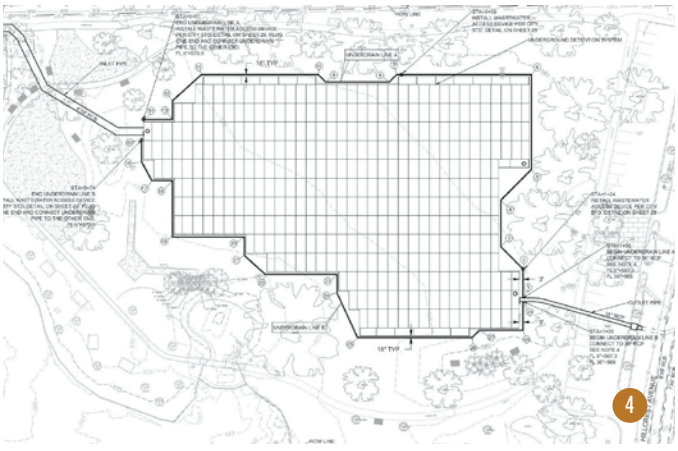


1: 10 MG ground storage tank at Agua Vista site in San Antonio. **2**: 60" diameter pipeline in Comal County, TX. **3**: High-service pump station in Lee County, TX.

City of University Park, Caruth Park Underground Detention Storage

Huitt-Zollars

The Caruth Park Underground Detention is the first phase of the University Park Storm Drain Replacement project, which includes proposed improvements developed as part of the upper Turtle Creek Basin A Stormwater Master Plan. Huitt-Zollars prepared both the study and design plans for the City of University Park, Texas. Due to the basin's close to fully-developed conditions and lack of available open space, underground storage was determined to be the best solution to reduce the area's flooding. HZ's innovative design, which incorporated a modular concrete stormwater management system called StormTrap®, has reduced flooding, saved on maintenance costs, and minimized resident complaints.



1: Phase one installation of StormTrap—only a small crane was needed on-site to lift individual precast pieces into place. **2**: Huitt-Zollars and City of University Park personnel inside installed modular system. **3**: Installation of phase one nearing completion.

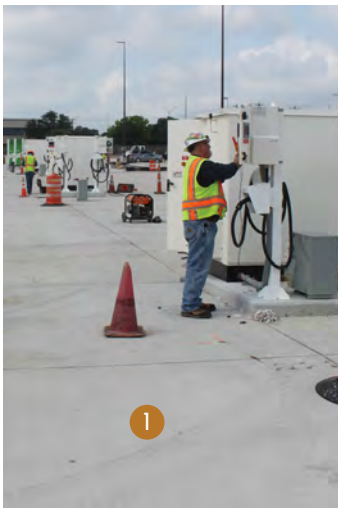
TEXAS GOLD

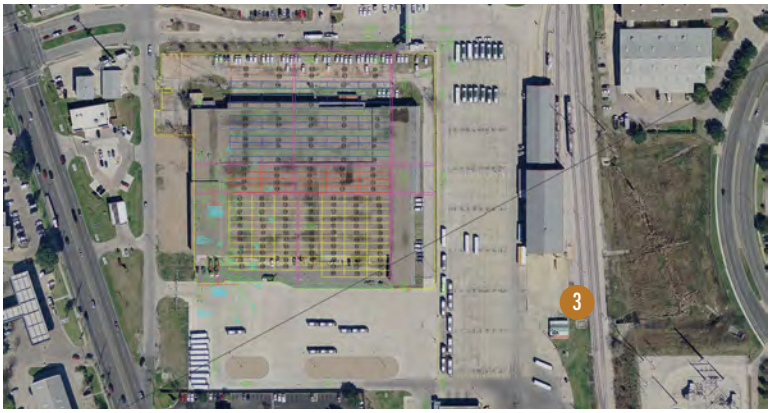
Transportation

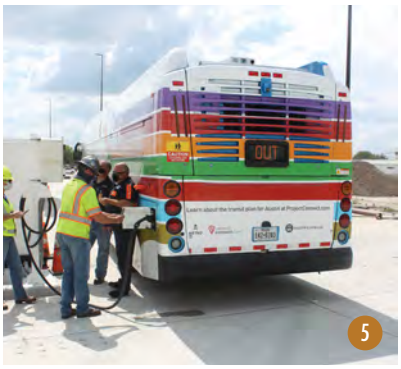
Capital Metro, North Operations Battery Electric Bus

Huitt-Zollars

As part of their Zero Emission Electric Bus Initiative, CapMetro partnered with Huitt-Zollars, Inc. to design the infrastructure needed to introduce and house the Agency's new and growing fleet of electric buses. The new North Operations battery electric bus (BEB) yard is able to support charging capacity for nearly 200 electric buses. The bus yard layout and underground conduit was designed for maximum flexibility and is able to accommodate any bus/charger configuration that CMTA chooses to test or implement. The new buses reduce energy consumption and harmful emissions, thus improving air quality throughout the city and minimizing negative impact on the environment.







1: Phase 1 of the North Operations bus yard included installation of three Siemens chargers capable of serving six new Flyer buses. **2**: Bus yard rendering. **3**: Site layout of future bus yard and infrastructure. **4**: Phase 1 also included installation of six Proterra chargers to serve six Proterra buses. **5**: Battery Electric Bus charging station in use.

West 8, Houston Botanic Garden

Walter P Moore

The 132-acre Houston Botanic Garden along Sims Bayou repurposed an existing municipal golf course in southeast Houston into a City gem. The Garden is a welcome investment in green spaces and cultural amenities. Houston Botanical Garden, opened in 2020, symbolizes Houston's revitalization of its green spaces and includes eight different gardens.

Walter P Moore provided civil, water, bridge, structural, and diagnostic engineering for Houston Botanical Garden. The firm designed Garden amenities such as the alcoves, Welcome Pavilion boardwalks and the supporting infrastructure including new wetlands and detention ponds, improved existing bridges, and designed a new entrance bridge.

1: The garden's Welcome Fountain greets visitors with the calming sound of soft falling water. **2**: A key structural feature is the water wall that was designed to highlight aquatic plants and offer a cool respite to Garden visitors on a warm day. **3**: Stormwater detention is accomplished in a wetland garden representing an important botanical feature working as its natural function to capture, treat, and attenuate rainfall runoff. Boardwalks are provided throughout the area to bring patrons close to the plants to experience the gardens at work.

TEXAS ★ GOLD

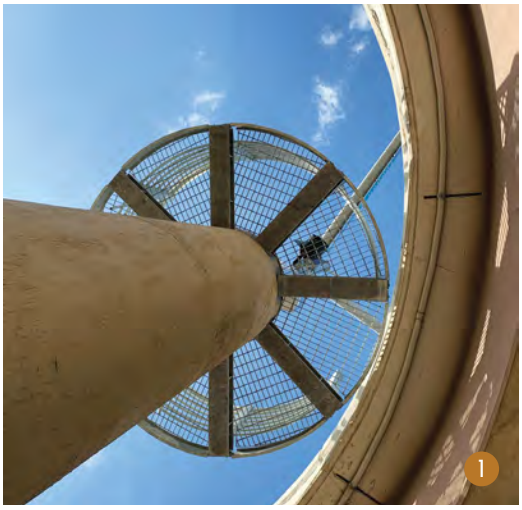
Small Projects

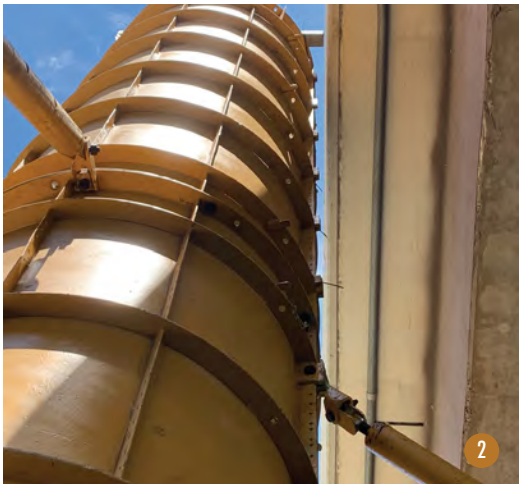
TxDOT, IH 635/Dallas North Tollway Split Diamond Traffic Signal Design

BGE, Inc.

Replacing obsolete traffic signals is generally routine. But when the signals are attached to an elevated structure, with no easy way to replace and reattach, that becomes a signaling challenge. That's what happened at the elevated intersections of the Dallas North Tollway (DNT) Frontage Roads (Inwood Road) and the IH 635 Frontage Roads in North Dallas.

BGE's Traffic and Structural Engineering teams created an innovative design solution using four dual mast arms located on columns, catwalks and handrails to allow for easy maintenance access and operation of the existing traffic signals while increasing safety for motorists and maintenance personnel.





1: The gap between the catwalk and bridge is about two inches to ensure maximum safety when accessing the platform. **2**: The structural columns had to be precisely located to ensure proper spacing for the catwalks and signal heads. **3**: BGE's traffic signal design at IH 635 and the Dallas North Tollway frontage roads is the first of its kind in TxDOT's Dallas District.

Giving North Texas Municipal Water District The Power to Deliver

Mbroh Engineering, Inc.

Mbroh Engineering's electrical improvements at Wilson Creek's Regional Wastewater Treatment Plant (RWWTP) provide the North Texas Municipal Water District (NTMWD) with highly innovative and unique operations. This project is one of NTMWD's largest electrical generation systems that parallels with a power company and provides plant-wide power reliability for over half a million customers. In Texas, just a year past Winter (Ice) Storm Uri of 2021, this translates into critical electrical reliability for wastewater service and displays the impact of engineering facilities that are both energy efficient and better designed to serve our region in collaboration with energy providers.

1: The plant's electrical distribution system includes a generator system to provide a redundant source of power. **2**: A unique aspect of the plant is the conversion of the plant's existing underground electrical distribution system to an overhead distribution system. **3**: Mbroh's modifications to the plant's electrical system included design and installation of 5 kV main paralleling switchgear, providing a fully redundant power source plant-wide via overhead distribution. **4**: The design updated aging and compromised electrical equipment with modern equipment to provide critical electrical reliability for wastewater service across North Texas. **5**: Electrical improvements at Wilson Creek's RWWTP include a new power yard with a main medium-voltage paralleling switchgear housed within an electrical building that parallels multiple medium-voltage generators with two electrical utility power services, providing a fully redundant power source plant-wide via overhead distribution.

TEXAS ★ GOLD

Industrial

Gulf Coast Water Authority, Joseph A. Willhelm Industrial Pump Station

Lockwood, Andrews & Newnam, Inc.

The Gulf Coast Water Authority (GCWA) retained Lockwood, Andrews & Newnam, Inc. (LAN) to replace a critical 70-year-old industrial pump station that provided 96 MGD of raw water to five major petrochemical customers in Texas City. Major challenges included ensuring continuous water supply to GCWA's industrial customers during construction, reusing nine existing below-grade vertical turbine pumps in the new pump station, providing a flexible design to install future above-grade pumps, and building a robust facility that can withstand 140-mile-per-hour hurricane winds. Despite these challenges, GCWA and LAN completed the new Joseph A. Willhelm Industrial Pump Station in July 2021.

1: GCWA reused existing vertical turbine pumps for the new 96-MGD pump station. **2**: The project was divided into four phases to ensure the new pump station was up and running as quickly as possible. **3**: Custom-designed carbon steel pipe was installed to support future above-grade pump discharge piping. **4**: Three new eight-foot-wide traveling screens were installed as part of the new intake structure.

Studies, Research and Consulting Engineering Services

TxDOT, State Wide Architecture As-Built Survey – Phase 1 Pilot Program

Huitt-Zollars

TxDOT is undertaking a program to update and modernize its facilities asset portfolio—nearly 400 facilities—for use in future renovations and maintenance projects. As part of a pilot program, Huitt-Zollars was selected by TxDOT to provide architectural as-built digital scan surveys (virtual reality capture) and spatial Revit BIM modeling of three TxDOT campuses, encompassing 33 buildings and approximately 175,000 square feet. Services included acquiring, modeling, and incorporating information into the State's facility management database.

The pilot program enabled the team to conduct the survey on a smaller scale in order to address any challenges and streamline processes for the remaining facilities.

Water and Wastewater

Coastal Water Authority, A Generational Transfer: The Impact of a Pig Retrieval Station on Houston's Water

BGE, Inc

The Luce Bayou Interbasin Transfer Project transports 500 million gallons of water per day from the Trinity River to Lake Houston. It includes a pump station, 23 miles of earthen canal, pig retrieval station and flow distribution basin.

The size of the pigging station presented significant design challenges. At the termination of three miles of dual 96-inch water transmission lines, the vault complex is covered by a metal building with removable sections to facilitate access.

BGE's design exceeded client expectations and saved money. The solution positively impacts millions of lives, helps reduce subsidence and sets the standard for future projects.

TEXAS ★ SILVER

Water Resources

City of Fort Worth, Twin 90-inch Sewer Pipe Emergency Bank Stabilization

Freese and Nichols

The City of Fort Worth faced a potential environmental and public safety crisis.

Erosion along the Trinity River had exposed a 90-inch-diameter pipeline that helped convey 150 MGD of wastewater to the City's Village Creek Wastewater Reclamation Facility. Emergency repairs were needed to stabilize the bank, prevent the wastewater flow from polluting the river and protect an adjacent pipeline.

A multidisciplinary team of engineers and scientists worked with the City to fast-track a solution using natural-design techniques that averted a wastewater disaster and will benefit the river long-term. Public services continued uninterrupted, and the City saved on construction costs.

Transportation

Northgate Constructors, The DFW Connector

WSP

The DFW Connector reconstructed the interchanges of SH 114, SH 121, and I-635 north of DFW Airport. WSP was the lead designer for NorthGate Constructors for this design-build project. WSP managed all design efforts, the geotechnical investigation program, the Design Quality Management Plan and provided project control management and reporting for design. In addition, WSP provided support of right-of-way (ROW) acquisition. The final product relieved traffic congestion with aesthetically pleasing and cost-effective infrastructure. The Design-build delivery approach greatly reduced the time required to meet TxDOT's schedule and kept traffic disruption to a minimum.

Special Projects

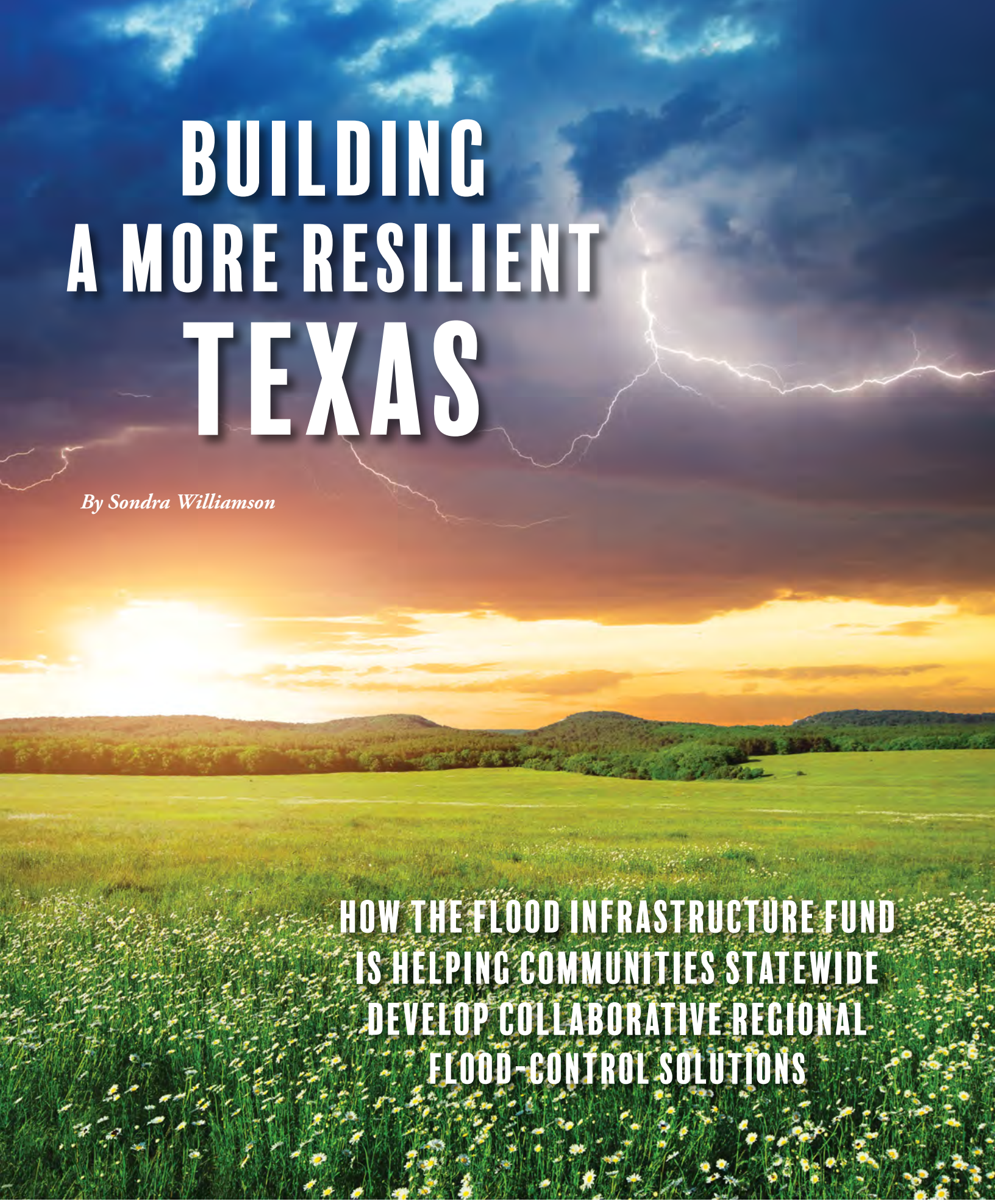
Grandscape

Olsson

Grandscape, LLC wanted to create a space that was world-class, where people would want to come explore, experience, and enjoy.

Designed as a "Go big and feel at home" entertainment destination, Grandscape sits on 433 acres in the City of The Colony, Texas. When finished, it will have its own city-like feel complete with 3 million square feet of retail, entertainment, restaurants, office space, and a 95-acre lifestyle center.

Phase 2 of the project, expected to take five years to complete, will add more features making it easier for people to gather, relax, and have a good time.



BUILDING A MORE RESILIENT TEXAS

By Sondra Williamson

HOW THE FLOOD INFRASTRUCTURE FUND IS HELPING COMMUNITIES STATEWIDE DEVELOP COLLABORATIVE REGIONAL FLOOD-CONTROL SOLUTIONS

When it comes to weather, Texas is a capricious lady, and hot and dry is just one of her moods. Depending on the season and locale, Texans may find themselves facing down a destructive hurricane or killer tornado, battling a virulent wildfire, buried by snow, encased in ice, or simply enduring extreme, oppressive heat. But the most common kind of natural disaster in Texas is flooding, and it is happening more frequently and with greater intensity.

By 2036, Texas will experience as much as 50 percent more flooding, according to a study released last October by the Texas state climatologist and Texas A&M University researchers, "Assessment of Historic and Future Trends of Extreme Weather in Texas, 1900-2036: The 2021 Update."

"Texas' weather is changing, and it's doing so in a way that will make it harder to live here and more expensive to recover from increasingly disruptive events," said State Climatologist Dr. John Nielsen-Gammon, regents professor in the Department of Atmospheric Sciences at Texas A&M. "That means preparation and resilience are more important than ever. Texas' long-term prosperity will depend on how well we prepare for these increasingly damaging natural disasters."

The Texas A&M report shows Texas' climate has already changed in ways that leave the state more vulnerable to extreme weather. Excessive rainfalls have become more frequent and severe, and that is expected to worsen. No part of Texas is immune. And while not always cataclysmic, it is always costly.

Generally, people associate Texas flooding with coastal regions — Houston, Beaumont, Galveston, Port Aransas, and parts of the Rio Grande Valley regularly hit by tropical storms and hurricanes. But Texas is a huge state — 268,597 square miles, to be exact. As the crow flies, Texas is 801 miles long and 773 miles wide. An area of land that large has a lot of variation in landscapes, ecosystems, and climate. Flooding occurs in every part of Texas, from the Red River to the Rio Grande, from the Gulf of Mexico to the Panhandle, from the Louisiana border to the New Mexico state line.

Austin and San Antonio lie in the heart of "flash flood alley," where storms regularly stall out along the Balcones Escarpment, creating a higher potential for flooding than anywhere else in the nation. Adding to the risk, parts of Central Texas have rocky, clay-rich soil and steep terrain that make them uniquely vulnerable to major flooding. In semi-arid areas like Lubbock, a two-inch rain event that would barely be noticed in the Houston-Beaumont area can cause serious flooding, as the water quickly runs off the bedrock and into neighborhoods. Last June, even the far-West Texas town of Presidio — where summers and winters are historically dry — experienced flash floods, killing two people.

Obviously, the simplest explanation for flooding is heavy rains, especially over long periods of time. When infrastructure and systems designed to move rainwater into basins and reservoirs work as intended, no one gives a thought to where the runoff goes. But when those systems are overwhelmed, drainage systems back up and water rises.

Locally heavy rain is not the only catalyst for flooding, as Texans who live alongside rivers and bayous know all too well. A downpour that occurs upstream can easily wash out their property if levees or dams are not properly maintained and managed to control the water flow. Even when a hurricane or other storm has occurred, it is often the storm surge — a rise in the sea resulting from wind and other atmospheric changes — that pushes floodwaters inland, flooding low-lying areas unprepared for so much water. Even modest rains can cause fast runoff and flooding in areas where the banks of rivers and channels are steep, reservoirs are improperly graded, or vegetation is sparse.

We must change our relationship with flooding, understand its natural behaviors, and work in sync with them, as well as with each other.

A large percentage of the land in Texas cities, both coastal and inland, is paved with concrete and other impermeable cover, leaving little ground to soak up rainwater during a heavy rain event. Urban drainage basins often cannot handle the load, and when they fill up, the surrounding low-lying areas flood. In some parts of Texas, large expanses of loose, dry, or heavily compacted soils cause the same kind of runoff problems. That is also the case when soils become super-saturated by a slow-moving, heavy rain system that sits stationary over an area for days.

At the same time, sinking coastal lands, climate change, and rising sea levels are making "sunny-day flooding" an increasingly common occurrence. The term refers to the temporary inundation of low-lying areas during high-tide events such as full and new moons.

The Texas Panhandle can get *as cold as a banker's heart.* West Texas can be *so dry the catfish are carrying canteens*. A North Texas tornado might just *blow an egg through a barn door*. And down in the Valley, as we all know, it can get *hotter than a two-dollar pistol.*

Indeed, every part of Texas has its own signature brand of weather, and each of them wreaks havoc on people and property at one time or another, in one way or another. But none are as pervasive, challenging, and insistently destructive as flooding. To protect against it, we must change our relationship with flooding, understand its natural behaviors, and work in sync with them, as well as with each other. That is why state legislators have been focused on finding a way to improve how we approach flood control and mitigation statewide.

Ladies and gentlemen, I think we have a winner.

MODEL LEGISLATION BEGETS OVERWHELMING VOTER APPROVAL

In 2019, with the 2017 destruction caused by Hurricane Harvey in mind, the 86th Texas Legislature overwhelmingly passed landmark legislation to fund flood mitigation projects and plan for future

flood events statewide.

With Senate Bill 8, the legislature established the framework for the Texas Water Development Board (TWDB) to develop and oversee statewide flood planning through a network of watershed-based regional flood-planning groups. The TWDB established a regional flood-planning process emphasizing watershed-based planning versus planning within political jurisdictions, designated flood-planning regions, named representatives for each region, and established technical and financial support.

Each flood-planning region must include representatives from the public, counties, municipalities, industries, agricultural interests, environmental interests, small businesses, electric-generating utilities, river authorities, water districts, and water utilities. Each region's flood plan is due to the TWDB in January 2023, and the TWDB will produce and adopt a comprehensive State Flood Plan by September 1, 2024.

The funding mechanisms for the flood-mitigation legislation were SB 7 and HJR 4 by Senator Brandon Creighton (R-Conroe) and Representative Dade Phelan (R-Beaumont), who now presides as Speaker of the Texas House. Senate Bill 7 combined the Senate version of the bill with the House alternative, creating two funds to provide grants and loans for flood-control projects. The bill passed unanimously on a voice vote in the House — a strong indicator of how brutally flooding has impacted communities statewide.

BELOW: *Representative Dade Phelan (R-Beaumont), Speaker of the Texas House. Photo courtesy of the Texas House of Representatives.*

Senate Bill 7 enabled creation of the Flood Infrastructure Fund (FIF) to provide financial assistance in the form of loans and grants at or below market interest rates for flood control, flood mitigation, and drainage projects. In its original form, SB 7 would have drawn nearly $3.3 billion for these purposes from the Texas Economic Stabilization Fund (the state's savings account, commonly called the "Rainy Day Fund"). As passed, it provided $1.478 billion to be appropriated in the state supplemental budget bill, SB 500. Of that amount, $793 million was allocated to the FIF, to be administered by the Texas Water Development Board.

The remaining $685 million was allotted to the Texas Infrastructure Resiliency Fund (TIRF), which is also administered by the TWDB. The Board can provide up to $638 million of these funds to the Texas Division of Emergency Management (TDEM) to be allocated to eligible political subdivisions for non-federal matches for projects related to Hurricane Harvey. The remaining $47 million is funding dedicated to support statewide flood-mapping and flood-planning activities.

An important distinction is that the financial assistance available through the Flood Infrastructure Fund is separate from the TWDB's statewide flood-planning process. For eligible projects, FIF funds are available now. After the State Flood Plan of 2024 is adopted, the TWDB may use the FIF only to provide financing for flood projects included in that plan.

Even more importantly, because the Flood Infrastructure Fund was created outside the Texas Treasury, its creation required an amendment to the Texas Constitution. Proposition 8 was placed on the November 5, 2019, ballot and approved by 77.87 percent of Texas voters. This constitutional amendment permanently dedicated the $793 million allocated by the legislature solely to the Flood Infrastructure Fund. Future legislatures cannot transfer constitutionally dedicated FIF funds to any other account or use them for any purpose other than those specified for FlF projects.

"As Hurricane Harvey reminded Texans in 2017, flooding can happen anytime and anywhere — and the damage done is oftentimes devastating, with recovery efforts historically lasting years and costing billions of dollars," said Speaker Phelan. "Thanks to legislation I authored and passed with the help of my colleagues in the Texas Legislature during the 2019 session, the Flood Infrastructure Fund is the first of its kind in the state that expedites much-needed dollars when those natural disasters hit and helps finance flood mitigation projects across Texas.

"Water does not follow political boundaries, as I've said before, and the lessons learned from Harvey helped us transform how Texas responds and recovers to future floods by promoting collaboration across all regions of the state," Phelan continued. "As roughly 1,000 people a day move to Texas, the broader conversation around infrastructure is one that is not going away anytime soon. The Texas House will study the issue throughout the interim, so we can hit the ground running when the legislature convenes again in January."

A RATIONAL APPROACH TO FLOOD PLANNING

Scoring Flood Infrastructure Projects

Senate Bill 7 was historic legislation that other states will likely replicate. It dedicated a far larger amount of funding for flood control than any previous legislative appropriation in Texas history. In doing so, it charged the Texas Water Development Board with implementing a mammoth new financial program with far greater potential for effectiveness against flood disasters than Texas communities had ever seen.

For the first time, the State of Texas recognized floods do not respect political boundaries and began working with all stakeholders — municipalities; counties; river authorities; and water, drainage, conservation, and reclamation districts — to design projects based on the impacts of flooding throughout their local watersheds, not just within their own jurisdictions.

Senate Bill 7 was historic legislation that other states will likely replicate. It dedicated a far larger amount of funding for flood control than any previous legislative appropriation in Texas history.

Texas Water Development Board Executive Administrator Jeff Walker spoke with us about how the Board arrived at its methodology for soliciting, vetting, approving, and prioritizing eligible projects. The genesis for it all lies in the State Flood Assessment the TWDB began conducting in 2017. The TWDB's top priority for FIF-funded projects was large regional watershed studies. Walker explained why.

BELOW: *Texas Water Development Board Executive Administrator Jeff Walker.*

"We went on a statewide tour asking local leaders about their flood-planning needs, and what we heard most often was, 'We don't know what we need,'" Walker said. "They knew they were flooding, but they didn't know why and had no idea how to solve it. We took that information to the Board, and they used it to categorize and prioritize regional floodplain studies."

"It's kind of hard to do planning when you don't know what you need and don't have any money to do the studies, so getting those big regional studies going was our number-one priority," he continued. "They account for almost half the projects we have funded so far through the FIF. They are enormously complicated and involve time-consuming, cooperative stakeholder efforts, but they will yield invaluable information. So even though no dirt has been turned yet, the studies will lead to more effective, basin-wide flooding solutions."

Texas has an extensive network of surface waters. Of the seventy-eight major watersheds in the lower forty-eight states, twenty-three of them are in Texas — confined within the state, shared with neighboring states, or straddling the international border. They include eight designated coastal basins: the Neches-Trinity, Trinity-San Jacinto, San Jacinto-Brazos, Brazos-Colorado, Colorado-Lavaca, Lavaca-Guadalupe, San Antonio-Nueces, and Nueces-Rio Grande. Each coastal basin is named according to the major river basins that bound it.

Essentially, every square inch of land in Texas is part of a watershed, a term used interchangeably with "river basin." Wherever you live or work, you are in a watershed, which is simply a land area that drains to a common location, such as a lake, river, or ocean. The National Environmental Education Foundation (NEEF) characterizes it this way: "You can think of it as a shallow depression or bowl in the landscape, where the 'rim' is a ridge or hill: even if your home is situated on the rim of the bowl, water washing off (the land in) your neighborhood is draining to the same place as areas on the opposite side of the bowl — everything is connected . . . Because of this interconnectivity, what may seem like a small action in one area of the watershed can have a big impact on natural systems elsewhere in the watershed, including the plants, animals, and people that depend on them."

That last sentence is key: The interconnectivity of watersheds is what makes taking a regional approach to flood planning critical.

"We wanted to come up with a solution to make sure that people downstream aren't negatively impacted by what communities upstream do. That's why we required everyone in the watershed to participate. Those types of large watershed studies are time-consuming, involving a lot of modeling and coordination. That's what everyone told us they needed most, so that's what we funded first."

Walker said the TWDB's FIF Category 1 regional studies were based on watersheds no smaller than hydrologic unit code 10 (HUC-10), which is a substantially large watershed. The U.S. Geological Survey uses the HUC classification system to categorize watersheds according to the size of their drainage areas. The smaller the number, the larger the watershed. For example, an HUC-2 encompasses the drainage area for an entire region, such as the Pacific Northwest; an HUC-10 watershed is typically 40,000 to 250,000 acres in size.

The Board's second priority was projects that could be implemented quickly and would immediately impact protection of lives and property — flood early warning systems (FEWS) like stream gages and telemetry equipment. An effective flood warning system is based on the regular collection of local rainfall, stream level, and streamflow data. This can be accomplished through routine monitoring of

gages and precipitation-measuring sites by operating personnel. However, a real-time monitoring system with telemetry makes data collection easier — and in many cases, more cost-effective — while freeing up personnel and enabling the fastest possible response to a flood event. The National Weather Service attests that, even in areas where they provide flood-warning coverage, a real-time, community-oriented flood warning system can significantly reduce risks associated with flooding.

Another priority was providing grants and loans for the local match required for projects that had already secured federal matching funds, to be certain the recipients would not lose those federal dollars. For the current round of Category 3 funding, applicants are all meeting the local match for the federal Hazard Mitigation Grant Program (HMGP). Typically, the initial performance period for an HMGP grant is three years, with the option of two one-year extensions. The HMGP is funded through the Robert T. Stafford Disaster Relief and Emergency Assistance Act, administered by the Federal Emergency Management Agency (FEMA).

The National Weather Service attests that, even in areas where they provide flood-warning coverage, a real-time, community-oriented flood warning system can significantly reduce risks associated with flooding.

"Construction projects were generally funded last, and we have started committing funds to them only within the past six or eight months," Walker said. "The construction process is long, often taking one or two years just for planning and design. Most entities aren't going to spend the money to design something if they don't also have the money to construct it. So, once we committed the construction funds for those projects, they were able to procure their design engineers, planning engineers and general contractors, and move toward getting underway."

Within each of those four areas, the Board focused on rural areas and areas with low median household incomes, which are often left out of the equation when government funding is allocated. Moreover, Walker said the ranking of approved projects does not necessarily reflect the merits of each project; it is simply a reflection of the scoring criteria.

"When the agency was formulating the funding structure, prioritization, and rules for the FIF, we were designing a program that would fund a wide variety of beneficial flood mitigation projects while, at the same time, offering a degree of grant funding that ensured project success based on the nature of the project and the category type," said Walker.

"The grants were combined with 0 percent loans to provide as much funding as possible for future flood projects, thereby leveraging for generations the initial funding provided by the legislature," he continued. "To further expand the scope of the program and increase the dollars flowing to beneficial flood projects, the agency allowed recipients to use their own funds in lieu of taking the eligible FIF loan portion. These funds were then provided to other flood projects on the prioritization list, resulting in an even greater impact from the initial FIF investment."

We asked Walker if there is a way to quantify the benefits of an FIF-funded project, other than looking back at the property damage costs of prior flood events. He cited the benefit-cost ratio (BCR), which is widely used by governments and private enterprise to determine the viability of cash flows from an asset or project. The higher the ratio, the more attractive the project's risk-return profile. If a project has a BCR greater than 1.0, it is expected to deliver a positive net return on investment; if its BCR is less than 1.0, the project's costs outweigh the benefits, and it should not be considered.

"The TWDB staff reviews the BCR, which is provided by applicants for Category 2 and 3 FIF projects, and some have BCRs as high as 2:1 or 3:1," Walker said. "It may be easier to think of it qualitatively: If you live in an area where the flood stage is four feet, that means in a severe flood, you are likely to get four feet of water in your home.

If the FIF finances a project in your area that will reduce that to six inches of water or less, your home is going to sustain a lot less damage in the next major flood."

The Flood Intended Use Plan

The Texas Water Development Board's Flood Intended Use Plan (IUP) sets forth in detail the eligibility criteria, structure of financial assistance (including any subsidies), and criteria to be used by the executive administrator in prioritizing applications.

A wide range of Texas political subdivisions are eligible to apply for financial assistance for flood mitigation projects through the FIF. They include cities, counties, and any district or authority created under Article III, Section 52, or Article XVI, Section 59, of the Texas Constitution, and any nonprofit water supply corporation created and operating under Chapter 67. Certain specific requirements apply to Category 1 applicants.

The IUP allows for a broad, diverse range of flood-control projects, structural and nonstructural, as well as nature-based flooding solutions. An overview of the types of eligible activities includes:

Planning Phase — preliminary engineering, project design, feasibility assessments, coordination and development of regional projects, obtaining regulatory approvals, and hydraulic and hydrologic studies.

Construction/Rehabilitation Phase — drainage infrastructure (channels, ditches, ponds, pipes, etc.); flood-control infrastructure; flood mitigation infrastructure; retention basins; detention ponds; sustainable infrastructure; nonstructural flood mitigation; development of or amendments to flood-related codes; permeable pavement; erosion control; levees; pump stations; rehabilitation of existing infrastructure (considering methods of improving resiliency, not including costs associated with current or future operations and maintenance activities); property acquisitions; restoration of riparian corridors, floodplains, coastal areas, wetlands, etc.; natural erosion and runoff control; and reasonable improvements to ancillary systems directly related to the project.

- **Other Eligible Activities** — such as warning systems, stream gages, educational campaigns, and crossing barriers.

Eligible projects are divided into one of four categories to prioritize certain types of activities and establish the relative grant percentage of FIF for funding:

1. Category 1 – Flood Protection Planning for Watersheds: Problem identification, strategy development, and solutions planning for entire watersheds before a flood event occurs.

2. Category 2 – Planning, Acquisition, Design, Construction, and Rehabilitation: Detailed planning, approval, and construction work required to move a project through these phases.

3. Category 3 – Federal Award Matching Funds: Funding for communities that have received a federal award for flood-related activities contingent on the availability of local matching funds.

4. Category 4 – Measures for Immediate Protection of Life and Property: Measures that can be implemented quickly for immediate impact, such as flood early warning systems like rain and stream gages.

A thoughtful, well-reasoned process for prioritizing and selecting projects for FIF funding is laid out in the Texas Water Development Board's Flood Intended Use Plan, consistent with the requirements of SB 7. An eligible entity must first submit an abridged application describing the proposed project from one of the four categories. These abridged applications were accepted through June 15, 2020. Entities were able to submit multiple abridged applications for funding of projects from several categories for prioritization within a one-year period.

Eligible projects are divided into one of four categories to prioritize certain types of activities and establish the relative grant percentage of Flood Infrastructure Fund for funding.

If a project encompasses multiple political subdivisions, all parties must sign a memorandum of understanding agreeing to the project and stating there will be no negative impacts to their jurisdiction if the project is implemented. Each party must also sign an affidavit stating the applicant has acted cooperatively with other political subdivisions to address flood-control needs in the area in which the political subdivision is located.

The TWDB's executive administrator prioritizes the abridged applications using criteria that score all projects falling under each of the categories described above. Criteria include:

- **Priority Projects** - Flood Protection Planning for Watersheds (Category 1). Is the project for flood protection planning for watersheds no smaller than the HUC-10 level?

- **Priority Projects** - Immediacy of Effects (Category 4). Are the measures expected to be immediately effective in protecting life and property?

- **Rural Versus Urban.** Is the project in a rural area, based on population density?

- **Emergency Need.** Is the project in an area where there has been a recent flooding failure, a failure is imminent, or a recent flood-related disaster declaration has been issued?

- **Distributed Benefits.** Will the project directly benefit or include the active participation of political subdivisions other than the applicant?

- **Estimated Completion Date.** Is the project expected to be completed within 18 months, 36 months, or longer?

- **Water Supply Benefit.** Will the project produce an integral, reliable, quantifiable water supply benefit to a specific group with an identified need? Benefits may include groundwater recharge.

- **Floodplain Impacts.** Will the project's impacts on floodplain characteristics increase the resiliency of the system being rehabilitated in a way that reduces the number of structures in the floodplain? If so, how many structures will be eliminated?
- **Planning, Acquisition, and Design (PAD) Only.** Is it a PAD project only, with no construction or rehabilitation funds requested?
- **Cost of Nonstructural Flood Mitigation Elements.** Do these costs constitute at least 20 percent of the total project costs?
- **Tiebreaker — Social Vulnerability Index (SVI).** The SVI uses fifteen U.S. Census Bureau variables to help local officials identify communities that may need support in preparing for hazards or recovering from disasters. In considering proposed FIF funding, the tie breaks in favor of the project with the highest SVI value.

At the Board's discretion, it may consider and allocate funding for any proposed project, bypass a higher-ranked project, or allocate funding to the highest-ranked projects in a particular category, regardless of their scores. Further, even after the Board approves the prioritization plan, its initial determinations of eligibility, category, compliance with minimum standards, grant percentage, and ranking for all projects are subject to change on further review. To date, the Board has allocated funding in priority order.

Once the Board approves the executive administrator's prioritization of projects, the applicants are invited to submit detailed TWDB Financial Assistance Applications.

WHAT IS THE STATUS OF THE FIF TODAY?

A significant concern at the outset of the program was whether all stakeholders would willingly work cooperatively toward a regional flood solution, especially if a proposed measure appeared to benefit one more than another. Virtually every person we spoke with said they experienced no difficulties; in fact, the stakeholders were excited to hear what their neighbors were working on, share data, and exchange ideas.

Although many first-round FIF projects, mostly large watershed studies, are in the planning and design phases and not yet turning dirt, approved FIF projects are underway in all parts of the state.

The FIF has already generated enormously positive impacts for communities statewide — not only those where residents are accustomed to the threat of severe flooding, but also in communities where the extent of flooding seldom meets FEMA benchmarks for disaster relief, but still has ruinous effects. In the latter case, the FIF has helped city and county officials pull down federal dollars to help pay the 25 percent match required for U.S. Army Corps of Engineers projects.

Of the $793 million allocated to the FIF, $770 million was set aside for FIF projects; $15 million was designated for the TWDB's administrative expenses in support of the program until 2025; and $7,013,767 was retained to provide local-match funding for projects in the federal Flood Mitigation Assistance Program, which is separate from FIF.

As of February 28, 2022, the TWDB has committed $396,578,209 to 123 projects, including 46 Category 1, 62 Category 2, six Category 3, and nine Category 4 projects. Of that amount, $288,379,393 has closed. Approximately $373,421,791 remains uncommitted.

It is important to understand the distinction between the terms "committed" and "closed." Committed funds have been approved by the Board for a specific project and use; however, the project has not yet closed — i.e., the funds have not been officially allocated — until the funds have been transferred to the applicant's escrow account.

Although many first-round FIF projects, mostly large watershed studies, are in the planning and design phases and not yet turning dirt, approved FIF projects are underway in all parts of the state. Here are just a few.

NORTH CENTRAL TEXAS

CITY OF EASTLAND — Leon River Watershed Study (Category 1)

The City of Eastland is located at the confluence of the North and South Forks of the Leon River in a predominantly rural area of North Texas. The North Fork flows through downtown Eastland, and the more dominant South Fork skirts the edge of the city. Due to its larger watershed, water flows from a South Fork storm event generally take longer to reach the confluence than flows from the North Fork. Further, when the South Fork is still flowing from a prolonged storm event, it can cause the North Fork to back up, causing flooding in Eastland. This occurred in 2015 and 2017.

A similar situation exists on Weaver Creek, a tributary to the North Fork, that leads to flooding of businesses and residential neighborhoods along Main Street. Another contributing factor is Ringling Lake Dam, an abandoned dam in north Eastland that discharges to the North Fork downstream of Lake Eastland before it flows through the city. The Texas Commission on Environmental Quality (TCEQ) considers Ringling a high-risk dam. Although the U.S. Army Corps of Engineers initially recommended breaching and removing the dam, it later recommended leaving it as-is due to wetland considerations. This makes additional evaluation necessary.

"This study will update the last hydrology study done in 1988 and help us understand post-rainfall water flows, so we can design improvements to move the water out of the city faster," said Eastland City Manager J. J. Oznick.

Oznick said funding from the Flood Infrastructure Fund is critical to small cities like Eastland that could never afford to do this type of study without grants and matching funds. "It will be an enormous help to us in the long term because it will guide our commercial and residential development."

Total Project Cost: $450,000
Grant Amount from FIF: 405,000
Local Cash Contribution: 45,000
Estimated Completion: March 31, 2023

SOUTHEAST TEXAS

CITY OF BAY CITY — Regional Drainage Study (Category 2)

Bay City is the county seat of Matagorda County, Texas. It is located at the junction of State Highways 35 and 60 in the north-central portion of the county, about 78 miles southwest of Houston. Bay City is home to 17,503 people and Matagorda County is home to 36,720.

Bay City and surrounding areas have seen multiple flooding events in recent years, including Memorial Day 2015, Hurricane Imelda, Hurricane Harvey, and June 19, 2019, rainfall events. Areas of the city often see flooding of structures even during heavy spring rain events.

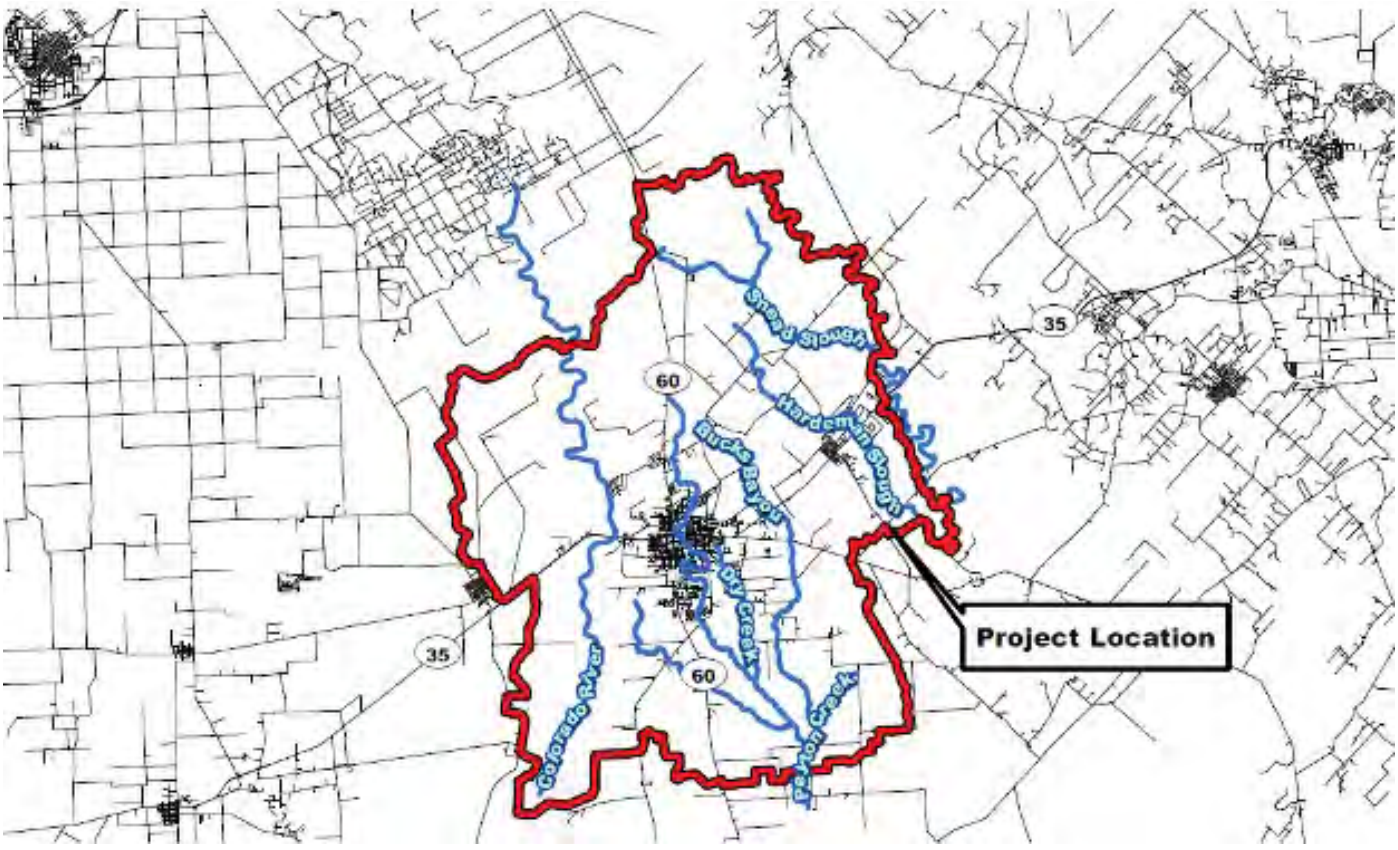
The City of Bay City sought planning funds from the FIF to develop a regional drainage study. The city partnered with the City of Bay City Community Development Corporation, Matagorda County Economic Development Corporation, Matagorda County Drainage District No. 1, Matagorda County Precinct No. 1, and Matagorda County Precinct No. 2 to fund the study. The purpose was to model different streams to identify and evaluate potential regional detention options and conveyance improvements necessary to reduce the impact of flooding, and to provide solutions allowing proposed developments to maximize property usage and support economic development.

The study included modeling four major streams in the vicinity — Bucks Bayou, Hardeman Slough, Cottonwood Creek, and the West Ditch (Colorado River Catchment). Additionally, it created new one-dimensional and two-dimensional models that will be used to determine the existing floodplain, based on Atlas 14 100-year rainfall estimates. These floodplain models, in turn, will be used to generate regional solutions for flood mitigation, as well as to prioritize projects and plans for funding, including evaluating future grant programs, collaborating watershed master plans, and implementing preferred alternatives.

Bay City qualified for an $88,740 grant under the FIF to pay for project management by an engineer, surveying, and other special services. The remaining project costs were covered by the city and partners.

"The study focuses on riverine models made for the streams throughout town, as well as regional detention," said Bay City Engineering Technician Alyssa Dibbern. "The Colorado River runs through Bay City, as do Cottonwood Creek, Bucks Bayou, and several other smaller creeks that drain the city and surrounding areas. Some of the smaller creeks and bayous on the east side had never been studied beyond the FEMA flood maps. Due to several changes we are experiencing, we knew we needed a plan to help us understand how the water runs through the area, check the accuracy of our local riverine study, and project the effects of local rainfall."

BELOW: *Matagorda County Regional Master Drainage Plan in City of Bay City, Matagorda County, Texas.*



The Bay City area is experiencing an increasing amount of development, including an anticipated new subdivision in the Bucks Bayou area. While levees surrounding local rice fields used to maintain the water at a consistent level, many of those fields have been converted to row crops, so the water runs off quickly. These changes altered the area's hydrology and created a need to know the effects of new development on flood risk.

Dibbern said it was a pleasure to work with the other stakeholders in preparing for the study. Each entity signed a memorandum of understanding (MOU) indicating they all supported the study; there was no hesitation or competition because flooding in the area affects them all.

Completed May 24, 2021, the study indicated flood planning should focus heavily on Bucks Bayou to the east of Bay City, where development is most heavily concentrated. It revealed the need for a regional detention pond there, a channel to divert floodwaters from downtown to the Colorado River, and a screen to prevent the channels from clogging with debris. Infrastructure planning for the Bucks Bayou subdivision is ongoing and should be finished by late 2022 or early 2023. Construction of the subdivision will start next year.

"The FIF has been invaluable in helping the city protect its citizens and better serve Bay City's drainage needs," said Dibbern. "Now that our local riverine models are completed, we can move forward with critical projects to address problem areas. The FIF is a tremendous program structured to help us work as a team to achieve sustainable flood-conscious development."

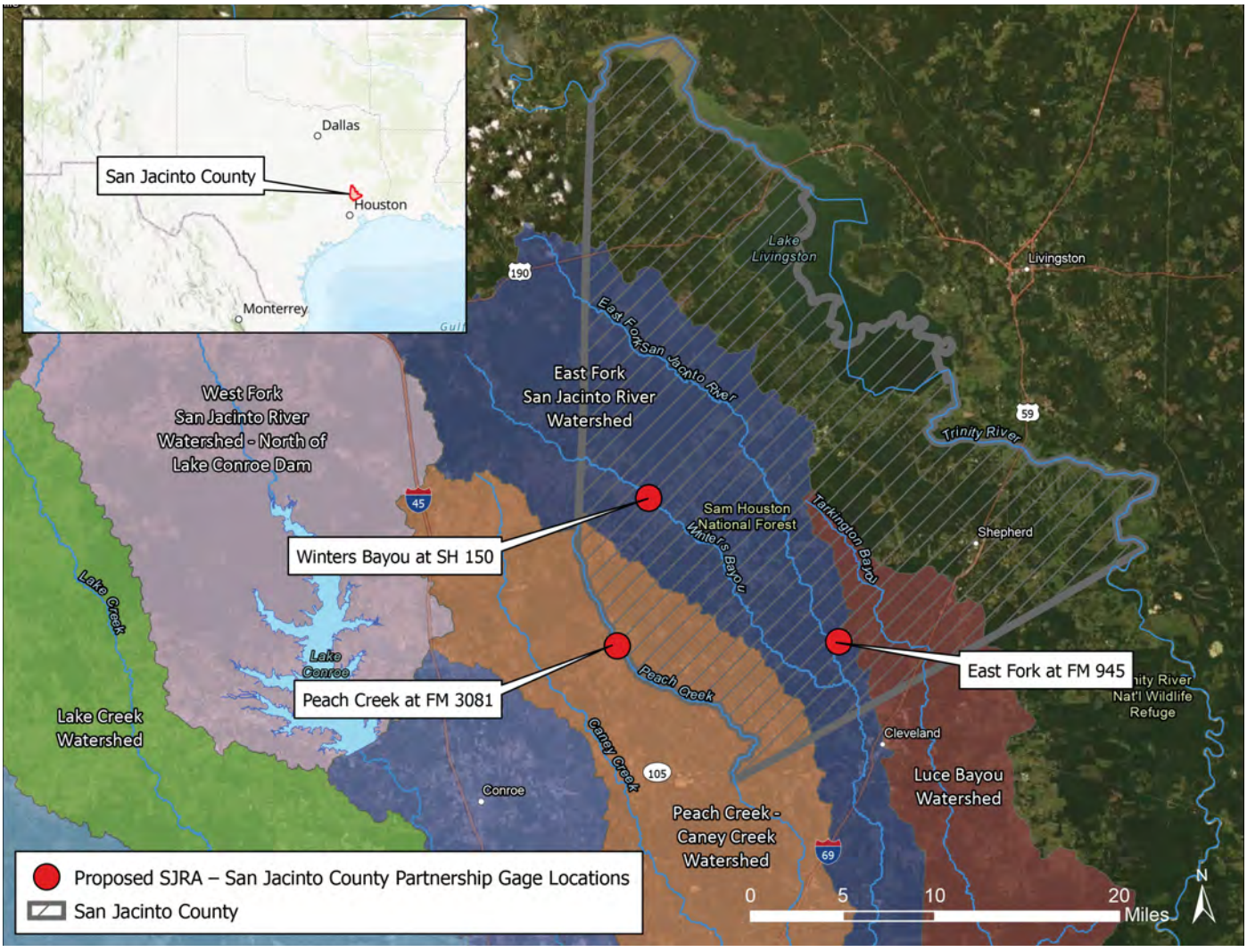
Total Project Cost: $306,000
Grant Amount from FIF: 88,740
Local Cash Contribution: 217,260
Project Status: COMPLETE

SOUTHEAST TEXAS

SAN JACINTO RIVER AUTHORITY – Flood Early Warning System for San Jacinto County (Category 4)

Residents and specific areas of the San Jacinto River Authority (SJRA) jurisdiction have been impacted by several severe storm events, including Hurricanes Harvey, Rita, and Ike, as well as torrential storms

BELOW: *Jacinto River Authority (SJRA) Flood Early Warning System map.*



in 1994, 1998, 2015, and 2016. These substantial flooding events resulted in multiple road closures and high-water rescues, prompting the SJRA to take proactive steps to decrease the dangers associated with such events and increase the readiness and responsiveness of citizens and emergency responders.

The TWDB approved 74 percent grant funding from the FIF for this project, enabling the SJRA to install three new rain and stream gages in San Jacinto County. By contributing $16,000 worth of in-kind funding in the form of staff services for purchasing, installing, calibrating, and testing the equipment, as well as project management, the SJRA was able to limit its local cash contribution to $900.

The project area is largely rural and impacts a population with low-to-moderate incomes, as compared with those in adjacent counties like Montgomery.

The SJRA staff plans to install varying types of rain and stream gages at three locations: (1) Winters Bayou at State Highway 150, (2) Peach Creek at FM 3081, and (3) the East Fork of the San Jacinto River at FM 945. The SJRA recently completed a path analysis to determine what types of gages are best suited for each location, and it revealed heavy vegetation and tree cover around the sites. For this reason, the SJRA hopes to install two types of gages at each locale — a radar sensor, which provides a more accurate reading than a traditional transducer, and a rain gage, which provides important rain and streamflow data.

"This project is really important to San Jacinto County because it will ease the burden on emergency services by allowing more time to close roadways and reducing the number of high-water rescues during flood events," said San Jacinto River Authority Project Manager Briana Gallagher. "Citizens will be able to easily recognize when the water is dangerously high and know they need to start packing."

The TWDB has approved three other SJRA projects for funding through the FIF:

The Spring Creek Watershed Flood Control Dam Engineering Feasibility Study is in progress, focusing on the feasibility of two dry-bottom detention areas along Birch Creek and Walnut Creek.

The Upper San Jacinto Regional Sedimentation Study, just kicking off, will identify heavy sedimentation areas in the basin — where it is coming from, where it is going, and how to reduce it.

The Lake Conroe-Lake Houston Joint Operations Study will look at ways to improve operations between the two lakes. A portion of it will look at potential reservoir prerelease.

"The SJRA has no source of revenue for flood management and no taxing authority, so any flood mitigation projects it undertakes must be funded by grants," Gallagher said. "Because of budget limitations, the SJRA staff works with surrounding counties and other entities to fund the local match. Funding through the FIF has been critical to us because it enables us to do flood mitigation projects we otherwise could not do — projects that save lives and property."

Total Project Cost: $65,000
Grant Amount from FIF: $48,100
Local Contribution: $900
Local In-Kind: $16,000
Estimated Completion: December 2022

BELOW: *City of Harlingen 9th and 13th Street Drainage Improvement Project.*

RIO GRANDE VALLEY

CITY OF HARLINGEN — 9th and 13th Street Drainage Improvements (Category 3)

The Texas Division of Emergency Management and the Federal Emergency Management Agency awarded the City of Harlingen a grant under the Hazard Mitigation Grant Program to address the effects of multiple severe storm events over a period of 28 months that were declared federal disasters. These storms impacted thousands of homes, disrupted transportation along arterial roadways, and caused millions of dollars in damages.

Harlingen's 9th and 13th Street Drainage Improvements project upgraded storm sewer systems, mitigating flood risks to 327 commercial and residential lots and streets within the city's main retail/commercial zones. The upgrades included removing the undersized drainage system and replacing it with 5,803 linear feet of reinforced concrete pipe, 27 junction boxes, and 46 inlets. In addition, the city is implementing Stormwater Pollution Prevention Plan measures for water quality control. Any needed utility adjustments and restoration of street pavement have been completed. The new storm sewer lines increase capacity of the upstream section of the existing drainage system, and the downstream system has enough capacity to handle that increase, thus reducing flooding.

The TWDB approved grant funding from the Flood Infrastructure

Fund for federal grant award matching funds to leverage the City of Harlingen's local match. The Board also approved grant funding through the FIF for a portion of the city's local match requirements for federal funds under the HMGP.

Construction of the project began in November 2020, and it is scheduled to be completed in September 2022. The area will likely see several heavy rains within the next six months that will test the new system's effectiveness.

"The 9tth and 13th Streets project involved repairing and replacing an antiquated drainage system in one of the older parts of Harlingen, near the city's center," said Harlingen Assistant City Manager-External Services Craig L. Cook, JD, PE, CFM. "This was a big project for a city of our size. It's unlikely we would have been able to undertake the improvements at all without financial help from the FIF and certainly not to the extent that funding allowed."

The City of Harlingen is now kicking off a second, larger project approved for FIF funding in December 2020 – a $6 million comprehensive basin study that will allow the city to update its most recent drainage study, which dates to 2008. The FIF will fund 90 percent of the study, and the remaining 10 percent of its cost will be borne by ten cities, three drainage districts, and one irrigation district in the region. The city recently awarded a contract for the study, which will encompass 295 square miles of terrain, 49 center-line miles of the Colorado River, more than 740 center-line miles of existing drainage channels and ditches. It will require two to three years to complete.

"Drainage is our number-one concern in Harlingen," Cook said. "A lot of development is occurring in the city and a lot more is planned, yet we are still forced to work with an old 2008 study that didn't anticipate all these subdivisions. We desperately need new, highly accurate data if we are to design and build these projects effectively. That's why the comprehensive basin study is so crucial."

Total Project Cost: $2,858,886
Harlingen Grant Amount from FIF: 1,349,394
Local Contribution: 337,348
Estimated Completion: September 2022

EAST TEXAS

CITY OF BRYAN — B-FEWS Scalable Flood Early Warning System (Category 4)

The City of Bryan lies in central Brazos County and is part of the Greater Bryan/College Station Metropolitan Statistical Area, accounting for more than 88 percent of the county's total population. Since 1950, Bryan's population has grown by 347.7 percent, or 2.4 percent annually. The city repeatedly experiences flooded roadways and delayed response times for closures during extreme events. To add to the problem, some older areas are seeing heavy development, which changes the way rainwater runs off and compounds existing drainage problems.

Current floodplain maps do not adequately reflect the region's inherent roadway flood hazards. There are 88 documented flood-prone roadways in the area, more than half of which are well away from defined streams, yet there are no sensors of any kind within the city's jurisdiction and very few in Brazos County. This can be largely attributed to how expensive it is to maintain and physically monitor traditional flood gage equipment and the labor required to put out barricades. The city's budget constraints, compounded by increasingly frequent 100-year rainfall events in the county, were overwhelming its ability to get ahead of the floodplain resiliency curve.

Bryan city officials knew they had to have a better solution for warning the public of impending danger. A growing city like Bryan sorely needed a modern, flexible flood early warning system comprised of networks of various types of flood sensors. With smart equipment delivering real-time data, water managers and first responders would know when to expect floods, approximate their severity, and accurately predict the course the waters were likely to take. That would enable faster, more efficient responses, empowering city officials to limit damage and save lives.

The City of Bryan's application for a flood early warning system was one of the first projects approved by the TWDB for FIF funding. The city engaged with a local team of scientists and engineers to implement a novel, scalable, flexible, and application-ready alternative to traditional gaging stations that leverages the latest advances in environmental monitoring, the Internet of Things (IoT), and cellular telemetry — all tailored to meet the city's unique current and long-term flood-monitoring needs.

The city's B-FEWS sensor calibration and gage station fabrications will employ a suite of sensors for flood-prone roadway locations in the city. The new equipment will alert emergency response crews and key personnel via text messaging and real-time online map updates for coordinating preemptive roadway closures. Drivers will be warned by "turn around, don't drown" via automated flasher beacons. Once the system has been sufficiently tested in real time, residents will be able to subscribe to receive texts/emails to ensure they are better informed at the neighborhood level.

"The City of Bryan has seven distinct drainage basins, and we chose sites within them based on historic flooding," said Bryan Assistant City Engineer Sam J. Vernon, PE, CFM. "We will install twenty gages in total, strategically spaced throughout the basins so we can collect rainfall data systematically. We expect to begin construction in early April."

The transducer in the gage will detect the height of the water in the stream and trigger flashers to instantly warn motorists

BELOW: *Bryan Assistant City Engineer Sam J. Vernon, PE, CFM*

when water starts flowing over the roadway. The gages will also collect rainfall data, allowing city engineers to create a hyetograph, which illustrates the distribution of rainfall and its intensity over time. Together, the transducer and the hyetograph will help them understand how a specific amount of rainfall in a certain area of a basin impacts the drainage system.

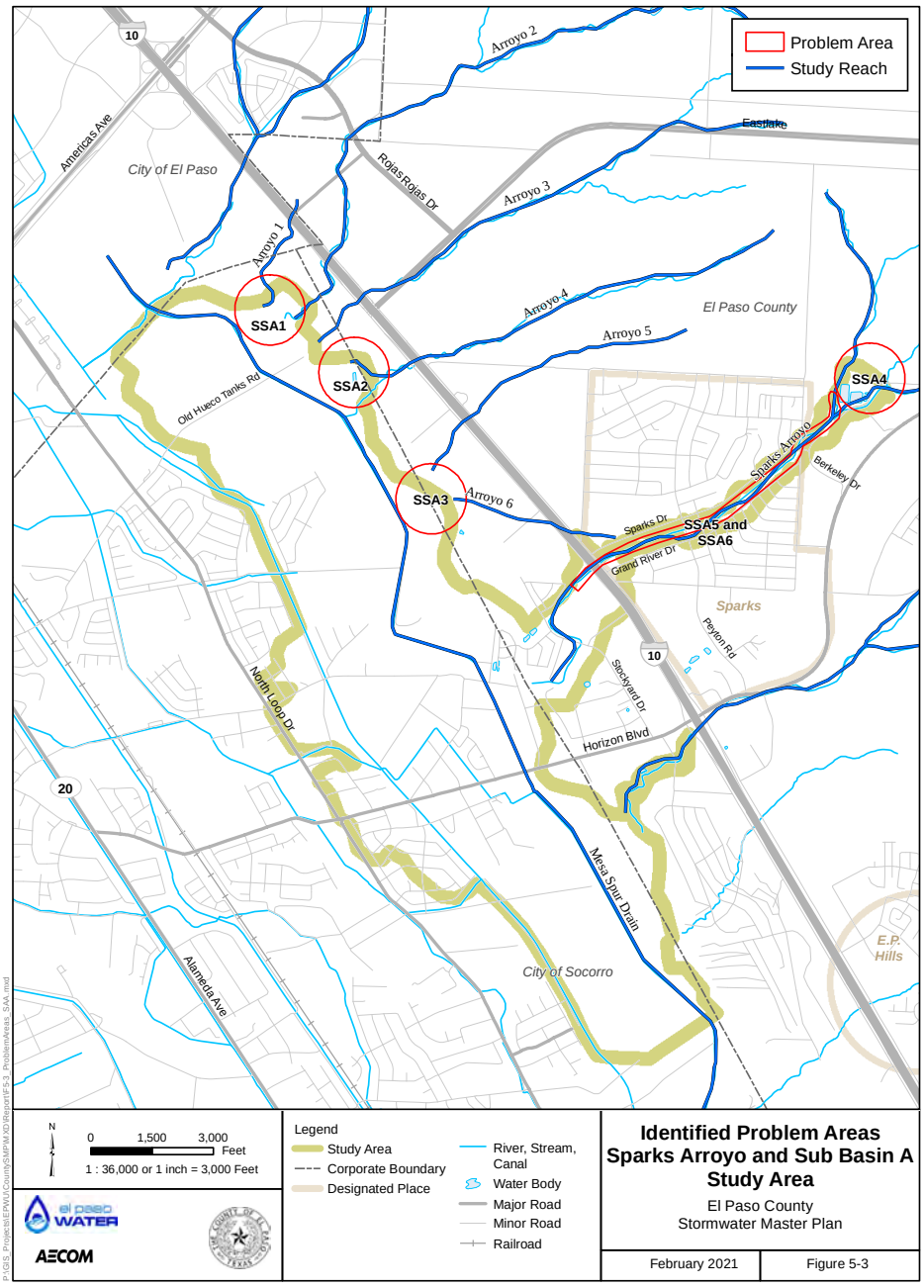
"The availability of funding through the Flood Infrastructure Fund enabled our local government to move ahead with this project when we would have had no way to pay for it otherwise," Vernon said. "I would love to see the legislature dedicate more funding to the FIF and make it a permanent resource. The need is great, and I know the City of Bryan and other small- to medium-sized cities would submit additional project requests."

Total Project Cost: $450,000
Grant Amount Requested from FIF: 180,000
Local Cash Contribution: 270,000
Estimated Completion: March 2023

WEST TEXAS

EL PASO COUNTY — Sparks Arroyo Detention Basin (Category 2)

This project will affect a watershed that lies within both the Greater El Paso and Socorro communities in El Paso County, impacting a population of 4,748 within the Special Flood Hazard Area (SFHA). The SFHA also encompasses 28 bridges and crossings, 578 residential structures, 52 commercial/industrial structures, and more than 800 acres of agricultural land.



Residences and properties in the Sparks Arroyo drainage area have flooded frequently. The area is about fifteen miles southeast of downtown El Paso and just northeast of the city of Socorro within the Interstate 10 (I-10) corridor. Homes located downstream and on the south side of I-10 are also at risk due to the uncontrolled volume of flow and increasingly heavy sediment deposits within the arroyo.

The problem is exacerbated by runoff from development north and west of the arroyo and I-10, which enters the upper tributaries of the watershed that converge to form the arroyo. Approximately 1,500 feet downstream, on the south side of I-10, the arroyo becomes undefined, with no clear outfall to the Mesa Spur Drain, which runs roughly parallel to I-10. The large volume of water flow and heavy sediment deposits create the potential to exceed the capacity of the Mesa Spur Drain and flood residences located south of the channel.

The county will construct a detention basin at the lower end of various arroyos on the south side of I-10 and northeast of the city of Socorro. The project's primary purposes are to (1) capture sediment transported down the arroyos and reduce deposits in downstream channels and floodplains; and (2) detain flood flows coming down the arroyos and release them from the detention basin at a slow enough rate to reduce flooding downstream.

The embankment for the detention basin is about 40 feet tall and will require some 300 acre-feet of excavation for flood and sediment pool storage. The outlet

structure for the basin will be a two-foot reinforced concrete pipe. This project will provide flooding benefits to areas served by the El Paso County Water Improvement District, as well as to parts of the city of Socorro.

"This area is mainly rural and has generally high poverty levels that lead to the population being disproportionately impacted by flooding events," said El Paso County Director of Strategic Development Jose M. Landeros. "Large parts of it are still agricultural, but the cotton and chili fields are gradually giving way to new development, and that's changing where the rainfall goes. Where historically, the open fields would allow water to sheet flow over 100 acres, that flow is now channeled into a storm sewer downstream. The amount of rainfall being channelized in larger, concentrated flows is a serious concern now and will only become a bigger issue with added development."

Heavy sedimentation in the arroyos is a particularly big problem because the area has a lot of loose soil that contributes to erosion. In 2016, seventeen homes were lost because they were completely covered in sand and debris. This unique geological condition must be heavily factored into all construction design.

The area's historic rainfall pattern has led local planners to expect a major storm event threatening life and property every four to five years. This has proven true going back to 2006, when the community experienced a 500-year rain event that caused countywide flooding. They are also seeing more smaller, localized events that either bring sediment from the desert onto the roadways, causing maintenance issues, or flood homes.

Landeros said the FIF financing methodology was innovative. Instead of requiring El Paso County to pay back the loan that constitutes its local contribution, the Board asked the county to issue the debt, and the TWDB will buy down the interest. Functionally, it is still a 0 percent loan, but it constitutes significant savings as opposed to the Board's loaning the money directly. In turn, that allows the FIF to help more people by funding more projects statewide.

The FIF has committed funds to El Paso County for its Sparks Arroyo Detention Basin project, but the funding has not yet closed. It is the second FIF-funded project commitment in the El Paso area. Last year, the Board approved a much smaller $3,210,000 funding request from El Paso County consisting of $1,605,000 in financing and $1,605,000 in grant monies from the Flood Infrastructure Fund for planning, acquisition, design, and construction of a detention pond and channel improvement project in the Hacienda Real area, located in the southeastern part of the county.

"I think continued funding of the Flood Infrastructure Fund by the Texas Legislature is critical," Landeros said. "Hearing what other stakeholders are planning, sharing ideas, and using regional data to make decisions about which projects will meet the needs of all our citizens has been transformational."

Total Project Cost: $34,530,000
Grant Amount from FIF: $13,812,000
FIF Loan: $ 20,718,000
Estimated Completion: December 12, 2024

TAKING THE FLOOD INFRASTRUCTURE FUND TO THE NEXT LEVEL

Less than two and a half years after 77.87 percent of voters approved its creation with an amendment to the Texas Constitution, the Flood Infrastructure Fund is already a success by any measure. It has been enthusiastically received by cities and counties; river authorities; water, irrigation, and drainage districts; electric and water utilities; agricultural interests; environmental groups; industries and businesses, large and small; and the voting public.

The Texas Water Development Board has done an outstanding job of getting the FIF up and running, despite the inherent sharp learning curve. The constitutional amendment creating the FIF passed November 5, 2019. By March 16, 2020, the TWDB was already accepting abridged applications for project funding. By September 17, the Board had developed and adopted the Flood Intended Use Plan and approved the prioritization list for the first round of preliminarily approved applicants. By September 18, letters inviting potential applicants to signal their intent to apply had been mailed, which also created a mechanism for compiling a

waiting list. Complete financial applications from the first round of invited applicants were received by October 19, 2020.

Between October 2020 and February 2022, project commitments and closings were ongoing. The fifth round of project applications is expected to go to the Board for consideration this spring, and the sixth round of applications was due on February 16. Currently, the TWDB is still in fiscal year 2021 of the FIF's Intended Use Plan, working down a list of abridged applications and inviting submission of new projects in cycles.

Countless lives will be saved and billions of dollars in property damage prevented by FIF-funded projects, and Texas taxpayers are getting as much as three dollars in benefit from every construction dollar spent.

The speed and efficiency with which the Texas Water Development Board has implemented the will of the legislature and the people is nothing short of incredible. It is a testament to the knowledge, resourcefulness, dedication, and professionalism of not only the Board, but every member of the TWDB staff.

Formulating rules and procedures for a $793 million program and getting that program off the ground was a mammoth task. True, the needle moved slowly at first, but the Board has done the hard work now. The program is operating smoothly. Projects are being analyzed quickly and expertly. Closings are occurring and dollars are going out the door faster. Countless lives will be saved and billions of dollars in property damage prevented by FIF-funded projects, and Texas taxpayers are getting as much as three dollars in benefit from every construction dollar spent.

During its first solicitation cycle, the TWDB received 285 applications from eligible political subdivisions across Texas for flood-control and flood-mitigation projects that qualified for FIF funding. Altogether, the funding requests totaled $2,390,567,776. That's $2.4 billion in qualifying needs, $1.65 billion of which cannot be satisfied given the FIF's current project funding level of $770 million, more than half of which has already been committed.

That's a lot of unmet need.

The State of Texas funds transportation infrastructure primarily through the Motor Vehicle Fuels Tax, vehicle registration fees, and other smaller taxes and permit fees. The Texas Water Development Board has a variety of programs that offer low-cost financing for major water and wastewater infrastructure, such as dams, pipelines, reservoirs, and desalination plants. Because water and wastewater utilities generate revenues, they can pay those loans back through fees included in customers' bills. Likewise for electricity and natural gas providers.

Flood infrastructure, on the other hand, has historically been an outlier. Until the creation of the FIF, Texas had no statewide funding mechanism for studying, designing, or constructing infrastructure to protect against the loss of life and property that comes with flooding.

The biggest problem with funding flood infrastructure is that it is risk-focused and does not produce revenue. For small communities, it is a lot like buying an insurance policy: they cannot justify spending money on preventing flooding that might never happen again when there are so many concrete demands on their budgets, such as police, fire, roads, and hospitals. The FIF allows locals to move ahead with their projects by replacing uncertainty with confidence.

Traditionally, flood infrastructure has been funded in response to disasters. That is not a good methodology. We don't wait for a major vehicle crash to fund highway infrastructure; we shouldn't wait for a destructive rain or storm event to fund flood infrastructure.

With the Flood Infrastructure Fund, we now have the architecture in place for approaching Texas' flooding challenges regionally, cooperatively, pragmatically, and effectively. The FIF can be the beginning of a permanent, reliable fund for flood-control infrastructure. But we need to make it sustainable.

It may seem premature to think in terms of additional FIF funding when not all its existing legislative appropriation has been spent, but that would be shortsighted. The $2.4 billion need is there, in black and white — documented, preliminarily vetted, and undeniable. The $793 million committed to the FIF in 2019 has been spent, if only on paper.

In its report to the 86th Texas Legislature, "State Flood Assessment," the TWDB estimated $31.5-$36 billion in flood mitigation needs statewide. The $2.4 billion figure represents only the tip of the iceberg — projects for which communities were able to develop estimates in time to submit them during the first call for FIF applications.

The real key to the Flood Infrastructure Fund's ultimate success is this: *What will FIF 2.0 look like?*

How big does the next legislative appropriation to the FIF need to be? Nearly half the first round of projects funded were large watershed studies. The data mined through completed studies will be incorporated into the State Flood Plan, which will identify permittable, constructible, and implementable projects to reduce flood risks. The regional plans submitted to the TWDB in January 2023 will provide critical information to help determine that number.

"There are a lot of reasons we need to make this fund sustainable," said TWDB Executive Administrator Walker. "Preventing loss of life and property damage are absolutely primary, but there are other factors at play. Flooding is morale-destroying. I personally have not seen that happen, but my father did, and he told me, 'A flood comes up and you can't stop it. Some folks watch their lives wash away. Whole communities disappear.' And even if you have insurance, it doesn't always pay enough to build back. If we can keep that from happening to folks with a little money and a little planning, it's something we ought to do."

Sondra Williamson is a freelance writer and researcher and owner of Paradigm Shift in the Austin, Texas area.

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TEXAS

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