



INFRASTRUCTURE
TEXAS
REPORT CARD

2021

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Texas Section of the American Society of Civil Engineers

2021 Texas Infrastructure Report Card

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INFRASTRUCTURE ROADS HIGHWAYS BRIDGES AVIATION
WATER WASTEWATER TRANSIT RAIL MITIGATION STREETS
ENERGY SUSTAINABILITY RESILIENT INFRASTRUCTURE
BRIDGES AVIATION DAMS DRINKING WATER WASTEWATER
MITIGATION STREETS AQUADUCTS AIR ENERGY SUSTAIN
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DEDICATION

In Memory of Russell ‘Rusty’ Gibson

1974-2020

Russell “Rusty” Gibson PE passed away November 24, 2020 in Tyler. He was born March 26, 1974, in Greenville, Texas. Rusty was a member of both the ASCE Texas Section Board of Direction and ASCE Texas Section Infrastructure Report Card Committee at the time of his passing. He was a dedicated engineer and tireless contributor to ASCE, as well as the Texas Council of Engineering Laboratories (TCEL) and Texas Geoprofessionals.



Rusty served as the 2020-2021 ASCE Texas Section Vice President Elect for Educational Affairs and was the Dams Subcommittee Chair and a Levees Subcommittee member for the *2021 Texas Infrastructure Report Card*. He previously served as ASCE Texas Section Director for the ASCE Northeast Texas Branch from 2014 to 2020. In addition, he was the 2020 Past President of TCEL and continuously active in the ASCE Northeast Texas Branch, serving in multiple officer roles over the past decade.

Rusty received his Bachelor of Science in Civil Engineering from Texas A&M University in 1997. He had been with E TTL Engineers & Consultants, Inc. since 2009 and maintained his Professional Engineer (PE) license in the states of Texas, Arkansas, Oklahoma, and Louisiana.

The ASCE Texas Section family and civil engineering community will forever feel this loss, as his family remain in our thoughts.

PREAMBLE

A few years ago, I attended the American Society of Civil Engineers (ASCE) Legislative Fly-In, in Washington D.C. I have one distinct memory of a conversation with a junior congressional staffer. I used the phrase “infrastructure investment.” He scolded me, advising I avoid using the word investment entirely, explaining that Congress members did not consider infrastructure spending to be an “investment.” He went on to say infrastructure spending was a politically explosive, high impact budget expenditure leading to increased deficit spending. He implied benefits could not be reasonably presented in terms of return on investment or ROI. I did not challenge him; I wish I had, because an ROI for the greater good is easy to define. The savings in maintenance of deteriorating, outdated infrastructure is a significant part of the equation. Higher infrastructure investment modernizes critical systems and lowers long-term operations and maintenance expenses.

Investing in infrastructure pays for itself several times over.

- “Reliable, modern infrastructure is the underpinning of economic growth across communities.”
– ASCE’s *2021 Failure to Act Report*
- “Infrastructure is the backbone of the U.S. economy and a necessary input to every economic output.”
– ASCE’s *2016 Failure to Act Report*

Years later, my Infrastructure Report Card (IRC) journey began as a member of the Texas 2017 IRC Water Subcommittee. Then, in 2019, I jumped at the opportunity to be the Chair of the 2021 Texas IRC Committee, **eager to become part of the solution.** I believe ASCE’s *Failure to Act Report* positions are well stated. Infrastructure is the backbone of a successful economy and will afford our communities a 21st Century way of life. Neglecting infrastructure will leave us mired in static 20th Century *status quo*, or worse. Investment in Texas infrastructure now will result in substantial quality of life improvement with environmental benefits, and an economy that will continue the economic prosperity Texas has enjoyed in recent years.

- According to national business leaders of the Business Roundtable, infrastructure investment pays for itself several times over. Every additional dollar invested in infrastructure delivers a return of roughly \$3.70 in additional economic growth over 20 years.¹
- The Interindustry Forecasting Project at the University of Maryland reported, “Reinvesting in U.S. infrastructure would raise average household disposable income by \$1,400 per year.”²
- The U.S. World Economic Forum estimates that every dollar spent on infrastructure can generate up to 25% in economic returns.³
- Council of Economic Advisers (CEA), within the Executive Office of the President, estimated that every \$1 billion in Federal highway and transit investment funded by the *American Jobs Act* would support 13,000 jobs for one year.⁴

‘Past performance is no guarantee of future results’ is a common caveat by brokers promoting investment opportunities. The opposite is true for infrastructure investment. Past performance by smart infrastructure investment is a **robust guarantee of future results.** Where would our economy and quality life be without our 20th century investments in the interstate highway system, water works, and other elements of critical infrastructure? Infrastructure spending is firmly tied to improvements in quality of life, environmental resilience, and economic prosperity.

Continued on page 6.

Continued from page 5.

Over countless months, through quarantined virtual meetings and attention to our regular jobs, the 2021 Texas IRC Committee found a way to deftly uphold their duties, meet draft deadlines, and religiously attend committee meetings. And with the advent of global pandemic, *we heard and saw it all through our virtual, audio-visual kaleidoscope and cacophony of malfunctioning video images, headsets, and microphones.* They all faced their own personal pandemic challenges but still made sure to uphold other personal and professional responsibilities along the way. They have described the current condition of our infrastructure, predicted funding needs, identified our state of preparedness and resilience, and attempted to anticipate how the current extraordinary global setting affected their analysis and predictions. These fine committee members are strong leaders in their communities, building a better quality of life across the street and around the world—leveraging smart infrastructure maintenance and design to do so.



This Report Card is dedicated to Dams Subcommittee Chair Russel “Rusty” Gibson PE who passed away suddenly just before the Thanksgiving Holiday 2020. Like a few others, Rusty pulled double duty as a member of the Levees Subcommittee. A perennial ASCE leader, you may read more about Rusty and his service to ASCE on page 4 of this Report Card. I enjoyed and admired Rusty’s approach during our many collaborative subcommittee calls. He was a respectful, kind, experienced, knowledgeable, down-to-earth, and thoughtful force driving all of us. Long before his passing, as I prepared the early draft version of this preamble, I was already considering Rusty amongst a handful of impactful leaders to mention here. I’ll let Rusty exemplify the entire committee. As a person and volunteer leader, Rusty reflected the mix of work ethic, human, and professional qualities of this committee and so many ASCE members I have known over the years. We were all deeply saddened by his untimely passing. I am grateful to newly elected ASCE Texas Section President Sean Merrell for representing all of us by personally attending and paying our collective respects at Rusty’s memorial service. We were all inspired to refocus with strengthened resolve to prepare the best possible final product as a fitting memorial to Rusty and his good work in support of ASCE and the communities we serve.

It has been one of my greatest professional privileges to work with this committee, a true high-performing team delivering a valuable service to the State of Texas with elevated hopes to inform sound and thoughtful infrastructure funding, planning and development. Through it all, the committee pivoted and adapted, immersed in the times and events that affected everything and everyone. They demonstrated the flexibility of thought and action that we’d all like to expect from engineers, scientists, and government leaders. They showed no fear, producing their analysis even while facing obvious substantial uncertainty. They walked the walk.

My sincere thanks go out to every contributor for their hard work and perseverance, which ultimately made this year’s Texas IRC the best ever! This version will forever be special because of the shared challenges we faced together during 2020.

We should follow their thoughtful lead to adapt our policies, plans, and funding to support meaningful progress toward an ever improving 21st Century infrastructure, quality of life, and environmental sustainability for all.

Mark K. Boyd PhD, PE, CAPM, D.WRE
Chair, 2021 Texas Infrastructure Report Card Committee

1. Business Roundtable; 2019; *Delivering for America*; <https://s3.amazonaws.com/brt.org/BRT-InfrastructureReport12052018.pdf>.

2. Business Roundtable; 1 February 2019; *New Study: Reinvesting in U.S. Infrastructure Would Raise Average Household Disposable Income by \$1,400 Per Year*; <https://www.businessroundtable.org/new-study-reinvesting-in-us-infrastructure-would-raise-average-household-disposable-income-by-1400-per-year>.

3. The One Brief; *Life in the Fast Lane: Infrastructure Investment’s Opportunities and Challenges*; Capital & Economics; <https://theonebrief.com/life-fast-lane-infrastructure-investments-opportunities-challenges/>.

4. US DOT, Federal Highway Administration; *Employment Impacts of Highway Infrastructure Investment*; <https://www.fhwa.dot.gov/policy/otps/pubs/impacts/>; accessed 11 February 2021.

A MESSAGE FROM ASCE TEXAS SECTION PRESIDENTS

ASCE Texas Section is pleased to present the results of our *2021 Texas Infrastructure Report Card*, a monumental effort that spanned over two Texas Section Presidential terms and involved an unprecedented number of 55 participating committee members. This group of hard-working, dedicated volunteers developed detailed report chapters in accordance with the new ASCE format for primary infrastructure categories in Texas. We appreciate the time contributed by our committee members, as well as the stakeholder review effort provided by key government agencies.

ASCE Texas Section represents more than 10,000 civil engineers statewide. As stewards of our infrastructure, we have an obligation to inform the public and policy makers about its condition and how best to make improvements. Infrastructure is a critical issue impacting the economy, society, security, and sustainable future of our great state.



The report card is an important tool used by the ASCE Texas Section membership to advocate for infrastructure funding. The *2021 Texas Infrastructure Report Card* is not intended to be a commentary on, nor an evaluation of, the performance of any government department, agency, or individuals of these groups. We commend these governmental agencies for their hard work and dedication to serving the citizens of Texas. It is through the hard work of the report card committee and the agencies that oversee the

respective infrastructure categories that the citizens of Texas and legislators may understand the state of our infrastructure.

The use of the *ASCE Infrastructure Report Card* in the popular television series, 'Designated Survivor,' is a clear indication that ASCE is making headway toward bringing the concept to a broader societal consciousness. We need to continue educating the public on the importance of infrastructure maintenance, while actively communicating to our elected officials that funding limitations continue to severely restrict the necessary investments needed to improve our infrastructure. Please join ASCE Texas Section in advocating for infrastructure funding. **Now is the time to grow, not cut, spending on our infrastructure to continue the state's economic prosperity, increase public safety, improve environmental stewardship, and build resilience.**



Sean P. Merrell PE, PTOE, RAS, F.ASCE
ASCE Texas Section 2021 President

Susan K. Roth PE, PMP
ASCE Texas Section 2020 President

EXECUTIVE SUMMARY

Texas. The geographically largest continental state, an economic powerhouse for the United States, leading the way in wind power energy production and some of the largest infrastructure with population growth pushing an ever-increasing need for improvement. This is the main theme of the *2021 Texas Infrastructure Report Card*, developed by the Texas Section of the American Society of Civil Engineers (ASCE Texas Section). Though several of the infrastructure categories reviewed show areas of adequate performance, the clear majority indicate that Texas' infrastructure lacks funding, proper maintenance, and is poorly equipped to deal with environmental change as Texas continues to grow.

Texas is the second most populous state in the Nation, behind California. With its population approaching 29 million people, the need for reliable and resilient infrastructure has become paramount. Texas civil engineers are in the best position to provide fellow citizens with reliable and resilient infrastructure for their daily lives. Too often, we take for granted the impact that each of these 12 infrastructure categories has on our day to day lives. Most people only think about infrastructure when it is broken. Consider the following:

- You only notice water infrastructure if your shower routine is interrupted by a funny smell coming from the pipes, or if the water does not come on at all.
- The bread you buy at the grocery store, which has its wheat grown and irrigated with the help of dams, has gone bad. The carton of eggs you purchase, transported on roads and across bridges, are cracked.
- Perhaps you are rushing to make a flight, only to find out it has been delayed due to too few terminal gates to absorb the influx of flights.
- You may take the garbage to the curb where it is collected with the help of roadway infrastructure; but what if it was never removed, or you had to haul it yourself in the back of the minivan?
- When you flush the toilet, freshwater rushes in to whisk your waste away, never to be worried about again. Have you ever wondered where it goes?
- During work, it starts to rain and your weather app SHOUTS that it is the biggest storm in over 100 years. Do you feel safe with the flood reduction measures in place protecting the community, or are you worried you cannot make it home?
- Texas, along with most of the entire country, has the safest and most reliable drinking water supply system in the world. Do you want it to stay that way?
- Do each of the newcomers to Texas bring their own water supply? Do they build their own roads? Do they bring their own wastewater treatment systems?

We expect infrastructure to work effectively but when it does not, we cannot afford to take it for granted. ASCE’s mission is to provide essential value to its members and partners, advance civil engineering, and serve the public good. In carrying out that mission, ASCE has advocated infrastructure and environmental stewardship through its *Infrastructure Report Card* since 1998. **ASCE Texas Section grades our state’s infrastructure an overall grade (GPA) of “C”.**

As civil engineers in the state of Texas, we have a responsibility to safeguard the health, safety, and welfare of the public. We believe part of this responsibility includes providing the public and our elected leaders with critical information about the current state of our infrastructure, which is the main goal of this Report Card. With this knowledge, the public will increase support for infrastructure improvement and maintenance.

They will subsequently urge elected leaders to prioritize funding so that our vital infrastructure meets the needs of current and future Texas citizens. Additionally, we as civil engineers need to utilize best practices and design techniques to ensure the State’s investment is wisely used.

OVERALL GPA AND GRADES BY INFRASTRUCTURE CATEGORY

With this most recent infrastructure snapshot, Texas receives a “C”, a slightly higher cumulative grade than the “C-“ GPA of 2017. Although several infrastructure categories are in good to fair condition, this grade indicates a below average condition in many infrastructure categories, including dams, levees, flood control, highways and roads, and wastewater in Texas, which all received a poor “D+ or below” grade. While the overall grade of Texas infrastructure has not changed significantly since the previous Report Card, a third of the categories received unsatisfactory grades. These categories, if left unchanged, will hinder the growth and competitiveness of the Texas economy, currently the largest and fastest growing in the nation, and the **9th largest in the world.**



METHODOLOGY

INFRASTRUCTURE CATEGORY SELECTION

Periodically, Texas civil engineers provide a comprehensive assessment of the state's various infrastructure categories in the *Texas Infrastructure Report Card*. In doing so, ASCE Texas Section follows in the footsteps of our parent organization, ASCE, which publishes an *Infrastructure Report Card* evaluating the nation's infrastructure.

ASCE recognizes 17 major infrastructure categories for consideration in preparing infrastructure Report Cards. ASCE Texas Section's Infrastructure Report Card Committee carefully considered each of these 17 major infrastructure categories within our state and determined which specific categories required immediate attention. The results reached by this infrastructure evaluation positively impact the public and enable elected leaders to make well-informed decisions with respect to infrastructure performance and funding.

ASCE Texas Section's Infrastructure Report Card Committee is made up of dedicated civil engineers from across the state, with decades of expertise across all categories, who volunteered their time to work with ASCE and ASCE Texas Section staff to prepare the Report Card. Infrastructure Report Card Committee members include civil engineers employed by public agencies, local government, private firms, and universities.

For the *2021 Texas Infrastructure Report Card*, the Infrastructure Report Card Committee identified a need to report on 12 infrastructure categories. This Report Card includes the following infrastructure categories: *Aviation, Bridges, Dams, Drinking Water, Energy, Flood Risk Mitigation, Highways and Roads, Levees, Public Parks and Recreation, Solid Waste, Transit, and Wastewater.*

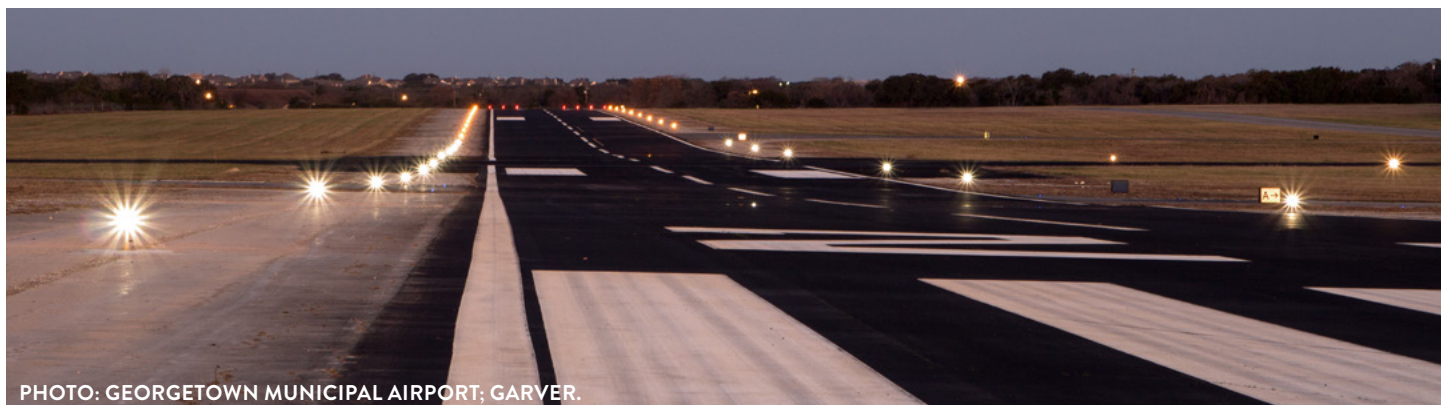
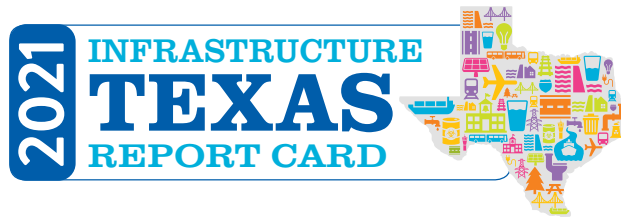


PHOTO: GEORGETOWN MUNICIPAL AIRPORT; GARVER.



GRADING METHODOLOGY

Using a simple A to F school report card format, the Report Card examines current infrastructure conditions and needs, assigning grades, and making recommendations to raise them.

The 55-member Infrastructure Report Card Committee comprised of subject matter experts, gathered data, and prepare detailed summaries for each infrastructure category. The committee coordinated with public agencies, private firms, and non-profit groups to gather the data and references presented herein. Summaries provided for each infrastructure category were peer-reviewed by members of ASCE's Committee on America's Infrastructure.

In addition, the summaries provided for each infrastructure category were reviewed by numerous stakeholders. ASCE Texas Section consulted with Travis N. Attanasio PE, past Infrastructure Report Card Committee Chair, to liaise with stakeholders across the state—including public agencies—to confirm the most recently available data was considered for the Report Card.

The collaboration of public, private, and university volunteers, along with the peer and stakeholder review process, resulted in this comprehensive assessment of Texas infrastructure.

The Infrastructure Report Card Committee assessed the best available data and references, consulted with other technical and industry experts, and assigned grades for each infrastructure category using the following criteria:

- **CAPACITY:** Does the infrastructure's capacity meet current and future demands?
- **CONDITION:** What is the infrastructure's existing and near-future physical condition?
- **FUNDING:** What is the current level of funding from all levels of government for the infrastructure category as compared to the estimated funding need?
- **FUTURE NEED:** What is the cost to improve the infrastructure? Will future funding prospects address the need?
- **OPERATION AND MAINTENANCE:** What is the owners' ability to operate and maintain the infrastructure properly? Is the infrastructure in compliance with government regulations?
- **PUBLIC SAFETY:** To what extent is the public's safety jeopardized by the condition of the infrastructure and what could be the consequences of failure?
- **RESILIENCE:** What is the infrastructure system's capability to prevent or protect against significant multi-hazard threats and incidents? How able is it to quickly recover and reconstitute critical services with minimum consequences for public safety and health, the economy, and national security?
- **INNOVATION:** How does future technology integrate with today's infrastructure?

GRADING SCALE



EXCEPTIONAL, FIT FOR THE FUTURE

The infrastructure in the system or network is generally in excellent condition, typically new or recently rehabilitated, and meets capacity needs for the future. A few elements show signs of general deterioration that require attention. Facilities meet modern standards for functionality and are resilient to withstand most disasters and severe weather events.



GOOD, ADEQUATE FOR NOW

The infrastructure in the system or network is in good to excellent condition; some elements show signs of general deterioration that require attention. A few elements exhibit significant deficiencies. Safe and reliable, with minimal capacity issues and minimal risk.



MEDIOCRE, REQUIRES ATTENTION

The infrastructure in the system or network is in fair to good condition; it shows general signs of deterioration and requires attention. Some elements exhibit significant deficiencies in conditions and functionality, with increasing vulnerability to risk.



POOR, AT RISK

The infrastructure is in poor to fair condition and mostly below standard, with many elements approaching the end of their service life. A large portion of the system exhibits significant deterioration. Condition and capacity are of serious concern with strong risk of failure.



FAILING/CRITICAL, UNFIT FOR PURPOSE

The infrastructure in the system is in unacceptable condition with widespread advanced signs of deterioration. Many of the components of the system exhibit signs of imminent failure.



INFRASTRUCTURE TEXAS REPORT CARD

2021



Aviation



B-

Bridges



B-

Dams



D+

Drinking Water



C-

Energy



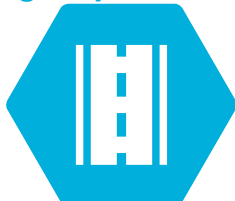
B+

Flood Risk Mitigation



C-

Highways & Roads



D+

Levees



D

Parks & Recreation



C-

Solid Waste



B

Transit



B-

Wastewater



D



AVIATION



PHOTO: DALLAS LOVE FIELD, CITY OF DALLAS



AVIATION

EXECUTIVE SUMMARY

Texas continues to be a geographically critical hub to the nation's domestic and international passenger travel and air freight, boarding 90 million passengers and moving 5.8 million tons of cargo in 2019. Though the physical condition of the state's airfield infrastructure is good overall, the increase in traffic from previous years puts strain on the aging system. Timely airfield pavement rehabilitation has occurred at airports through continued investments from the Federal Aviation Administration (FAA), the Texas Department of Transportation (TxDOT), and local municipalities. While airfield infrastructure is in good condition, too many airports around the state are overcrowded, cramped, and operate inefficiently at peak travel times due to outdated terminals and support facilities, including baggage and package handling systems.

Six of Texas' commercial airports rank in the top 50 nationwide for annual passenger enplanements with Dallas Fort Worth (DFW) International Airport as the 4th busiest and George Bush Intercontinental Airport as the 14th busiest. The aviation industry is changing in a variety of ways, driven largely by fluctuations in consumer behavior, expectations, and rapid shifts in the characteristics and structure of logistic supply chains. Texas' general aviation airports serving private and small aircraft charter operations are a significant component of aviation infrastructure, conducting 5.7 million operations annually that generate \$9.3 billion in economic impact. Texas' inevitable aviation change will need to be met with increased economic investments, ongoing airport redesign, capacity expansion, and service improvement projects throughout the state—leading to an estimated \$11.2 billion in airport infrastructure demands over the next 5 years.

CONDITION

The current state of Texas’ airfield infrastructure is good. Timely upkeep and airfield pavement rehabilitation has occurred at commercial services and general aviation airports through continued investments from the FAA’s Airport Improvement Program (AIP); airport sponsors such as city, county, or airport boards, and TxDOT’s Aviation Block Grant. As of 2020, the National Plan of Integrated Airport Systems’ (NPIAS) report shows 98% of commercial airports have airfield pavement in fair condition or better. General aviation airports are reporting runways in satisfactory condition with a pavement condition index (PCI) rating of 75 (out of 100) while the taxiways have a PCI rating of 76. Although runways and taxiway condition can be an easy and convenient representation of infrastructure condition, pavement is only one of many components.

While passenger and cargo traffic through commercial airport facilities continues to grow at a moderate rate, Texas’ outdated aviation infrastructure in terminals, support facilities, baggage handling, package handling, and other areas are not keeping up with the changing logistical passenger, freight delivery and business demands. As a result, too many airports around the state are overcrowded, cramped, and operate inefficiently at peak demand times. Parking and ground transportation structures, and the systems surrounding them linking other components are also in need of rehabilitation. This can be seen by the recent uptick in terminal projects at various airports around the state.

Texas has a total of 264 general aviation (GA) airports of which 186, including 2 heliports, are included in the current NPIAS report. An additional 78 other airports are deemed necessary for the system. Texas GA airports are home to over 25,000 registered aircraft. GA airports have 9,100 based aircraft reported with 5.7 million operations. General aviation as an industry has an annual impact that exceeds \$9.3 billion in Texas, and in 2018, was responsible for generating 50,000 jobs.

CAPACITY AND INNOVATION

Commercial service airports are public facilities with scheduled passenger service and 2,500 or more enplaned passengers boarding per year. Texas has 24 commercial service airports, which together received 80 million enplanements in 2019. Currently, 1.1 million jobs are created and sustained by commercial service airports contributing \$41.8 billion to local payrolls while providing an overall economic impact of \$130 billion to the Texas economy.

The FAA’s NPIAS forecasts modest 1.5% long term commercial passenger demand growth. To minimize financial losses, air carriers will continue to fine-tune their business models by lowering operating costs, cutting unprofitable routes, and grounding older, less fuel-efficient aircraft.

The state’s airport airfield capacity is largely sufficient because runways and taxiways can accommodate most air traffic demand. Some needed capacity improvements include runway extensions to accommodate larger aircraft and longer routes. Capacity constraints are related to cargo sorting facilities, terminal gates, Federal Inspection Facilities (FIS), aircraft parking aprons for Remain Over Nights (RONs) and Ground Support Equipment (GSE) areas, as well as terminal garage parking.

Texas aviation activity continued to grow at a slightly higher rate than the U.S. average. Currently, Texas GA airports handle approximately 5.7 million operations annually. Currently, Texas has over 25,000 registered aircraft making up 9% of the total U.S. registered aircraft fleet. Most Texas GA airports continue to have enough capacity for the near term. The larger GA airports designated as relievers continue to program projects to increase capacity and safety, enhance service at major commercial service airports and meet the recent changes to the FAA Airport Design Advisory Circular 150/5300-13 (latest edition).

Federal	Block Grant & Discretionary to TxDOT	AIP for Commercial Service & Discretionary	Total
2019	\$53,813,735	\$265,718,534	\$319,532,269
2018	\$60,710,492	\$177,485,558	\$238,196,050
2017	\$55,010,157	\$200,064,262	\$255,074,419
2016	\$67,183,650	\$176,591,979	\$243,775,629
2015	\$75,968,186	\$198,832,936	\$274,801,122
2014	\$56,514,593	\$195,200,377	\$251,714,970
Total	\$369,200,813	\$1,213,893,646	\$1,583,094,459

TABLE 1. Summary of Federal Funding. This table illustrates state apportionment and discretionary granted funding through the State Block Grant Program (SBGP) and Airport Improvement Program (AIP).

GA traffic for Texas should eventually return to a growth rate of 3% over the next 5 years. Changes to commercial air travel due to COVID-19 may impact this growth rate as it is possible that travel by private aircraft may be preferred over commercial travel in the near term.

NextGen flight procedures are an innovation that continues to be implemented at many commercial service airports around the country. Improved data communications between pilots and air traffic controllers helps to communicate more quickly and more easily with less risk of miscommunication than radio communications. The switch to a primarily satellite-enabled navigation system that is more precise than traditional ground-based navigation. Satellites enable the FAA to create optimal flight paths in the national air space from departure to cruising altitude to landing. These procedures have increased the flight safety, efficiency and helped to improve the environmental performance of aircraft. As NextGen continues to be implemented over the next decade, it will allow for more exact location of aircraft as well as clearer vision of the surrounding conditions for that aircraft, including weather patterns and other aircraft.

Other areas of airport innovation include use of autonomous shuttles and clean energy vehicles for environmental improvements, use of touchless technology is also increasing to improve the customer service experience.

FUNDING AND FUTURE NEEDS

Commercial service airports in Texas utilize FAA AIP entitlement, discretionary and passenger facility charge (PFC) for funding for airfield infrastructure improvements. Commercial service entitlement and discretionary grant funding over the last five years was \$1.2 billion. FAA AIP grant funding is expected to continue at an average of \$220 million annually. PFCs vary by the number of enplaned passengers that fly from the airport. This fee has been capped at \$4.50/passenger for over two decades now and needs to be increased to help meet demand. Depending on the airport, economy, and other outside factors the amount a commercial service airport receives can vary greatly from year to year. Estimates of PFCs for Texas airports can be found here: https://www.faa.gov/airports/pfc/monthly_reports/.

According to the Airports Council International (ACI), Texas airport infrastructure needs \$11.2 billion over the next five years. Additional investments and funding sources are needed to accommodate airfield configuration updates to meet new, more stringent standards.

At nearly 56%, terminal projects account for the largest share of airport infrastructure needs. Such projects are needed to accommodate more passengers and larger aircraft, implement new security requirements, facilitate increased competition among airlines, and enhance the passenger experience. Legacy carriers are shifting larger aircraft to international services, and 70 to 90-seat regional jets are replacing 50-seat regional jets. Low-cost carriers have been initiating service at major airports, creating a demand for additional gates. Anticipated requirement changes are needed to respond to the evolving aviation market.

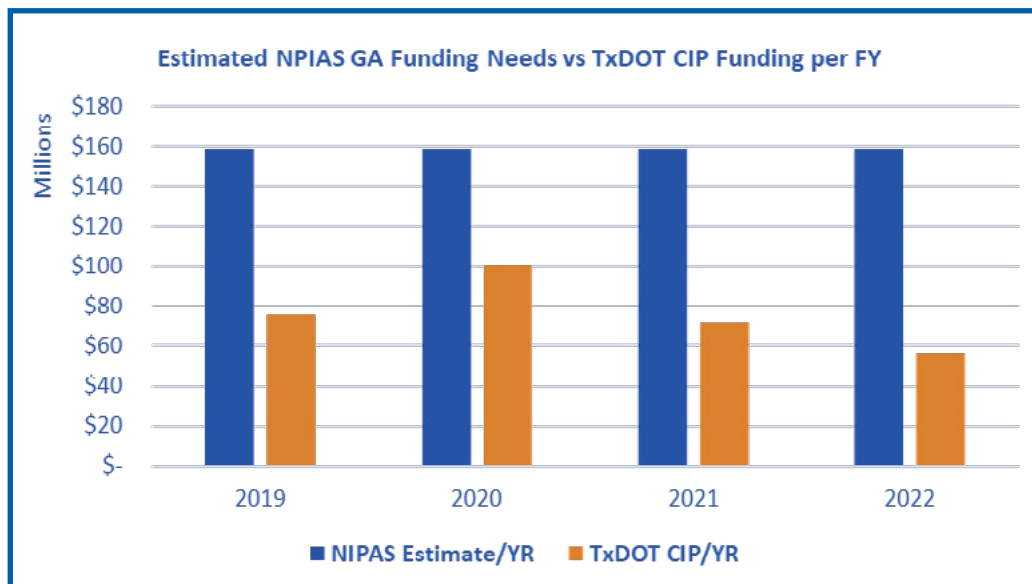


FIGURE 1. Estimated National Plan of Integrated Airport Systems (NPIAS) General Aviation Funding Needs vs Texas Department of Transportation (TxDOT) Capital Improvement Program (CIP) Funding per fiscal year.

The FAA's NPIAS estimated the need for \$901.3 million in Airport Improvement Program-eligible development projects at Texas GA airports over the five-year period from fiscal years 2021 to 2025. Capital improvements at Texas GA airports are funded through a combination of FAA AIP funds administered by the state. The most current Texas Aviation Capital Improvement Program (CIP) has \$228 million programmed for fiscal years 2021 to 2023: \$159 million through federal funding, \$45 million from state funding and \$24 million from local sponsor funding. As seen in Figure 1, the available funding is well below the NPIAS projected development needs.

TxDOT has closed a portion of this funding gap with the Routine Airport Maintenance Program (RAMP), allowing GA airport sponsors to use TxDOT district staff or bid prices from their own contracts to perform a variety of maintenance work on their airports. TxDOT puts airfield maintenance work at the top of its priorities, so nearly all maintenance is eligible. Funding is 50% of project costs annually up to a \$50,000 grant amount. TxDOT provides a 50% funding match up to a \$500,000 grant amount for development of new terminal facilities at GA airports and will cover up to 90% of project costs up to \$1.5 million in federal funds for development of air traffic control towers. Closing the funding gap will be critical in keeping pavements maintained.

PUBLIC SAFETY, OPERATION, MAINTENANCE, AND RESILIENCE

Worldwide air travel for persons using, working, or living in the vicinity of airports is well known for its excellent track record of safety. Texas' aviation safety record is part of that national and worldwide safety success. Planning and funding for airport infrastructure must keep up with the inevitable demands of Texas' expanding role as a national and worldwide hub. Falling behind on infrastructure development may cause a severe chain reaction to nationwide and worldwide systems.

The FAA continues to improve the national airspace to make it safer and more efficient for the flying public. GA aircraft continue to be updated with Global Positioning System (GPS) equipment while more GA airports are requesting GPS and LNAV (lateral navigation) approaches into their airports to improve location accuracy on approach.

Another less obvious stress on airport development is the changing climate and our ever-evolving understanding of Texas weather. Good drainage is especially important to airport operations. The National Weather Service (NWS) Atlas 14 study shows that Texas is more likely to experience larger and more intense storms than previously thought, making severe flooding more likely. Airfield operations can be compromised by flooded runways and taxiways, and access to and from the airport can also be impaired by flooding. For Texas airports to remain resilient and operational when faced with increased stormwater pressures, there is a need to update drainage master plans, judiciously perform routine operation and maintenance procedures to minimize preventable instances of flooding, and invest in stormwater capacity improvements with drainage designs based on the most recently developed climate information.

The COVID-19 pandemic has additionally uncovered the challenges airports will face implementing safety measures such as effective social distancing strategies in passenger terminals. Implementing and maintaining the recommended spacing between people for effective social distancing can be difficult to achieve but will need to be addressed at security checkpoints, customs, ticket counters, aircraft boarding gates, hold rooms, concessions, and restrooms. There is an urgent need for effective health standards in commercial service airports, and release of federal grant funding to aid with implementation of new health standards.



PHOTO: ADDISON AIRPORT; GARVER.



AVIATION



RECOMMENDATIONS TO RAISE THE GRADE

- Increase the cap on the Passenger Facility Charge (PFC) so Texas airports may access the capital needed to support and improve the state's aviation infrastructure.
- Implement NextGen system encompassing the planning and implementation of new airspace technologies.
- Allow the fuel tax to support aviation facilities within the state by increasing the fuel tax cap on air carrier/transport companies.
- Invest in modernization and expansion of existing airport facilities to ensure resiliency and sustainability and to accommodate future airline growth.
- Provide additional state funding to aviation initiatives
- Support Texas legislature toward regulatory zoning and development reforms to improve strategic land planning for new and expanded airport facilities.
- Invest in stormwater capacity improvements to accommodate the most recent information about geographic rainfall patterns within the state.
- Support and foster leadership to fill the funding gap between available funding and needs so Texas can fulfill its potential to become modernized like never before.

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BRIDGES



PHOTO: AUSTIN 360 BRIDGE; B. SEIDEL



BRIDGES

EXECUTIVE SUMMARY

Texas maintains the largest bridge inventory in the nation, has the smallest percentage (1.3%) of structurally deficient bridges along with Nevada, and, according to the Texas Department of Transportation (TxDOT), achieves a level of safety where zero crashes are caused annually by poor bridge conditions. However, to accommodate Texas' growth and continue this good standing, estimates show \$3.6 billion needed annually for bridges and culverts over the next 10 years, while \$18 billion is still needed over the same timeframe to erase the backlog of deficient bridges. Public initiative and legislative leadership led to the passing of Propositions 1 and 7 in 2014 and 2015, respectively, to raise funds, but heavier trucks, a growing population, and some bridges in flood-prone areas, exert increasing demand on the system, requiring continued priority and resources for maintaining and improving the state's assets.

INTRODUCTION

Texas has the largest bridge inventory in the United States. The assets are valued at \$104 billion and include about 57,000 bridge structures which include over 22,000 culvert crossings with an overall deck area of about 539 million square feet. These bridges carry an astounding 737 million vehicles a day. Based on the responsible authority for funding, Texas bridges are grouped into two categories: on-system and off-system bridges.

- **On-system bridges** are located on state highway systems and funded by a combination of state and federal sources, which includes about 461 million square feet of deck area comprised of 36,000 bridges and culverts.
- **Off-system bridges** are the rest of the system not located on the state highway system and are owned by local governments.

CAPACITY

As of 2019, there are over 18,000 national highway system (NHS) bridges and culverts carrying an average 595 million vehicles per day and accounting for 350 million square feet of deck area.

Based on a 10-year analysis (from 2010 to 2019) of structure inventory data, traffic volumes on bridges and their associated culvert systems have been increasing at an average annual rate of 1.4% for on-system and 1.2% for off-system. To keep up with this demand, TxDOT and the off-system jurisdictions have been adding 8.7 million square feet per year with an annual investment of \$1.7 billion for on-systems and \$230 million off-system.

The nature of bridge capacity demand is changing and adversely impacting infrastructure. For example, the TxDOT Bridge Division must process and approve requests from the Texas Legislature for increased truck size and weight regulations as well as developments in new truck configurations such as Specialized Hauling Vehicles (SHVs). These heavier single unit trucks (not tractor trailers) cause structural wear and reduced bridge life.

CONDITION

Despite the daunting maintenance task associated with the nation's largest bridge inventory, Texas, along with Nevada, has the smallest percentage (1.3%) of *structurally deficient* bridges in the nation. According to the TxDOT 2018 Report on Texas Bridges, 82% of Texas bridges were classified as “good” or “better” condition. The percentage of “Good or Better” bridges increased from 78.5% in 2008 to 82% in 2018, indicating a positive trend in this classification.

Figure 2 presents deck area age distribution for both on and off-system bridges. Assuming a forecasted average 50-year bridge life, 24% of the on-system bridge network is older than 50 years while only 16% of off-system bridges are at or nearing the end of their service life.

FUNDING AND FUTURE NEEDS

Primarily, funding comes from two sources: federal and state. Federal funds are appropriated by Congress through the federal Highway Trust Fund while the State utilizes motor fuels tax, vehicle registration fees, sales taxes (Proposition 7), and oil & gas production tax (Proposition 1). Proposition 1 allocates approximately \$700 million per year from 2022 to 2029 based on the historical average since 2015. Proposition 7 dedicates a portion of the state's general sales tax for non-tolled highway construction, maintenance, and rehabilitation projects. The 10-Year TxDOT Unified Transportation Program (UTP) 2020 allocates \$3.6 billion/year to Category 6, which is dedicated to bridge replacement and rehabilitation.

TxDOT's UTP 2020 allocates funding of \$3.6 billion per year for bridges and culverts through 2030. Texas population is projected to increase to 45 million people by 2040. This population increase will require expansion of the transportation system to keep up with the economic growth. An estimated \$2 billion per year investment in bridge and culvert expansion is needed to meet future capacity demand. An additional estimated \$1.8 billion per year is needed to erase the backlog of deficient bridges for the next 10 years. Without considering inflation, these estimates are based on average spending in past years to meet demand and an estimated upgrade cost per square foot for bridges not classified as Good or Better. The values in the 2020 UTP may fall short to meet these requirements over the next ten years.

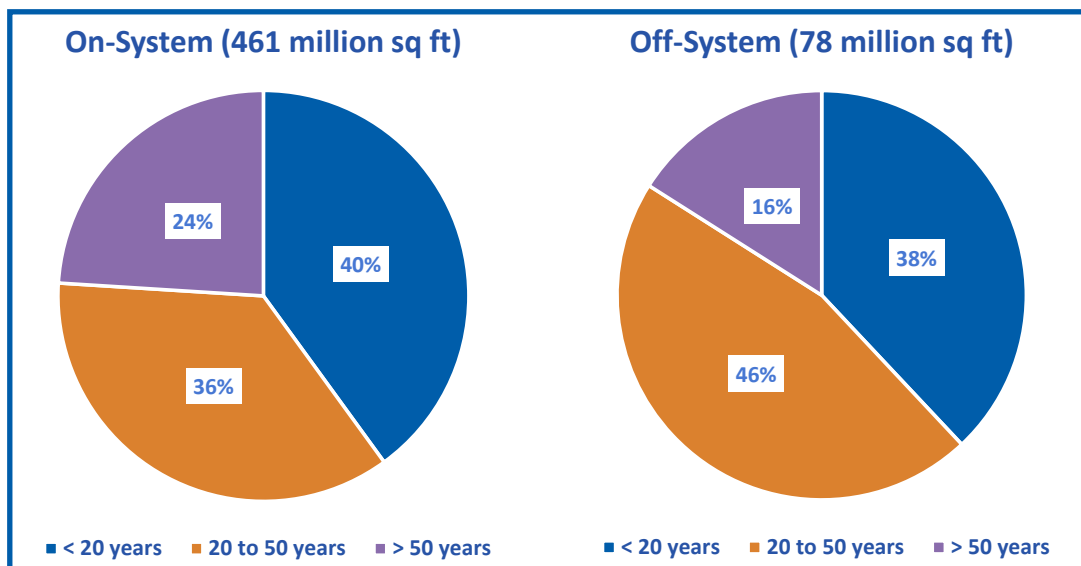


FIGURE 2. Age of On- and Off-System bridges per deck area.

OPERATION AND MAINTENANCE

To maintain and/or improve the Texas bridge quality, proper operation and maintenance (O&M) of the state bridges is essential. Lack of proper and timely O&M results in a decline in the bridge's useful life and ride quality, an adverse impact on drivers' public safety, and an increase in deteriorated bridge repair cost. Extensive repairs or bridge replacement also adversely affects traffic flow and travel time due to potential bridge closures. Bridge maintenance ensures the integrity of bridge structural elements, repairs the bridge deck and deck joints, paints the bridge, and repairs guard rail damage. Maintenance of the river channel underneath the bridge is also included in bridge maintenance costs.

Recognizing these facts, the Federal Highway Administration (FHWA) has allowed funds to be used to perform preventive maintenance on highway bridges under the Highway Bridge Replacement and Rehabilitation Program (HBRRP). The 2030 committee report estimated an annual cost of \$105 million to inspect and provide regular maintenance for bridges on average over a 20-year planning horizon. Annual maintenance could include cleaning debris (on the bridge or under water crossing bridges), painting, joint and approach slab repairs and bridge pads and pins inspections and replacement.

PUBLIC SAFETY

Public safety concerns are associated with bridges that are unable to carry current and future traffic due to restricted number of lanes and geometric road design aspects, such as alignment issues with the existing roadway approaches. Capacity issues can lead to possible traffic queueing and an associated increase in crash numbers and severity. Bridge-road alignment issues such as limited sight distances to structure approaches have also been known to increase crash rates, according to road safety research. Road and bridge flooding are also associated with crashes and will later be discussed in the Resiliency section of this report.

TxDOT's maintained Crash Records Information System (CRIS) shows an average of 3,500 bridge crashes per year for the past 10 years. There have been no reports of crashes due specifically to poor bridge condition, except for any due to low clearance from bridges designed under older criteria.

In Texas frequent bridge icing and flooding at water crossings have heightened public and media attention to bridge safety concerns. Such attention can be used to advance bridge replacement funding by legislators. Recent federal transportation legislation has also contributed to systematic approaches to data collection and management systems for crashes involving bridges to ascertain impacts of measures to improve transportation efficiencies and crash prevention strategies.

RESILIENCE

Texas rainfall patterns are changing with evolving scenarios for Texas weather and climate patterns. Texas bridges and the motorists they serve will become increasingly vulnerable to flooding, with the current Texas bridge design not expected to hold up to flooding in the coming years. The current TxDOT approach to selecting the design standard for a structure that may experience flooding such as a bridge or culvert, is to use a reference table that specifies a range of design Annual Exceedance Probability (AEP). AEPs are selected depending on the risk associated with different types of structures and highway functional classes. This predicts the flood standard around which the bridge should be designed. Analysis of the AEPs suggests original design accounted for a 50-year return period whereas for the off-system the return period would be lower or 25-year. There is an economic balance for using higher design standards with impacts on construction costs and associated reductions on weather related traffic impacts. To increase the resiliency of the bridge and culvert infrastructure, TxDOT will be facing an increased demand for funding.

INNOVATION

Innovation in bridge design and development comes in many forms and shapes: Geometry, structural design, materials, testing, foundations, construction methodology, and contracting methods. TxDOT has been open to innovation, **primarily the use of prefabrication**, in its projects to solve complex problems, expediting construction and reducing costs.

TxDOT has been a pioneer in improving construction speed and control by opting to use pre-cast structures when feasible such as on the Louetta Road Overpass project in Houston. Traffic disruption was minimized to only 6 hours on the US 290 Ramp G project with a pre-cast straddle bent cap. The projected disruption using other methods was 41 days. To increase durability of the new structure, designers used high performance concrete (HPC) and hollow column segments to take advantage of the high strength concrete that goes with pre-casting. The column segments were stacked sequentially, the joints epoxy-bonded, and the columns post-tensioned vertically after all segments were in place. The bottom segment was filled with concrete to protect it against possible vehicular impact.



BRIDGES



RECOMMENDATIONS TO RAISE THE GRADE

- **Prioritize efforts to maintain and improve the national highway system (NHS).** The NHS carries the bulk of state traffic and is of strategic importance to maintaining flow of goods to keep Texas' economy rolling.
- **Reevaluate design standards.** Certain bridges and culverts in high traffic demand areas should be built to more stringent flood standards. The balance of risk and cost and prioritizations focusing on the replacement of flood prone bridges and culverts should be directed to increase the transportation network resiliency.

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PHOTO: LAKE TRAVIS AND MANSFIELD DAM, AUSTIN, TEXAS; R. BENDER.



DAMS

EXECUTIVE SUMMARY

Dams in Texas serve many purposes including recreation, flood risk mitigation, irrigation, water supply and fire protection, among others. About 1 in 3 of the state’s dams are for flood risk mitigation and one in seven dams are for irrigation or water supply. Dams have great value and great consequence. The consequences of a dam failure far exceed the loss of a water supply or your favorite fishing hole. When a dam fails, the area downstream faces loss of life or property, or both. Of the about 7,200 non-federal dams in our state, approximately 25% could result in loss of life should they fail. Furthermore, underfunded and understaffed regulatory agencies impact dam safety and increase risk. More than 3,200 Texas dams are exempt from dam safety requirements by State legislation.

In 2019, the Association of State Dam Safety Officials (ASDSO) estimated the cost to rehabilitate all non-federal dams in Texas at around \$5 billion. The Texas State Soil and Water Conservation Board (TSSWCB) estimates about \$2.1 billion is needed to repair or rehabilitate dams included in the Small Watershed Programs.

Hazard Classification	Number of Dams	% of Total
HHP	1,502	37%
SHP	306	8%
LHP	2,261	55%
Total	4,069	100%

TABLE 2: Dams Subject to State Dam Safety Regulations.

CONDITION AND CAPACITY

Dams are classified as high hazard potential (HHP, probable loss of life if dam fails), significant hazard potential (SHP, possible loss of life) or low hazard potential (LHP, no loss of life expected). There are currently 7,324 dams in Texas with the oldest over 170 years old, according to the National Inventory of Dams (NID). 126 federal dams are included in that total with about 40% of those classified as significant or high hazard potential. 97% of the dams in Texas were built prior to 1996 and over 75% of HHP dams were constructed before 1975.

In 2013, House Bill 677 Legislation amended the Texas Water Code to exempt an owner of a dam located on private property from meeting the requirements related to dam safety if the dam meets one of the following criteria: 1) impounds less than 500 acre-feet (top of dam capacity) at maximum capacity; 2) has a hazard classification of low or significant; 3) is located in a county with a population of less than 350,000; and 4) is not located inside the corporate limits of a municipality. According to the Texas Commission on Environmental Quality (TCEQ), 3,273 dams are exempt from dam safety requirements by this legislation. That leaves about 4,000 dams in Texas that must comply with dam safety regulations.

According to the Texas State Soil and Water Conservation Board, of the 2,041 dams built in Texas since 1948 under the Small Watershed Programs, almost 1,200 of them have exceeded their life expectancy of 50 years with 188 of these dams are in need of repair. In addition, there are 516 HHP dams that need to be rehabilitated to meet current safety criteria.

OPERATION AND MAINTENANCE

With aging dams and rapid urbanization in many parts of Texas, the need for dam maintenance, repair, and rehabilitation continues to grow each year. According to TCEQ, a high percentage of the HHP dams do not have a maintenance and inspection program in place. The dam safety program administered by the TCEQ monitors and regulates private and public dams in Texas. The program periodically inspects dams that pose a high or significant hazard, meaning there is a potential loss of life if the dam fails; and makes recommendations and reports to dam owners to help them maintain safe facilities. The financial responsibility for maintenance and repair falls on the owner of the dam. Many owners, both private and public, do not have the financial capacity to properly maintain and upgrade the aging structures.

The largest impediment to implementing an adequate maintenance and inspection program as well as EAPs is funding. Many of the private and municipal owned dams have a lack of available funds. The state inspection program makes maintenance and repair recommendations for all of the dams that are inspected; however, of the approximately 3,900 state-regulated dams, less than 25% show a current inspection with the remaining dams either overdue for inspection or not listing an inspection date.

Many dam owners and operators do not receive training on their responsibilities for dam safety. However, since 2016, the Texas Dam Safety Program has conducted 12 workshops for owners with 1,222 people registered. In 2019, three workshops were conducted with 272 total registrants.

PUBLIC SAFETY

Data from the Association of State Dam Safety Officials (ASDSO) lists a total of 280 incidents related to dams in Texas since 1900 with 23 of those being failures. However, it should be noted that 89 incidents, including 3 failures, occurred prior to 2000. Since 2000, there have been 189 reported incidents, more than double what occurred between 1900 and 2000. Of those incidents, the number of failures has increased to 19. It should be noted that the ASDSO began compiling data in 2010 and any prior data was supplied by the state and this information may not be

Hazard Classification	Number of Dams
SHP	240
LHP	3,033
Total	3,273

TABLE 3: Dams Exempted by House Bill 677.

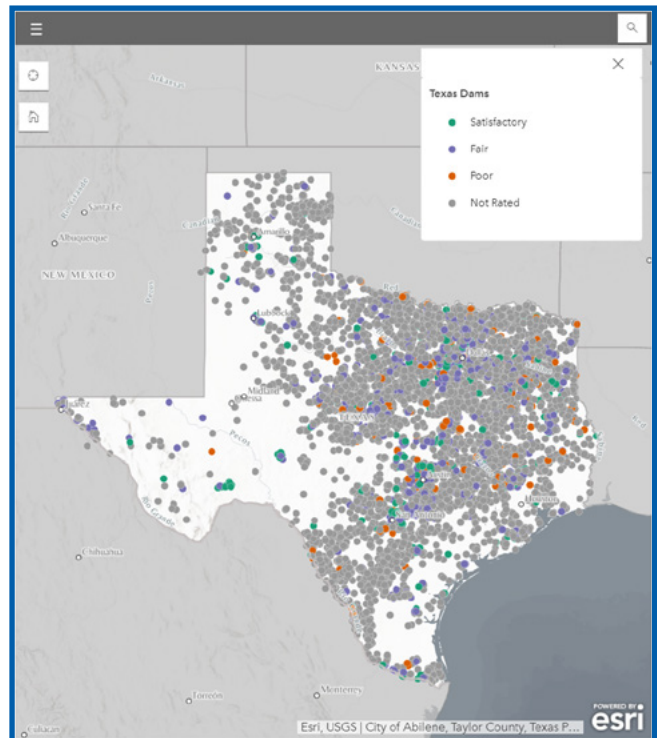


FIGURE 3. Condition of Dams in Texas; Texas Observer.

CLIMATE EFFECTS ON DAM SAFETY

A degree of wishful thinking seems to underlie the state's science on rainfall. In 2016, John Nielsen-Gammon, Texas' state climatologist, was asked to peer-review a study commissioned by TCEQ's dam safety division. It had been 40 years since the last study on extreme rainfall in Texas, which provides important guidance for sizing dams in flash-flood-prone Texas. In the meantime, many devastating, unprecedented floods had swept through the state.

TCEQ contracted with a Denver consulting firm to update rainfall data, but when the analysis reached Nielsen-Gammon for review, he was surprised to see that the firm hadn't looked at how climate change would worsen rainfall in Texas. But that's not unusual. Meteorologists haven't yet devised a universally agreed-upon method to factor climate change into extreme rainfall analyses. "Without a standardized way to incorporate climate change, the approach is to assume that what happened historically is representative of what could happen in the future," said Nielsen-Gammon.

But such an approach is problematic, particularly for Texas. Rainfall in the state is influenced by the Gulf of Mexico, a warm bathtub of an ocean that's steadily warming. As oceans heat up, evaporation increases and storms have more fuel to gather before they make landfall. That makes climate change a key component in understanding extreme rainfall events.

Still, even without factoring in climate change, the TCEQ study found that worst-case rainfall scenarios are significantly worse for parts of the Gulf Coast and East Texas compared to the findings in the 1978 study. In East Texas, for instance, the most extreme rainfall events could result in 12 percent more rain for large drainage areas.

FIGURE 4. Excerpt from *Dammed to Fail*, Texas Observer.

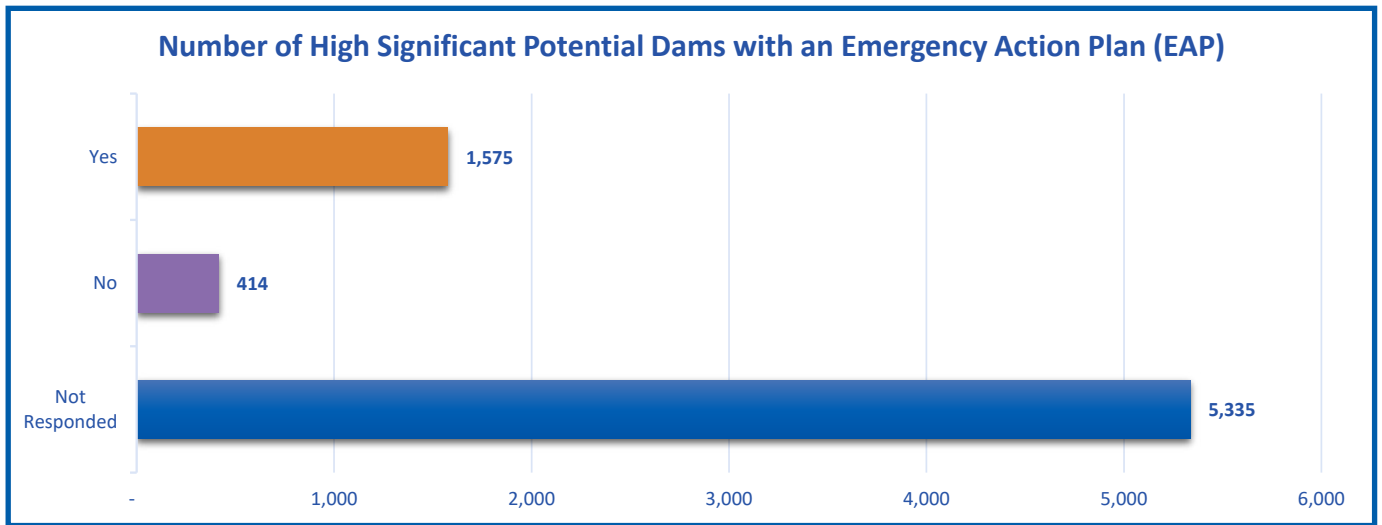


FIGURE 5. Number of High Significant Potential Dams with an Emergency Action Plan.

comprehensive. However, the apparent increase in incidents and failures can likely be traced to a combination of factors including dam age, an increase in severe weather events and the need for rehabilitation. For example, all 20 incidents in 2017, including 4 dam failures, were attributed to Hurricane Harvey. The effect of severe weather events on dams is discussed in the following article excerpt presented as Figure 4.

Emergency Action Plans (EAP's) and inundation maps have been required for many years. EAPs improve dam safety by identifying potential emergency conditions at dams and outlining a preplanned set of actions to help prevent loss of life and minimize property and environmental damage. In 2019, there were 7,324 total dams in Texas, 1,989 (27%) of which were HHP dams. Of the 1,989 total HHP dams, 80% had EAPs. Many private and municipal-owned dams have no EAP due to lack of available funds.

There are no statewide limitations on development downstream of a dam. Therefore, as the Texas population continues to grow, areas downstream of existing dams once classified as LHP are being developed into residential areas. Many of these dams were originally constructed as farm ponds and many were not designed to meet current dam safety requirements.

Some local governments have taken their own steps to address this issue. In the April 1, 2019 Texas Observer article, *Dammed to Fail*, the City of McKinney is cited as one example:

In 1999, the city passed a stormwater management ordinance that restricts development downstream of dams in the breach zone. It also requires upstream developers planning to pave over prairies and increase impervious cover to contribute to the cost of dam rehabilitation. Michael Hebert, the assistant director of engineering for the city, estimated that builders are typically pitching in between \$500 and \$1,000 per acre.

FUNDING AND FUTURE NEED

In 2019, the Association of State Dam Safety Officials (ASDSO) estimated that nation's dam rehabilitation costs are \$66 billion dollars for all non- federal dams. The cost to rehabilitate all non-federal dams in Texas is estimated to be about \$5 billion.

The Texas Soil and Water Conservation Board states that 188 of the dams that have exceeded their life expectancy need repair at a cost of \$139 million. Currently 25 of the 188 dams are under contract for repair at a construction cost of about \$15 million and 29 dams are in the design stage for repairs to be completed in the next two years. It is estimated that rehabilitation of 516 HHP dams will cost an estimated \$2 billion. Of these 516 HHP dams, state funds will be used to upgrade 20 dams while 8 dams will be upgraded using federal funds.

“The problem is the smaller dams,” said Wes Birdwell, a civil engineer in Austin. Many of them were built several decades ago, Birdwell said, and predate TCEQ’s dam safety program. “There’s more that’s going to fail,” he said. “Maybe somebody’s grandpa bought a bulldozer ... and scraped up a bunch of dirt. We don’t know a lot about a lot of these dams.”

FIGURE 6. Excerpt from *Dammed to Fail*, Texas Observer.

The 2020 Texas dam safety budget, administered by 26 full time employees, is about \$2.1 million, with \$1.8 million in the state budget and about \$330,000 in FEMA grant funding. Texas lags significantly in regard to the dam safety budget per HHP dam when compared to the national average. There have been two significant legislative events in 2019 that would improve safety of flood control dams in Texas. First, a \$150 million appropriations bill was passed and signed into law on June 6, 2019, and then Senate Bill No. 8 (SB8) became an act on June 10, 2019.

SB8 created the framework for the first state flood plain in Texas. SB8 Sec 201.0227 specifically requires the state board prepare and adopt a plan describing the repair and maintenance needs of flood control dams that are 1) not licensed by the Federal Energy Regulatory Commission, 2) do not have flood storage, 3) are required to pass floodwaters, and 4) have failed. Additionally, the TSSWCB is required to prepare and adopt a new plan before the end of the 10th year following adoption of a plan. Implementing SB8 will require about \$7 million in funding in 2020 and greater than \$35 million per year beginning in 2021. A portion of the funding will be spent on meeting SB8 Sec 201.027 requirements. The state also appropriated \$150 million in funds to TSSWCB to administer through grants to local Flood Control Dam sponsors, including soil and water conservation districts. The funding will be spent on dams needing rehabilitation based on a priority list developed by TSSWCB.

Dams with a revenue stream usually have adequate funds for rehabilitation. Recent impacts of Hurricane Harvey and devastating 2015 and 2016 floods resulted in an increased focus by the Texas legislature on flood control infrastructure, including dams. The resulting SB8 and appropriations will help improve assessment and rehabilitation efforts. In addition to the impact of Hurricane Harvey on dams in the Houston area in 2017, the failure of the Lake Dunlap Dam spillway gate, likely due to the age of the structure as stated by the Guadalupe-Blanco River Authority, further illustrates the need for adequate inspection, maintenance, and upgrades to our dams. A collaborative effort will be needed to assess and support the rehabilitation needs of dams that are maintained by private owners and operators and are exempt from dam safety requirements. Efforts may include technical expertise, financial assistance and community engagement or awareness.

INNOVATION AND RESILIENCE

There is an opportunity to apply innovative and resilient design and construction methods, and operational and maintenance best practices to Texas dams. Innovation within the dams infrastructure category is limited but the availability of online documents for the Dam Safety Program and access to workshops is important. Texas dam rehabilitation plans do not currently take climate change into consideration, a necessary factor to ensure resiliency as more extreme precipitation events are anticipated in the future.

	National Average	Texas	Rank
NID Dams	1,793	7,324	1
State Regulated Dams	1,665	3,995	6
HHP Dams	245	1,502	1
State Budget	\$1,207,134	\$1,698,741	1
Budget per HHP Dam	\$6,156	\$1,256	48
Full Time Employees (FTE)	9	27	2
Dams per FTE	191	148	24
HHP Dams per FTE	28	50.1	7

TABLE 4: 2018 Statistics on State Dam Safety Regulation; Association of State Dam Safety Officials.



RECOMMENDATIONS TO RAISE THE GRADE

- Increase funding for the Dam Safety Program to perform inspections and identify hazardous conditions as quickly as possible.
- Develop a mechanism to enforce the requirement for maintenance, rehabilitation, and inspection programs for all high hazard dams in the state.
- Develop emergency action plans for the remaining 20% of significant and high-hazard potential dams, including those dams subject to reclassification as high-hazard potential due to population growth in rural areas.
- Create a state loan or grant funding program for dam rehabilitation, repair, abandonment, or removal.
- The State of Texas, local political offices, and zoning boards should pursue regulating the development in breach inundation zones by establishing or acquiring easements in these areas.
- Remove or modify the current legislative exemptions to reduce the number of dams exempt from dam safety regulations.

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DRINKING WATER



PHOTO: WICHITA FALLS REVERSE OSMOSIS TRAINS, NORMALLY USED FOR BRACKISH SURFACE WATER, USED HERE FOR DPR TREATMENT.



DRINKING WATER

EXECUTIVE SUMMARY

Texas' drinking water sector has improved in the conservation, planning, management, and increases in State funding and financing support.

Texas' commitment to fund safe, adequate, and reliable drinking water is critically important for continuing growth and prosperity. Texas' population is projected to grow by more than 1,000 people per day— from 29.7 million in 2020 to approximately 51.5 million by 2070. Meeting these increasing water demands is imperative to the state's economy.

The Texas Water Development Board (TWDB) developed the first State Water Plan (SWP) in 1961 for Texas legislators. Updated every five years since 1992 and incorporating 16 regional water plans since 2002, the SWP guides state water policy. Current and anticipated shortages are addressed in areas with limited surface water supplies or areas concerned about groundwater resource conditions. Water conservation currently adds 1.07 million acre-feet per year (AFY) of supply and is projected to increase by 140%, by 2070. The total capital cost of water supply strategies identified in the 2017 water plan is \$63 billion with an expected \$26.8 billion funding gap to be filled by water utility revenues.

CONDITION AND CAPACITY

As of July 1, 2020, the State of Texas regulates 7,056 public water systems (PWS), covering 4,520 service areas (Figure 7) and providing drinking water to more than 29.1 million customers (98.5% of the State’s population). While this report provides an overview of condition and capacity of Texas’ drinking water infrastructure, limited data exists, especially from a comprehensive, state-level database regarding the ages of the distribution and treatment systems.

Table 5 shows the majority of PWS are Community systems. The Community systems represent approximately 97% of the State’s population.

Table 6 shows the Water main length, repairs, and replacement for utilities with 3,300 connections and who have financial obligations of \$500,000 or more with TWDB.

According to the TWDB’s estimate, the total water use in Texas in 2017 was 13.75 Million acre-feet per year (AFY), 30% of which is municipal water use. This supply is made up of 62% surface water and 33% groundwater and reuse. Using estimated total population and water use estimates, the average municipal water use in Texas is 132 gallons per person per day (gpcd). Not including industrial and other uses, the average residential water use is estimated to be lower (89 gpcd). Existing supplies are projected to be 13.6 Million AFY in 2070. However, the anticipated population growth in the State will lead to potential water shortages (needs) of 8.9 Million AFY by 2070 if no additional water supplies are developed.

Regarding water quality, Texas Commission on Environmental Quality (TCEQ) reported more than 1,500 boil water advisories were issued in the entire state of Texas for 2015, increasing from 650 in 2008. Though more recent statistics were not available, anecdotal information showed that notable boil water incidents since 2015 were attributed to excessive runoff overwhelming the water treatment system in Austin, sanitary sewer outflows caused by high rain events and failures of wastewater pump stations. Boil water advisories are a reaction to the potential of contaminated water, and the increasing number of advisories raise concern over an aging infrastructure.

Public Water Systems (PWS)	Number of Systems	Population Served
Community	4,657	28,300,817
Non-Transient, Non-Community	887	504,826
Transient Non-Community	1,512	290,850

TABLE 5. PWS Population by Type. Source: TCEQ Office of Water, Water Supply Division, 2020 July 1, State of Texas Public Drinking Water Program 2019 Annual Compliance Report.

OPERATIONS AND MAINTENANCE

High and increasing water losses within a drinking water utility’s system can be an indicator of low operational maintenance. One way to estimate adequacy of water system maintenance funding is the Infrastructure Leakage Index (ILI). TWDB maintains the ILI database, which is a ratio of real annual losses to unavoidable losses. A lower index suggests losses are controlled and most water losses are unavoidable due to normal operational factors including hydrant or dead-end main flushing and firefighting, for instance. A higher index suggests the system is losing water due to factors that can be addressed through best management practices, maintenance and modernization, main replacement, leak detection and repair.

Figure 8 shows in 2018 that the ILI for the state is most similar to the index number from communities with population between 50,000 and 99,999. Communities with <10,000 and >100,000 population were seeing more leakage in the infrastructure.

One of the State’s initiatives toward improving infrastructure maintenance is funding Asset Management Plans for Small Systems (AMPSS) through the TWDB. The AMPSS facilitates managing systems in a financially and technically sustainable manner. In state

Utility Connections	Total Length of Main Lines		Total Length of Main Lines Repaired		Total Length of Main Lines Replaced	
	Utilities Reporting	Miles	Utilities Reporting	Miles	Utilities Reporting	Miles
3,300 or Greater	296	116,765	201	421	197	241
Less than 3,300	202	12,259	137	7	101	30

TABLE 6. 2018 Reported Water Main Length, Repairs, and Replacements; Source: Texas Water Development Board.

Program	Year of Inception	Funding Since Inception
Clean Water Revolving Fund	1987	\$ 9 Billion
Drinking Water State Revolving Fund	1996	\$ 3 Billion
Economically Distressed Areas Program	1989	\$ 839 Million
Texas Water Development Fund	1957	\$ 2.7 Billion
State Participation Fund	1962	\$ 368 Million
Agricultural Conservation Loans and Grants	1985	\$ 111 Million
Rural Water Assistance Fund	2001	\$ 181 Million
State Water Implementation Fund for Texas (SWIFT)	2013	\$ 8.3 Billion

TABLE 7. TWDB Administered Financial Assistance. Source: TWDB and US EPA, *Water for Texas Financial Assistance Fact Sheets*.

fiscal year 2021, TWDB will begin incentivizing more entities' adoption of AMPSS, a process which began in July 2019, when the TWDB expanded some of the financial incentives to any eligible entity, not just small systems. TWDB efforts emphasize the state's value in using asset management for planning, scheduling, and coordinating the funding for maintenance needs.

FUNDING

The Drinking Water State Revolving Fund (DWSRF), established by the federal Safe Drinking Water Act, protects public health by offering attractive financing and principal forgiveness for designing, building, and improving public drinking water facilities. Since the inception of the DWSRF Program, TWDB has issued 452 funding commitments totaling \$3 billion.

Most regional plans in the overall State Water Plan (SWP) emphasize expanded state role in financing infrastructure and water supply improvements. In 2013, Texas voters approved a constitutional amendment creating the State Water Implementation Fund for Texas (SWIFT) and the State Water Implementation Revenue Fund for Texas (SWIRFT) to finance projects included in the SWP.

Of the \$63 Billion in capital costs required to implement the 2017 SWP over the next 50 years, approximately \$36.2 billion, or 57% was reported as requiring state financial assistance. This creates a \$26.8 billion funding gap to be filled by water utility revenues.

State and Federal financial assistance programs and their commitments to fund projects since inception are shown in Table 7.

FUTURE NEED

Total capital costs for the recommended water management strategies developed by the 16 Regional Water Planning Groups for the 2022 Initially Prepared Plan (IPP) are shown in Figure 9.

The socioeconomic study included in the 2017 SWP indicates a combined economic loss impact to Texas of \$98.1 billion and 597,000 jobs by 2020; \$135.7 billion and 1.3 million jobs by 2070 if water infrastructure needs are not met.

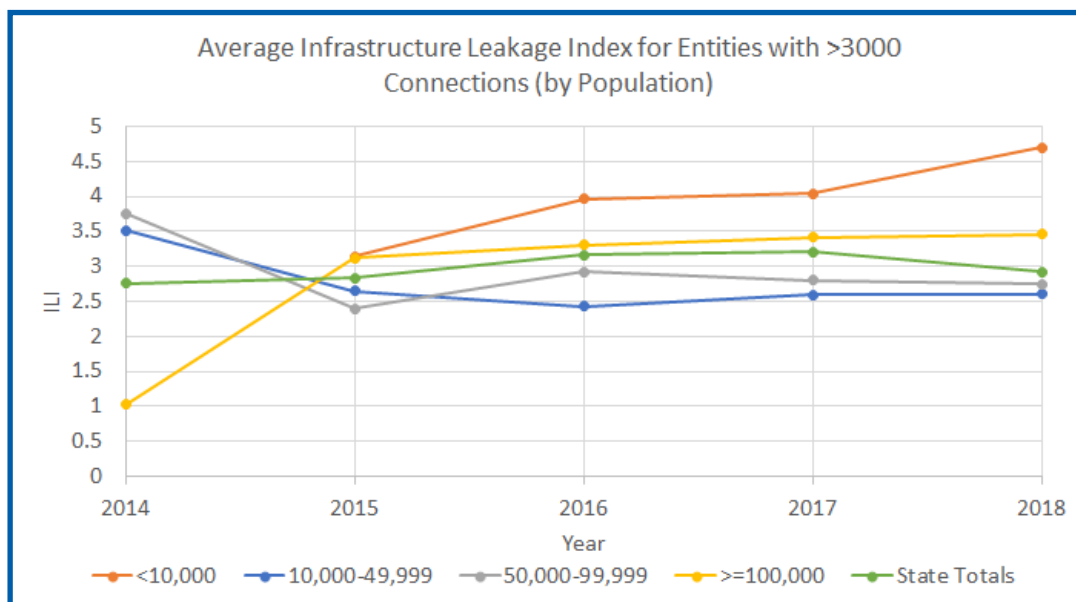


FIGURE 8: Average Infrastructure Leakage Index. Source: TWDB, Water Loss "WLA" Database, accessed 2020 May 21.

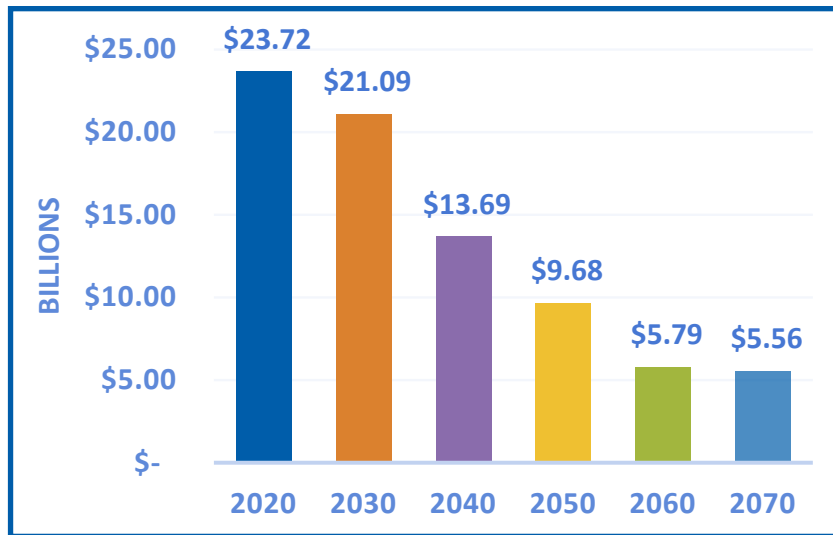


FIGURE 9. Projected Funding Needs by Decade for Recommended Water Supply Strategies. Source: TWDB database “TWDB DB22,” accessed 2020 May 21.

PUBLIC SAFETY

TCEQ is the primary Texas agency enforcing the federal Safe Drinking Water Act to protect public health by regulating PWS. According to the Public Drinking Water Program 2019 Annual Compliance Report by TCEQ, 96% of the total PWS serving 99% of the population were in compliance with health-based standards. However, 17% of PWS, serving 7% of the population, were in violation of the major monitoring and reporting regulations. The top three health-based violations in 2019 were for disinfectant residuals, arsenic, and nitrate.

RESILIENCE AND INNOVATION

Resilience and innovation play a major role in maintaining a state-of-good-repair at the lowest life-cycle cost for infrastructure. Predicting future trends and planning for both known and unknown factors, such as natural disasters, is also crucial. The Office of the Texas State Climatologist analyzed historic observations of temperature, precipitation, and extreme weather in Texas and identified ongoing and future trends in weather to 2036.

Texans rely heavily on surface water sources that are over-allocated that can be significantly depleted during prolonged droughts. According to the U.S. Drought Monitor, Texas suffered a 271-week long drought from May 2010 to July 2015. In 2013, approximately 30 communities were at the risk of running out of drinking water within six months. As of May 14, 2020, TCEQ listed seven communities with a total population of more than 41,000 are at the risk of running out of water within six months. The estimated 8.9 million AFY of water needs for 2070 by the 2022 IPP are projected to be fulfilled in part by innovative strategies (i.e. reuse, desalination and aquifer storage and recovery) implemented by decade.

Water conservation is part of the water supply planning strategy in Texas. As per the TWDB 2017 SWP Conservation is projected to provide 31.4% (including drought management) of future water needs in Texas. Water conservation plans are required to be submitted by various water utilities, depending on criteria, to either the TCEQ, TWDB, or both. In 2018, 499 water suppliers, representing over 7 million connections, submitted a Water Conservation Annual Report.

According to the 2018 biennial desalination report by TWDB, the number of municipal desalination facilities in Texas has increased from 12 producing 22 million gallons per day (MGD) in 1999 to 49 producing 142 MGD in 2016. The source water for these facilities is brackish groundwater (34), brackish surface water (13), and reclaimed water (1) [Figure 10]. TWDB has funded three feasibility studies, two pilot-plant projects, and several research studies on seawater desalination. Several brackish groundwater studies have also been completed and funded by the TWDB Brackish Aquifer Characterization System (BRACS) to map out the available brackish groundwater zones to aid the development of the desalination strategies.

There are three operating aquifer storage and recovery (ASR) systems in Texas: El Paso Water Utilities (1995), City of Kerrville (1998), and San Antonio Water System (2004). TWDB is currently funding a study, to identify the relative suitability of aquifers for ASR and managed aquifer recharge (MAR).

Parameter	Trend
Average Temperature	Historical data and climate models lead to similar conclusions. If recent trends continue, as expected, a middle-of-the-road estimate of the overall rate of temperature increase in Texas would be about 0.6 °F per decade.
Extreme Temperature	Overall, extreme heat is becoming more frequent and more severe, while extreme cold is becoming less frequent and less severe.
Precipitation	An overall trend of increasing rainfall, with projected changes in seasonality and increases in intensity.
Drought	Because of all the factors at play, it is impossible to make quantitative statewide projections of drought trends; however, the majority of factors point toward increased drought severity.

TABLE 8. Texas Climate Trends. Source: J. Nielson-Gamon, J. Escobedo, C. Ott, J. Dedrick, A. Van Fleet, 2020 March 5, Assessment of Historic and Future Trends of Extreme Weather in Texas, 1900-2036, Texas A&M University Office of the Texas State Climatologist.

Water reuse is the practice of using treated wastewater for a beneficial purpose. Currently, there are four direct potable reuse (DPR) projects planned or implemented in the state. TexASCE presented the 2019 Texas Outstanding Civil Engineering Achievement Award for the Wichita Falls Direct Potable Reuse & Indirect Potable Reuse Project.

The resilience of Texas’ water supply and infrastructure is tested by severe events such as hurricanes and droughts. In 2017, Hurricane Harvey shut down more than 200 PWS impacting 915,000 residents in Texas. Additionally, 61 PWS were rendered inoperable or even destroyed at the height of the storm. During the aftermath of the storm, the impacted PWS issued boil-water notices from August 25, 2017 to October 01, 2017. The impact of Hurricane Harvey did not significantly undermine the long-term adequacy of Drinking Water infrastructure in the affected areas.

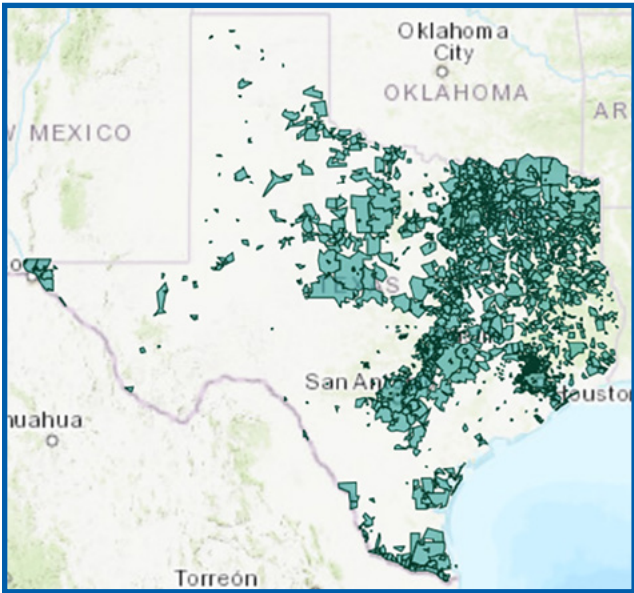


FIGURE 7. PWS Area Location and Distribution. Source: TWDB, Texas Water Service Boundary Viewer, accessed 2020 September 8.

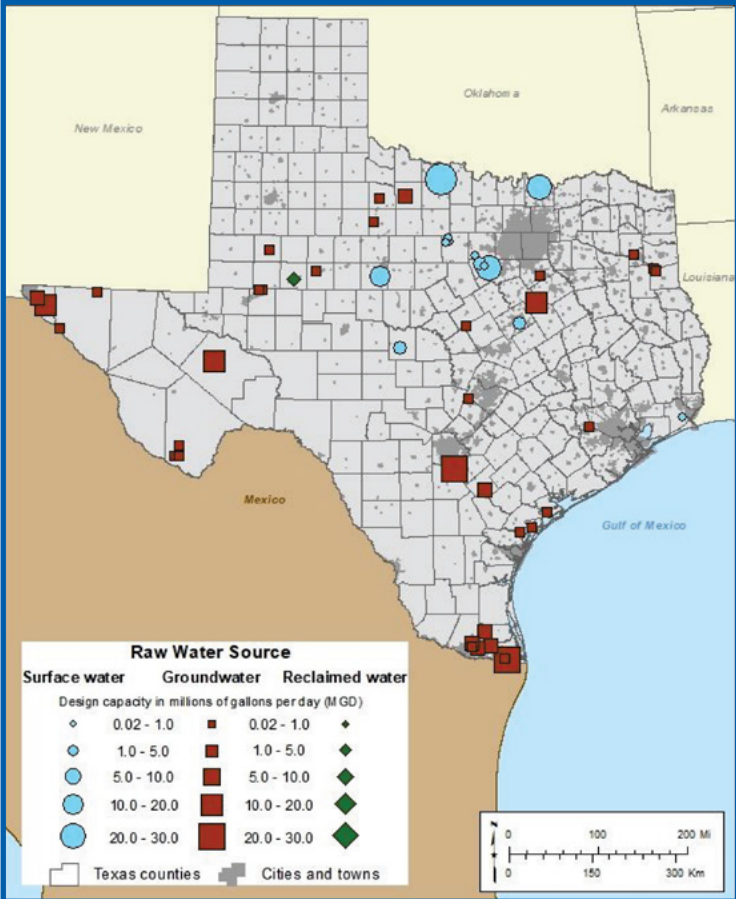


FIGURE 10. The Future of Desalination in Texas. Source: The Future of Desalination in Texas, 2018 Biennial Report on Seawater and Brackish Groundwater Desalination, Texas Water Development Board.



DRINKING
WATER



RECOMMENDATIONS TO RAISE THE GRADE

Water Conservation has increased 32% since 2010 to 1.07 Million AFY in 2020 and is planned to increase to 2.57 Million AFY by 2070. State funding of water infrastructure includes new funding from the SWIFT. Recommendations for improving the infrastructure grade include:

- Comprehensive risk assessments and new initiatives should be incorporated into the planning, design, construction, operations, and maintenance activities for drinking water infrastructure.
- Encourage utilities to adopt rate models to fund adequate maintenance of drinking water infrastructure. Rates should reflect the true cost of supplying clean, reliable drinking water.
- Improve asset management to plan and project adequate maintenance funding needs and to prioritize the capital improvement needs.
- Use asset management data to communicate long-term funding needs to Federal and State leaders.
- Implement leakage management controls to support the infrastructure's ability to meet long-term water supply demand.
- The Texas Legislature should help fund costs of compliance of new drinking water treatment standards through legislation.

Sources

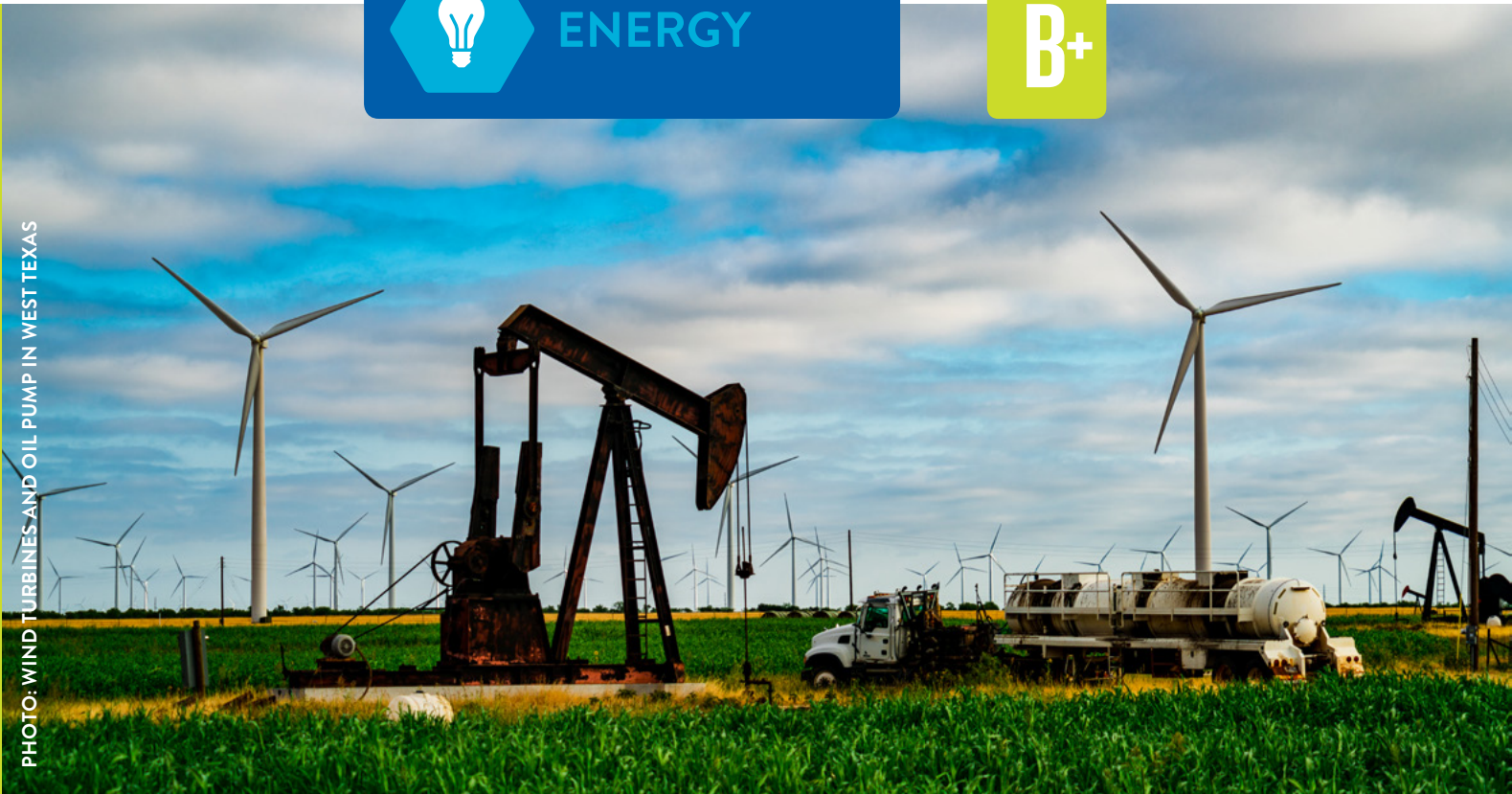
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ENERGY



PHOTO: WIND TURBINES AND OIL PUMP IN WEST TEXAS



ENERGY

EXECUTIVE SUMMARY

Two categories make up energy in Texas: oil & gas and electricity. Texas serves as an important hub for North America, leading the U.S. in oil & gas energy production, at more than 20% of nationally produced energy.¹ Texas has established itself as the energy innovation capitol of the world. Innovation has led to dramatic growth of oil production from about 1 million barrels per day in 2011 to over 5.4 million barrels per day in 2019. Texas energy contributed to United States (U.S.) energy production being greater than consumption for the first time in 62 years. Building on the status quo will require continued innovative infrastructure investments to maintain Texas' global energy leadership position.

On the electricity front, the Electric Reliability Council of Texas (ERCOT) system is comprised of 46,500 miles of transmission lines and more than 680 generation resources.² This infrastructure is sufficient to meet current demands. However, electricity demands in Texas have continuously increased and are expected to continue growing. Over the past decade, energy use in ERCOT increased by 20% due to a strong economy and population growth.³

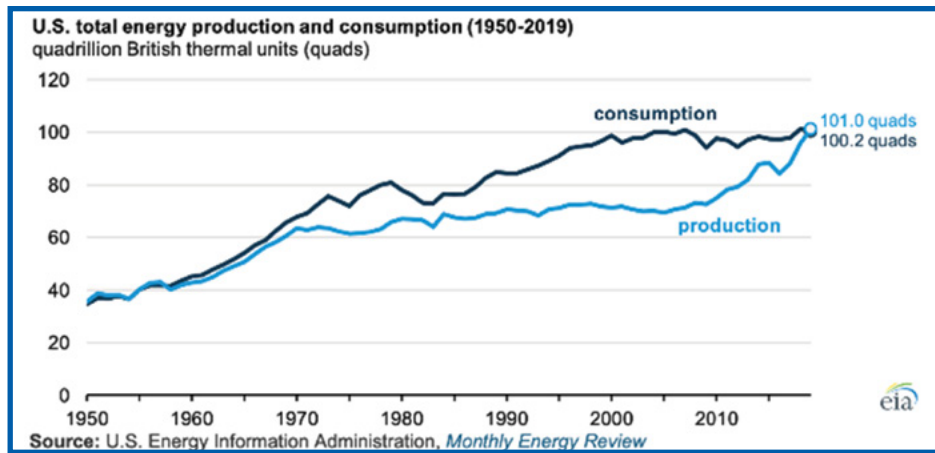


FIGURE 10. U.S. Energy Production and Consumption; U.S. Energy Information Administration (EIA).

CAPACITY AND CONDITION

Demand for electricity in ERCOT reached an all-time high of 74,820 megawatts (MW) on August 12, 2019 between 4:00 PM and 5:00 PM. This was an increase of 1,300 MW from the previous peak demand set in 2018.

The following mix of generation sources served demands for electricity in 2019: Nuclear - 11%, Coal - 20%, Wind - 20%, Natural Gas - 47%, with the remaining 2% coming from a variety of renewable sources, the majority of which was solar. The largest change has been an increasing share from wind and decreasing share from coal. In 2007, wind and coal contributed 3% and 37%, of total generation, respectively.⁴

On the whole, transmission upgrades are generally made in a timely manner across the region ensuring the network’s condition and capacity are sufficient to serve users. However, in areas where there has been rapid growth, adding transmission infrastructure has been challenging. One example has been the rapid increase in oil and natural gas production activity in far-west Texas. During the summer of 2019, the Far West region of ERCOT experienced peak demand in excess of 4,000 MW, an increase of 700 MW when compared to 2018. ERCOT expects that the planned transmission system will serve customer demands in the area through 2024. However, if load grows faster than forecasted, additional transmission will be required. Conversely, if production in the area reduces as a result of the recent drop in oil prices, current planned buildout could potentially be underutilized.

Another area where transmission capacity planning has been difficult has been for the multiple new Liquefied Natural Gas (LNG) terminal facilities proposed for locations along the Texas Gulf Coast. Each facility is a large electricity consumer and will require certain transmission network upgrades to ensure reliable electrical service. It is unclear that the LNG market can support all proposed terminals, but the transmission planning process does not discriminate and will move forward recommending and potentially building transmission facilities that may not be needed. Since all transmission costs in ERCOT are paid for by all load in ERCOT, the cost of any underutilized transmission is borne by all customers.

The amount of installed reserve capacity has dropped to historically low levels in the past few years. However, even at these low levels of installed reserves, there have not been any recent firm load curtailments. As of 2020, the most recent curtailments of firm load occurred during extreme cold weather in February 2011.

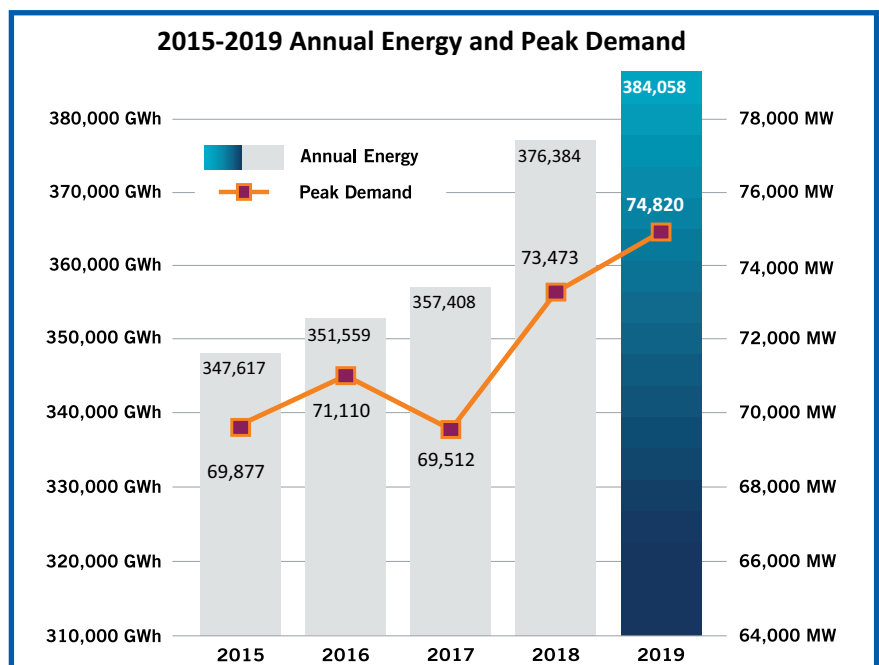


FIGURE 11. Annual Energy and Peak Demand, ERCOT 2019 State of the Grid Report.

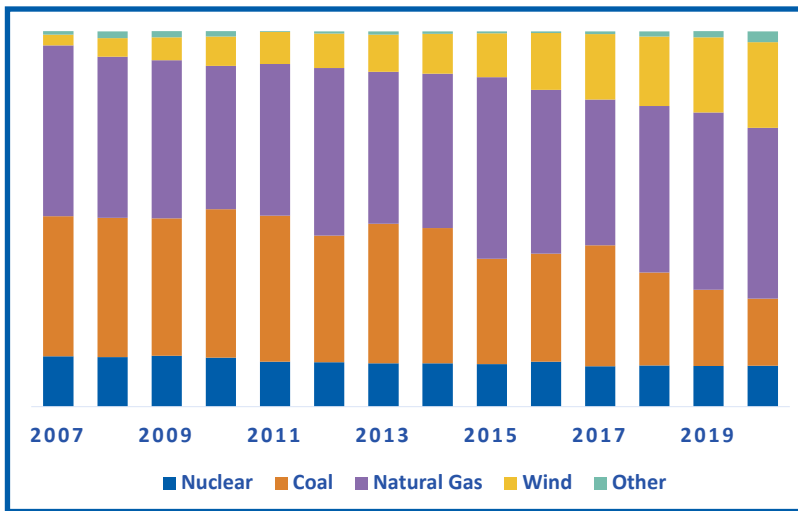


FIGURE 12. Demand by Fuel Type; data from ERCOT Demand and Energy Reports, Energy by Fuel Type.⁴

The Texas energy infrastructure has been re-purposed continuously. These changes combined with weather related resilience demands drive the need for proactive condition assessments of all infrastructure to improve safety, reliability and reduce single point failures. Since most of the energy infrastructure is privately held and is reported to various agencies, there is no single reliable resource for aggregating condition assessment data across the energy space.

FUNDING AND FUTURE NEED

Electricity infrastructure is owned by a combination of entity types across the different sectors - generation, transmission & distribution. Roughly 20% of generation capacity is owned by community based, public power entities that have an obligation to serve the customers in their service territory and an ability to set their own rates, subject to limited oversight by the Public Utility Commission (PUC). The remaining generation capacity is owned by different types of business entities (publicly traded, limited partnerships) whose revenues are not guaranteed and are subject to market conditions. Transmission ownership is slightly more skewed to public power entities (30%), and all owners are compensated under the same PUC of Texas process. Distribution ownership is by assigned territory, with rates set by the PUC for investor owned utilities and by the governing boards of the public power utilities. Market uncertainty has been a historical risk and led to cyclical investments by the private sector and will be a challenge in the future.

Robust planning for the future of Texas transmission infrastructure is in place. An abundance of companies are willing to build, own and operate facilities in exchange for a regulated rate of return. Generation capacity is not centrally planned and investments are made by companies seeking an adequate return on the capital invested.

Significant investment has been and continues to be made in ERCOT transmission infrastructure, as evidenced by the increasing amount of transmission related costs to be recovered on an annual basis. Rate-based transmission costs of \$3.9 Billion in 2020 represent a 250% increase from 10 years ago.⁷

Renewable Energy (wind, solar and some storage) receives the benefits of federal tax incentives. The state has no specific generation incentive funds. The state did amend legislation in 2005 to enable the construction of a large-scale, centrally planned set of transmission projects to enable the wind energy produced in West Texas to reach urban areas. This set of transmission projects, generally referred to as CREZ, resulted in the construction of more than 3,500 miles of 345kV circuits designed to carry 18,500 MW of electricity and was completed in 2013. Although originally intended to support the transmission of wind generation, these lines also are supporting increasing amounts of solar generation in West Texas.

Generators in ERCOT are only paid when electricity is produced or readily available to address sudden changes on the electric system. This is fundamentally different than in other regions of the U.S. in which generators may receive payment for their capacity to produce, regardless of whether they produce. These 'capacity' payments can be a significant portion of revenues for generators located in other regions. Without capacity payments, wholesale electricity prices can rise to much higher levels in ERCOT, when compared to other regions. The threat of high prices provides strong incentives for all types of customers from residential customers conserving to large commercial and industrial customers who are directly connected to the transmission grid to actively manage their demand to avoid consuming during high-price periods. Conversely, the promise of high prices provides equally strong incentives to generators to be available and produce during the times they are most needed.

OPERATIONS, MAINTENANCE, AND PUBLIC SAFETY

Continuity of electricity service is primarily affected by weather. Hurricanes are a well-known risk to all aspects of Texas' energy infrastructure. The most recent significant hurricane to affect Texas was Harvey, which made landfall as a Category 4 on August 25, 2017. The storm inflicted major disruptions in the Corpus Christi, Houston/Galveston, and Beaumont/Port Arthur areas. Damage in the Corpus Christi area, the site of initial landfall was mostly wind-related with downed transmission and distribution lines. As the storm stalled further east, damage was primarily due to flooding.

In response to the current pandemic, the PUC of Texas approved a plan to assist Texans experiencing economic hardship due to COVID-19. The PUC frequently asked questions document provides information on the actions the PUC has approved, including the COVID-19 Electricity Relief Plan. This plan orders Retail Electric Providers (REP) to immediately offer a deferred payment to any residential customer who requests one, and to suspend disconnections for residential customers who have been added to the state's unemployment and low-income list due to the effects of COVID-19. Costs the consumers are unable to cover will be borne by a combination of sources including a new monthly fee paid by paying customers, losses absorbed by the REP, and eventually, the customer through a deferred payment plan.

Improvements have been made in the level or rigor for routine operational inspections to reduce pipeline leaks and eliminate spills. New technology has been rapidly adopted, especially in pipeline assessments using such tools utilizing Shear Wave Ultrasonic Testing and Transverse Flux Inspections. This remains an ongoing challenge similar to the safety journey of seeking zero accidents and to reliably operate this network and ensure public safety. State metrics have been prioritized for the Oil & Gas sector and indicators such as leak elimination reduction and inspection days have been improving over the past decade.⁸ Texas regulators have tended to approve applications for flaring instead of prioritizing innovative solutions, like renewable incentives applied to reduce gas flaring.

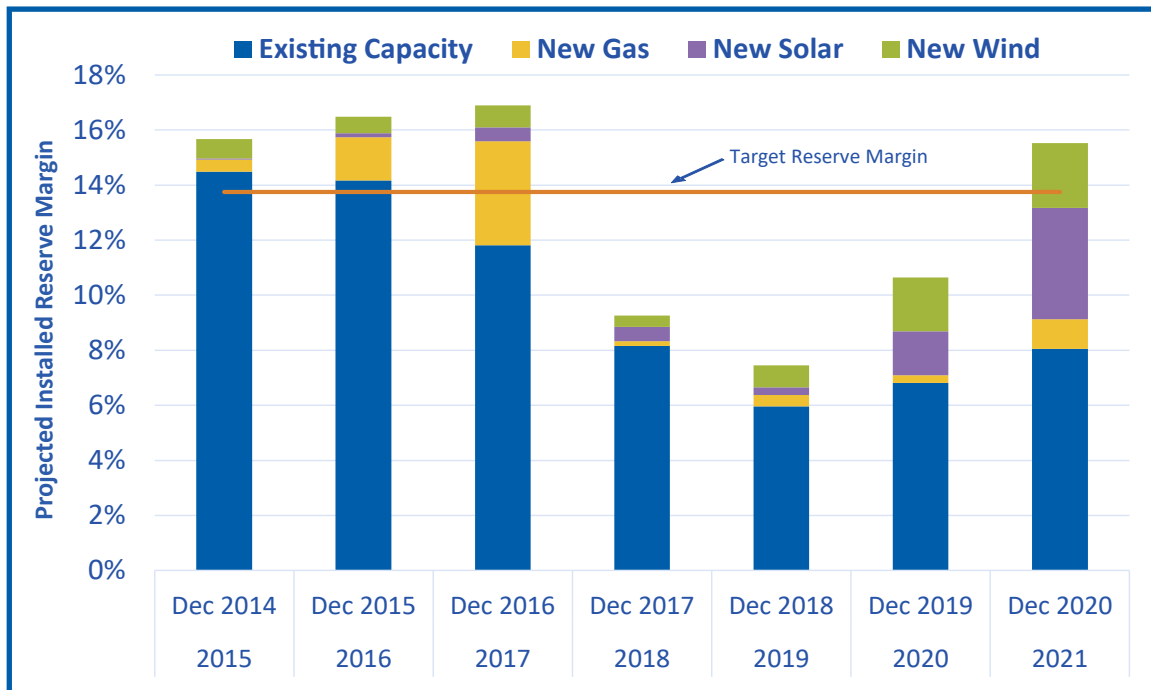


FIGURE 13. Projected Reserve by Type; data from ERCOT Capacity, Demand and Reserves reports.⁶

RESILIENCE AND INNOVATION

Hurricane Harvey's impact on ports caused an estimated \$17.4B in economic impacts due to port closures and caused nearly \$250MM in damage to port facilities not including costly damage and lost revenue impacts to private infrastructure owners and their customers. The increasing reliance on coastal infrastructure increases the risks from major storms. Innovations, such as remote Network Operations Centers employing AI have improved resilience of coastal infrastructure through faster recovery and improved operations.

Texas' growing and complementary position as a leader in renewable energy, from the largest wind power resource in the U.S.⁹ to developing innovations in biomass, biofuel and biochemical resources promises a bright future toward transitioning to new energy markets.

From the first wind generation installations beginning in 1998, annual increases have ranged from steady to meteoric. Early on, wind generation amounted to several hundred MWs located in a handful of counties in West Texas. A little more than 20 years later there are now roughly 24,000MW of wind generation facilities spread across 57 of Texas' 254 counties. Texas has the most wind generation of any state and through the years, ERCOT's practices and processes regarding wind generation have gotten more sophisticated. Two examples of this improvement are forecasting of wind generation and detailed modeling of electrical characteristics of wind generators. Continuous improvement by the ERCOT organization allows them to ensure reliable operation of the electricity grid, even at times when wind generation is meeting more than half of total requirements.

Building on their experience supporting wind generation, ERCOT is taking action to prepare for the large amounts of battery storage being added. Battery storage has the potential to help manage the gaps between renewable generation production and customer demand for electricity. Storage may look like a load taking electricity from the grid when charging and a generator adding electricity to the grid when discharging, but its characteristics are different than either a load or a generator and will require unique market and operating rules to ensure effective integration.

In the aftermath of Hurricane Harvey, the PUC of Texas commended parties' response and recovery efforts. The Commission also coordinated a set of working groups to improve coordination amongst utilities and between utilities and the Texas Department of Public Safety's Texas Division of Emergency Management, which manages the State Operations Center. The results of this work are documented in PUCT Project No. 47552.

FOOTNOTES

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2. ERCOT 2019 State of the Grid Report; www.ercot.com.
3. ERCOT 2019 State of the Grid Report; www.ercot.com.
4. ERCOT Demand and Energy Reports, Energy by Fuel Type tab; www.ercot.com; graphic by Beth Garza.
5. ERCOT 2019 State of the Grid Report; www.ercot.com.
6. Reserve Margin graphic by Beth Garza, using data from ERCOT Capacity, Demand and Reserves reports, www.ercot.com.
7. PUC dockets/controls 50333 (2020) and 37680 (2010); interchange.puc.Texas.gov; graphic by Beth Garza.
8. Interstate pipelines (crossing state borders) regulated by U.S. DOT while Intrastate pipelines (located entirely within the state boundaries) are regulated by Texas Railroad Commission (TX RRC).
9. EIA state energy profile 2019 Texas leads the nation and accounted for 28% of all domestic wind power energy in 2019.



ENERGY

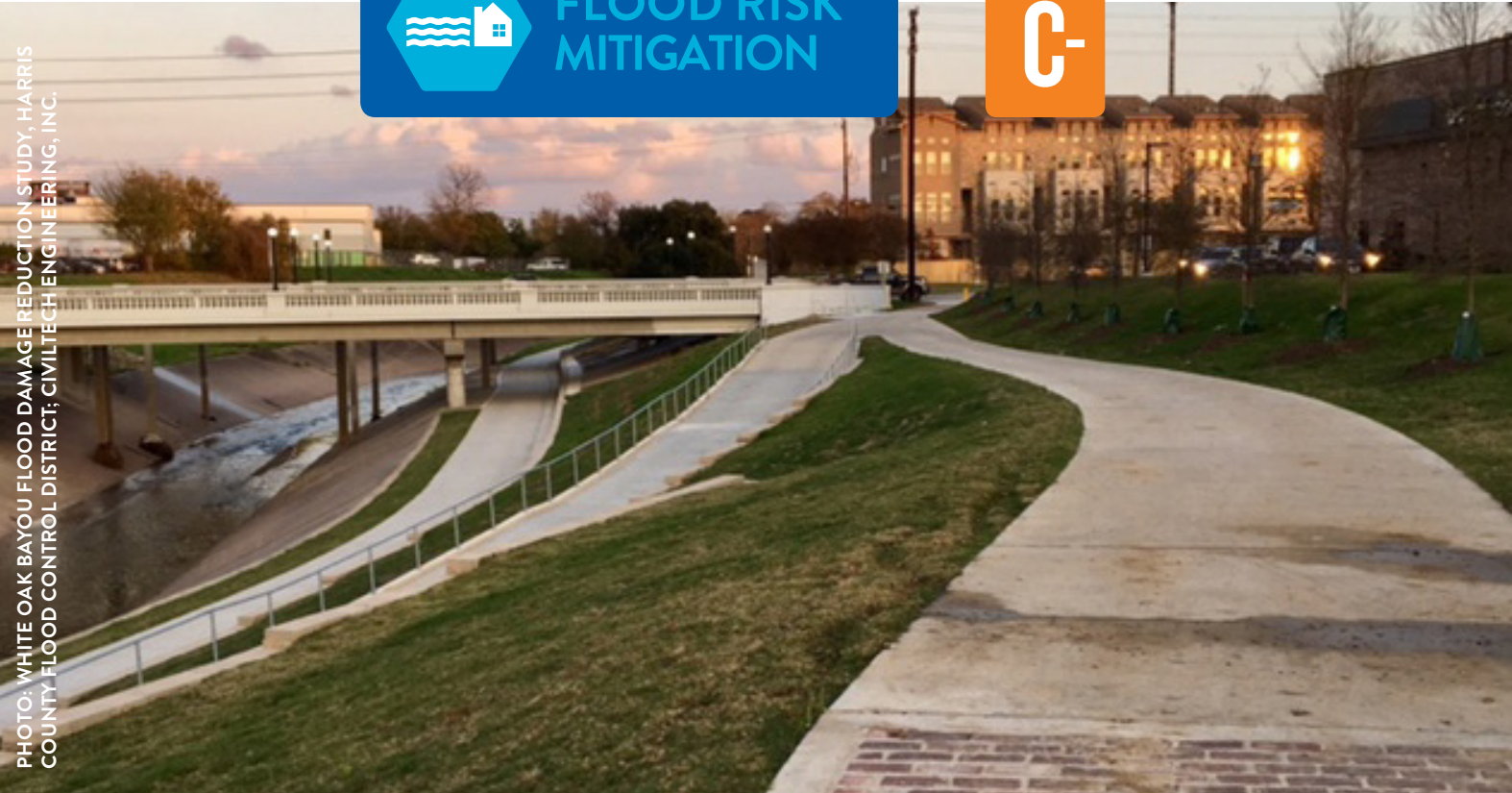


RECOMMENDATIONS TO RAISE THE GRADE

- To maintain present production, preparedness, and progression of energy service, Texas needs to continue its leadership by example.
- Support infrastructure resilience, maintenance and expansion funding for critical port and related infrastructure.
- Continue to be the nation's leader to support innovation to eliminate gas flaring and reduce environmental impacts by capturing wasted resources.
- Maintain focus on reducing leaks and increasing environmental protection in its safety and infrastructure condition assessments.
- State regulators and industry need to develop innovative solutions to support timely energy infrastructure investment and expansion toward new energy sources.
- Based on increased amounts of generation resources at lower voltages, new rules and procedures are required to ensure maximum contribution and transparency.
- Increased amounts of Storage resources will require new market rules and oversight.

Sources

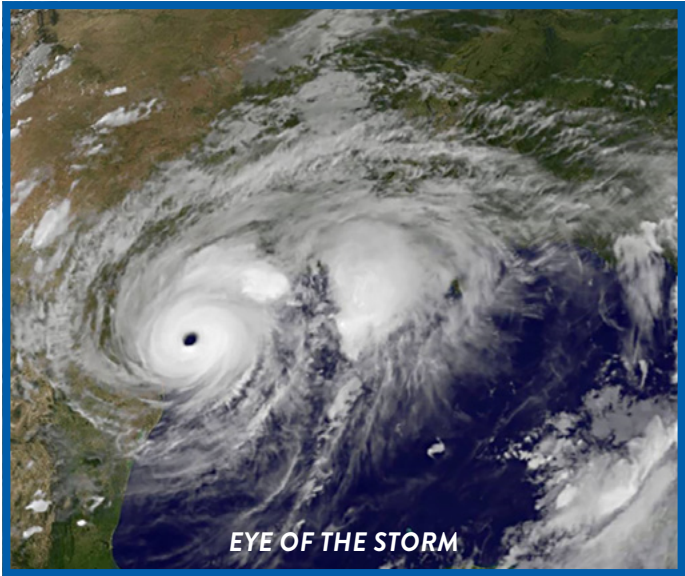
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- *BTU Analytics; July 2019; based on NOAA VIIRS data aggregated by Sky Truth.*
- *EIA U.S. liquefaction capacity; April 2020.*
- *Reuters; 2017 September 02; Texas refineries restart – after Hurricane Harvey knocks out ¼ of US refining capacity and increased gasoline prices to a 2 year high.*
- *Texas A&M University; 2015; Survey of State Funding Practices.*
- *Texas A&M University; 2017; Texas Ports and Texas exports.*
- *Texas Comptroller of Public Accounts; 2015.*
- *TX RRC 2018 Energy Market Outlook from Commissioner Ryan Sitton.*
- *U.S. DOT & TxDOT reporting data through 2019.*
- *Kinder Morgan; Investor Day; presentation (PDF); 2020 January 29; page 31.*



FLOOD RISK MITIGATION

EXECUTIVE SUMMARY

Roughly 1 in 10 Texans are exposed to moderate or high annual riverine flood risks, which will increase as our population exponentially grows. Eliminating the riverine or coastal flood risks from **extreme** storm events is impossible, but local communities and state leaders are taking initiatives to reduce flood risks through better planning, improved asset management, and new bonding measures for funding flood risk mitigation infrastructure. Greatly influenced by the Governor’s Commission to Rebuild Texas November 2018 report entitled “Eye of the Storm,” in 2019 the Texas Legislature passed significant legislation initiating the State Flood Plan and increasing funding by over \$1.8 billion for new, statewide flood risk mitigation. The State identified three key pillars of comprehensive flood risk management: 1) mapping, 2) planning, and 3) mitigation. However, as documented in the Texas Water Development Board (TWDB) 2019 *Texas State Flood Assessment Report to the 86th Texas Legislature*, the magnitude of Texas’ need is significant, exceeding \$31.5 billion over the next decade.



EYE OF THE STORM

BACKGROUND

From 2015 to 2019, Texas experienced 11 presidentially-declared disasters associated with flooding induced by hurricanes and severe storms, including Hurricane Harvey in 2017. These events impacted more than 76% of the state’s population, nearly 21 million people. Hurricane Harvey is the second-most costly storm to hit the United States, causing about \$125 billion in damage and 82 deaths. As a result, 2017 is the most expensive year on record for disasters in the United States.

The TWDB evaluated the state’s flood risks and needs as documented in the *2019 Texas State Flood Assessment Report to the 86th Texas Legislature*. This provided an initial statewide assessment of flood risks in Texas, an overview of roles and responsibilities, an estimate of flood mitigation costs, and a synopsis of stakeholder views on the future of flood planning. It recommended three pillars of investment by the Texas Legislature:

- Improved and updated flood mapping and modeling;
- Coordinated watershed-based planning; and
- Mitigation efforts, such as policy enhancements, increased technical assistance, and financial assistance for project implementation.

Traditionally, local communities have the primary responsibility to prepare for and mitigate flood impacts using local funds and, sometimes, federal funds through the U.S. Army Corps of Engineers (USACE) or Federal Emergency Management Agency (FEMA). For coastal areas, the USACE and Texas General Land Office (GLO) are the primary agencies to fund coastal flood protection studies and projects.

CAPACITY AND CONDITION

Flood risk mitigation is an activity undertaken to prevent or reduce the impacts of flood events. Flood mitigation activities can be structural and non-structural. Structural activities include construction of levees, dikes, floodwalls and dams and other channel alterations. Minor structural activities would include green infrastructure, culverts, storm drainage systems, and detention/retention basins. Non-structural activities include public awareness, flood early warning systems, and mitigation plans.

Most communities in Texas use Flood Insurance Rate Maps (FIRMs) prepared by FEMA to communicate local flood risks. As of September 2018, Texas has 1,280 communities that participate in the National Flood Insurance Program (NFIP), while the State itself does not participate. The TWDB houses the State Coordinator’s Office for the NFIP in Texas and is responsible for aiding, advising, and coordinating the efforts of local communities wishing to participate in the program.

Flood control design, management, and planning are typically based on statistical analyses of available historic rainfall data for a given geographic region. Roughly 1 in every 10 Texans is exposed to moderate or high risk of riverine flooding each year; coastal flooding is projected to become the costliest weather-related hazard to the state; and **more than half of recent flood insurance claims occurred in areas outside high-risk flood zones**. FEMA’s FIRMs show the boundary of inundation for the 1% annual chance flood event – commonly referred to as the 100-year flood and often misinterpreted as the line between safe and not safe. The use of the term “100-year storm” has been debated because it implies that a rainfall event of such magnitude will happen only once every 100 years, but it actually represents a 1% probability of the event being equaled or exceeded in any given year. Many Texas communities have outdated FIRMs that are not based on the most current topographic, land use, or rainfall data. Therefore, to protect these areas, updated FIRMs should be used to determine the appropriate type of flood risk mitigation infrastructure and resources allocated to implement it. While FEMA maps still require updating, localized initiative throughout the state, like that in Harris County, demonstrates leadership and planning through updating flood risk maps to expedite the use of state and federal funding for construction of flood risk mitigation projects.

Approximately 15% of the country’s flood policies, insurance coverage, and premiums are for Texas properties, ranking our state second in the nation. Flood insurance is the best way to be financially protected from losses caused by floods.

According to FEMA, there are approximately 760,000 flood insurance policies in Texas as of July 2019. The total flood insurance coverage (including both building and contents) in Texas is valued at \$2.16 billion. Since 1978, FEMA/NFIP has paid 371,264 claims at \$16.14 billion in Texas – approximately 23% of the total dollars paid by FEMA for flood claims in the United States.

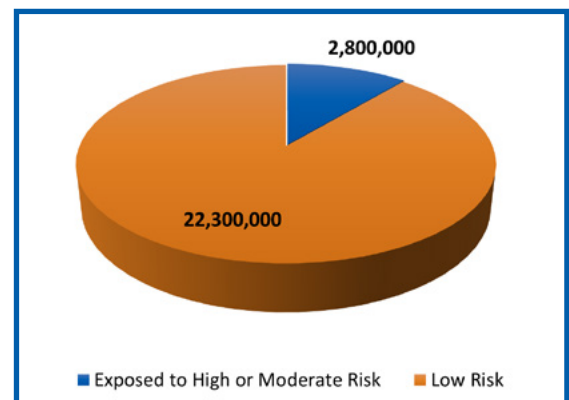


FIGURE 14. Population of Texas at Risk of Riverine Flooding, Based on available Flood Insurance Rate Maps (FIRMs) and 2010 Census.

Flood risk in Texas is significant in comparison to other states. Hurricane Harvey accounted for 76,257 flood claims and \$8.91 billion paid by FEMA. Texas ranks second in the nation to Louisiana in terms of dollars paid for flood claims.

USACE and the GLO are examining the feasibility to reduce flooding risks in coastal Texas counties. A Texas coastal study is being conducted to identify needs and recommendations, such as the Coastal Storm Surge Barrier, to protect our coastal communities and critical assets from hurricanes and tropical storms.

FUNDING

Funding is the greatest need for Texas communities to implement flood mitigation projects (2019 *Texas State Flood Assessment Report to the 86th Texas Legislature*). The anticipated statewide flood mitigation costs over the next 10 years are more than \$31.5 billion. The TWDB estimates local communities may need access to \$18 to \$26.6 billion in financial assistance for these projects.

Texas communities traditionally receive flood mitigation funds through FEMA Hazard Mitigation Assistance (HMA) Grants. From 1989 through 2019, HMA programs provided approximately \$1.47 billion to Texas in response to natural disasters, such as tropical storms and hurricanes.

In the past few years, unprecedented levels of federal investment in disaster response and recovery is provided in support of “mitigation” activities to protect our communities from the predictable damage of future flood events. In response to the 2015, 2016 and 2017 disaster declarations, the U.S. Department of Housing and Urban Development (HUD) allocated over \$4.3 billion in HUD Community Development Block Grant Mitigation (CDBG-MIT) funds to Texas in 2019.

In 2019, the 86th Texas Legislature also responded by passing several bills entrusting the TWDB with new responsibilities related to flood planning and financing in Texas including the creation of the Texas Flood Infrastructure Fund (FIF) and Texas Infrastructure Resiliency Fund (TIRF). Over \$1.8 billion was appropriated by Senate Bill 500 for flood related initiatives to TWDB and other agencies including Texas General Land Office (GLO) and Texas Department of Emergency Management (TDEM) for flood related initiatives. Statewide regional planning is on-going to create the first State Flood Plan by 2024. At the time of this report, TWDB is accepting applications from communities for flood planning and project financing under the \$793 million FIF.

After Hurricane Harvey, large metropolitan areas in Texas passed flood control bond referendums. These include:

- Harris County - \$2.5 billion
- Fort Bend County - \$83 million
- San Antonio - \$550 million (\$139 million dedicated to drainage and flood control projects)
- Dallas - \$1.05 billion (\$49 million dedicated to flood protection and storm drainage facilities)

Flood and drainage infrastructure funding for communities in Texas are traditionally available through bonds and general revenue funds (ad valorem and sales taxes). 31 of 40 cities in Texas with populations greater than 100,000 have a stormwater utility, based on the 2019 *Texas State Flood Assessment Report*. The statewide average stormwater fee is \$4.28 per month. In Houston, Build Houston Forward Program is a dedicated, pay-as-you-go fund to invest over \$20 billion to rebuild and maintain the City’s drainage and street infrastructure.

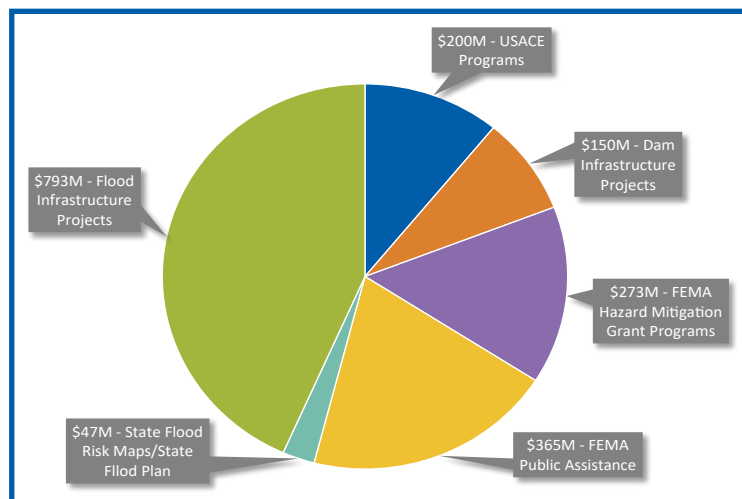


FIGURE 15. Senate Bill 500 Funding Allocation.

FUTURE NEED

Engineers and scientists are predicting more severe weather patterns in Texas resulting from climate change and sea level rise. Therefore, planning will be of the foremost importance to reduce statewide flood risks, address drainage needs, and determine appropriate investment strategies.

Hurricane Harvey produced the highest rainfall totals for an individual storm recorded in the contiguous United States. Within a four-day period, the storm produced rainfall of 60+ inches over southeastern Texas. Rainfall values are used for infrastructure design and planning activities. They also help delineate flood risks and manage development in floodplains for FEMA's NFIP.

The U.S. Army Corps of Engineers, in partnership with the Texas General Land Office, began an examination of the feasibility of constructing projects for coastal storm risk management and ecosystem restoration along the Texas Coast. The Coastal Texas Protection and Restoration Study, also known as the Coastal Texas Study, involves engineering, economic, and environmental analyses on large-scale projects, which may be considered by Congress for authorization and funding.

In 2018, NOAA updated rainfall frequency values for Texas (NOAA Atlas 14 Volume 11). The new data shows increased rainfall values throughout the state that will result in changes to the rainfall amounts that define 100-year events. Urbanized areas of Texas will need updated floodplain mapping using this new data to better understand their flood risk and more accurately plan and design infrastructure to minimize the threat of flooding. TWDB estimates for creating FEMA regulatory flood risk maps (FIRMs) following FEMA's phased approach for riverine flooding in all Texas watersheds could cost up to \$604 million.

Significant federal and state investment in flood mitigation for Texas will require coordinated watershed-based flood planning and technical assistance to communities. Mitigation without proper mapping and coordinated planning may be ineffective, or worse—intensify flood impacts in upstream and downstream communities.

To address the concern that a growing population places on flood risk mitigation infrastructure, building standards and flood risk mitigation regulations are continually becoming more stringent. Protective policies have been put in place that incorporate smart growth and new principles in urban planning to protect this growing population.

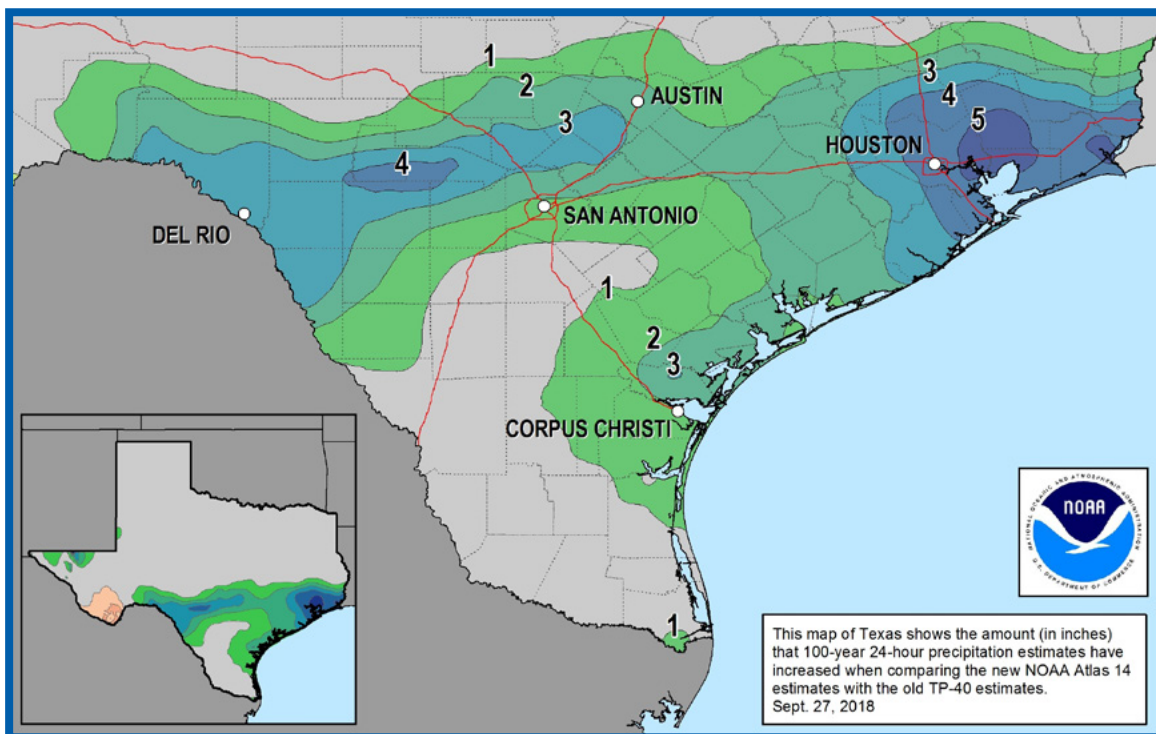


FIGURE 16. The 100-year rainfall estimates increased anywhere from 1 to 5 inches for a 24-hour storm. Source: NOAA.

OPERATIONS AND MAINTENANCE

Local communities, special districts, drainage districts and TxDOT are generally responsible for operations and maintenance of their communities' flood risk mitigation infrastructure. Asset management is playing a vital role in operation and maintenance of drainage systems using geographic information systems (GIS) technologies. Considering the new, significant investments in flood control infrastructure planned statewide, increased demands will be placed on communities to adequately fund operations and maintenance for these projects. On average, local communities with defined flood management activities spend roughly 49% of their local funds on operation and maintenance for flood risk and drainage infrastructure.

PUBLIC SAFETY AND RESILIENCE

Over the past five years, Texas had the most weather-related deaths in the United States. There were 180 flood-related deaths from 2015 to 2019, approximately 58% of which occurred while driving. The Texas Department of Transportation (TxDOT) states that flash flooding is the leading cause of weather-related deaths in Texas. Hurricane Harvey in 2017 was directly responsible for 68 deaths, the largest number of direct deaths from a hurricane in Texas since 1919.

Initiated in early 2020, Texas stakeholders were given the opportunity to determine the best flood mitigation strategies for each region through flood planning initiated by TWDB. Flood planning regions correspond with 15 major Texas rivers and coastal basins. The first State Flood Plan for Texas is due to be completed by September 2024. The Coastal Texas Study recommendations will enhance resiliency in coastal communities and improve our capabilities to prepare for, withstand, recover, and adapt to coastal hazards including inland inundation from storm surge.

INNOVATION

Scientific and engineering advancements in computer simulation modeling using two- and three-dimensional hydraulic modeling will better define floodplains. This is accomplished using detailed terrain models acquired through the collection of Light Detection and Ranging (LiDAR) data. In addition, flat topographic areas such as Houston and coastal communities are using advanced modeling techniques to understand localized flooding associated with urban drainage systems in flood-prone areas outside the mapped floodplain.

NOAA River Forecasting Centers, National Weather Service (NWS) and U.S. Geological Survey (USGS) are advancing their flood predictions and flood warning capabilities through real-time river flood forecasting and flood inundation mapping. USGS stream gauges and stream monitoring provide valuable data for government and academic research. Such information is used to provide flood solutions and improve drainage infrastructure in communities.



PHOTO: BRAYS BAYOU FLOOD REDUCTION PROJECT, CONTROL STRUCTURES (PROJECT BRAYS); HARRIS COUNTY FLOOD CONTROL DISTRICT; CIVILTECH ENGINEERING, INC.



RECOMMENDATIONS TO RAISE THE GRADE

Texas has a singular opportunity to make a noteworthy impact on the flood risk reduction and stormwater drainage infrastructure improvements within the state, and significantly reduce future problems with development. Specific recommendations are listed below:

- The State's current plan needs to emphasize the implementation of infrastructure projects as a result of the ongoing planning effort by TWDB and GLO.
- Increase coordination across local, municipal, and state authorities to facilitate watershed-based flood risk reduction planning and to provide technical assistance to communities.
- Flood mitigation planning leads to a perception of "analysis paralysis" by the public. Therefore, a blend of shovel ready and planning projects is recommended to show public dollars at work.
- Revenue sources need to be identified and have dedicated Operations and Maintenance Funds. Facilities need to be maintained or failures can occur; therefore, robust vetting of the O&M Funds should be undertaken to prevent maintenance shortfalls in the future.
- Flood mitigation designs need to consider environmental and climate impacts, sea level rise, subsidence, future population growth, and other factors.
- Continue to update FEMA FIRM maps using the most recent scientific data, updated models, and updated rainfall rates for all watersheds in the state.
- Continue to educate localities and the public on the benefits of the FEMA National Flood Insurance Program (NFIP).
- Work with communities to minimize development in identified flood hazard zones and at-risk areas.
- Encourage localities to explore the broader use of stormwater retention and detention strategies, including green infrastructure, regional systems, and public/private partnerships.
- Encourage localities to revisit, create and/or enforce development standards which consider alternative design practices and current rainfall values as presented in NOAA Atlas 14.
- Continue to ensure financial assistance is available for implementation of flood mitigation and stormwater drainage projects.



Definitions

NFIP: The National Flood Insurance Program (NFIP), managed by the Federal Emergency Management Agency (FEMA), enables homeowners, business owners and renters in participating communities to purchase federally backed flood insurance.

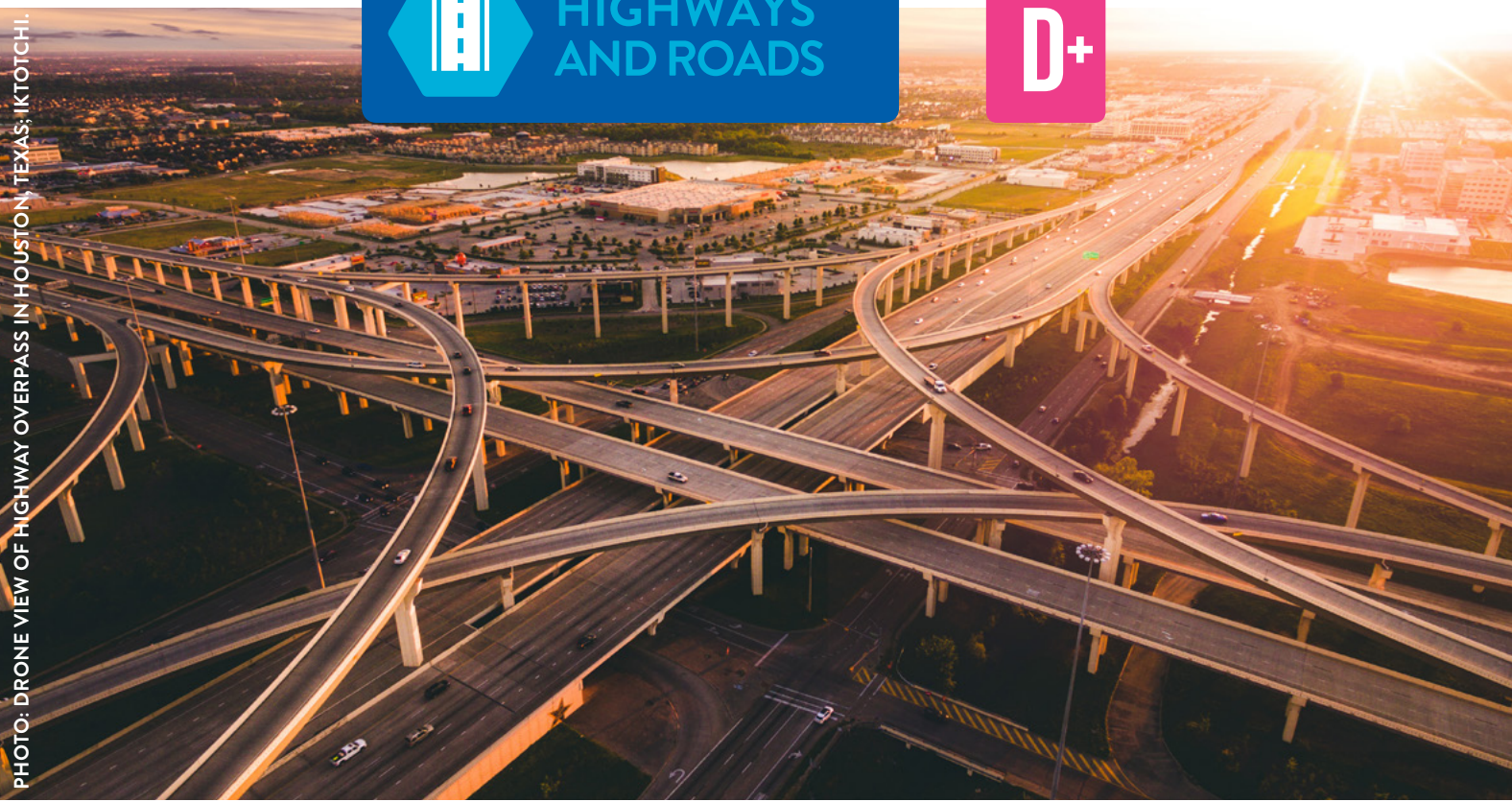
Mitigation: Can broadly be described as actions taken to protect communities from the predictable damage from future events.

Nonstructural Measures: Home buyouts, floodplain preservation, raising buildings (elevation), flood-proofing, flood insurance which activities alter the impact or consequences of flooding and have little to no impact on the characteristics of the flood.

Structural Measures: Channels, dams, reservoirs, detention ponds, levees and floodwalls which activities alter the characteristics of the flood and reduce the probability of flooding in the location of interest.

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HIGHWAYS AND ROADS

EXECUTIVE SUMMARY

Texas’ highway network is the nation’s largest and critical to our economy. The State’s economic growth depends on the efficiency, reliability, and safety of our highway system, supporting individual mobility, commerce, and industry needs. From 2015 to 2020, Texas’ population grew by nearly 9% and roadway conditions saw modest improvements pointing to positive outcomes and a continued need for infrastructure expansion and updates. From 2010 to 2016, daily vehicle travel rose nearly 16%, resulting in many Texas motorists are seeing increased delays, limited roadway capacities, and deteriorating conditions. Auto commuters in Austin, DFW, and Houston face significantly more congestion than the national average. The average Texan spends 54 hours in traffic at a cost of \$1,080 annually.

However, current funding levels and resources from the state’s gas tax are inadequate to keep up with Texas’ projected growth, leaving a \$15 billion annual gap through 2040. While some of Texas’ urban centers are seeing trail and bikeway improvements and voters supported transportation funding increases in 2014 and 2015, a continued, collaborative effort from the public, state legislators, and professionals is needed to “keep the foot on the gas” in guiding the state’s roads in the right direction.

CONDITION AND CAPACITY

The State of Texas has more roadway lane miles than any other state, with 679,917 total lane miles per the Federal Highway Administration (FHWA). Table 9 outlines the roadway classification and the corresponding lane miles across the State. With the amount of lane miles, Texas Comptroller data shows Texans are driving more than ever. Due to growing cities and urban sprawl across the State daily vehicle travel rose 100 million miles, or 15.5%, from 2010 to 2016.

The 2019 Reason Foundation’s Annual Highway Report presented a troubling finding for the condition of America’s highway system — our nation’s freeways are deteriorating, and interstate pavement and roads are in much need of repair. In Texas, however, the percentage of lane miles in good or better condition has modestly improved in recent years. Based on data submitted for 14 categories, including disbursements, pavement conditions, and fatality rates, Texas’ roadway condition results in its rank as 23rd in overall performance.

Many Texas motorists are seeing increasing delays from traffic, limited roadway capacities, and deteriorating condition. The Texas A&M Transportation Institute (TTI) identified the most congested roadways across the State. Three of the top five segments are in the Houston area, with the most congested segment having a total of 1,407,760 annual hours of delay per mile resulting in a sum of \$105,116,332 annually in congestion costs. The Austin and Dallas/Fort Worth areas have the two of the top 5 most congested areas.

Congestion and delays are not confined to on-system interstates or highways. Table 10 shows the 2019 Urban Mobility Scorecard, published by the TTI, reporting that three of our largest cities face significantly more congestion than the national average, with the average auto commuter spending 54 hours in traffic and wasting 21 gallons of fuel due to congestion at a cost of \$1,080 in wasted time and fuel (annual cost per commuter).

Roadway Classification	Total Lane Miles
Interstates	16,604
Freeways and Expressways	7,390
Arterials	98,776
Collectors	138,409
Local Roads	418,738
Total	679,917

TABLE 9. FHWA Functional System Lane Length for Texas; 2017.

OPERATION AND MAINTENANCE (O&M)

By prioritizing preventative operations and maintenance approaches, TxDOT has begun to address the many facilities throughout the Texas transportation system that have exceeded their design life and no longer meet current design standards. Improving these facilities becomes increasingly costly as pavement deteriorates and design standards improve. TxDOT’s “Condition of Texas Pavements PMIS Annual Report FY 2017-2020” states the percentage of lane miles across Texas in “Good or Better Condition” has increased to 88.80% from 87.98%. This can be attributed to TxDOT’s commitment to Strategic Goal #6 in their 2019-2023 Strategic Plan to “Preserve our Assets and deliver preventive maintenance across their system and capital assets to protect our investments.”

City	National Ranking for Annual Delay per Auto Commuter	Annual Delay per Auto Commuter (Hours)	Annual Costs of Congestion per Auto Commuter
Houston	9	75	\$1,508
Dallas/Ft. Worth	13	67	\$1,272
Austin	14	66	\$1,391
San Antonio	34	51	\$964
El Paso	70	41	\$794
Beaumont	70	41	\$718
Corpus Christi	80	38	\$745
Laredo	93	32	\$593
Brownsville	96	29	\$571
National Average	N/A	54	\$1,080

TABLE 10. 2019 Urban Mobility Scorecard.

FUNDING

The federal government is a major source of funding for the construction of highways through the federal Highway Trust Fund and competitive grant programs for specific projects, like Better Utilizing Infrastructure to Leverage Development (BUILD). State and local governments are responsible for the O&M of highways (except for roads on federal lands).

Federal investment in highways has historically been paid for from a dedicated, user fee-funded source, the Highway Trust Fund. The tax of 18.4 cents per gallon for gasoline and 24.4 cents for diesel has not been raised since 1993, and inflation has cut its purchasing power by 40%. Additionally, continued improvements in vehicle fuel efficiency and the popularity of hybrid and electric vehicles reduce the demand on motor fuels. It is commonly accepted that the gasoline and diesel tax cannot fund the State's future infrastructure needs, but the political will to push toward raising the tax or coming up with a funding alternative has not materialized.

Texas voters have approved multiple measures to help support the State Highway Fund. Texas recently attempted to shore up highway funding with Proposition 1 and Proposition 7 in November 2014 and 2015 elections, respectively. These measures can provide up to \$2.5 billion in sales tax revenue annually if fully allocated, and severance tax revenues estimated at more than \$700 million annually during the next two years. Proposition 1, which authorized a portion of existing oil and natural gas production taxes (also known as severance taxes) to be divided evenly between the Economic Stabilization Fund (ESF) and the State Highway Fund (SHF) and may only be used for constructing, maintaining, and acquiring rights-of-way for public roadways other than toll roads. Proposition 7, which authorized a portion of sales and uses taxes as well as a smaller portion of motor vehicle sales and rental taxes may only be used pursuant to the Texas Constitution, the funds may only be used for constructing, maintaining, and acquiring rights-of-way for public roadways other than toll roads.

The state's motor fuels tax revenue is typically the largest funding source for highway construction in Texas. Fluctuations in oil and gas production, such as the sudden and dramatic disruption caused by the 2020 global pandemic affect Proposition 1 deposit amounts and create uncertainties in highway funding. Highway funding from motor fuels tax and Prop 1 money from oil and gas production taxes will likely take a dip in the state's current fiscal year ending August 31, 2020. The next budget cycle could be affected even more, according to Texas Comptroller Glenn Hegar, in a presentation to Associated General Contractors (AGC) on May 6, 2020.

Gas tax funds "traditionally have held up a little bit better during downturns than other revenue sources. They're getting hit hard right now because of the lockdown, but we do expect they will rebound pretty quickly." The comptroller underscored the uncertainty of these early projections, which will change based on the duration of the impacts, public health response, development of treatments, vaccine developments, and longer-term data.

FUTURE NEED

Because the U.S. has been underfunding its highway system for years, the backlog of highway and roadway capital needs have grown. Most of the backlog includes repairing existing highways, system expansion, and system enhancements (which includes safety enhancements, operational improvements, and environmental clearance).

The infrastructure backlog also amplifies the need for actions as the state's population and daily vehicle miles traveled are both on the rise. TxDOT's Texas Transportation Plan 2040 includes an investment of \$396 billion in state and federal funds to maintain, repair and expand the state's roadways by about \$15 billion annually through 2040. TxDOT is in the process of updating to the Texas Transportation Plan 2050.

To help reduce delays in the large metropolitan areas TxDOT has instituted the "Texas Clear Lanes" initiative in 2015 to focus on improving many of the highly congested roadways in the five metropolitan areas: Austin, Dallas, Fort Worth, Houston, and San Antonio. The goal is to complete 40 projects specifically in these major cities by 2028. However, TxDOT anticipates a \$18.15 billion funding gap specifically on these 40 improvement projects highlighting only a portion of the state's overall funding shortfall.

PUBLIC SAFETY

The number of traffic fatalities decreased from 3,727 in 2017 to 3,639 in 2018. However, the fatality rate in Texas of 1.29 deaths per hundred million vehicle miles traveled is still above the national average of 1.14. The number of people killed in crashes involving distracted driving has decreased 12% since 2017, but the number of fatalities in rural areas has increased since 2016. Educational campaigns such as TxDOT's End the Streak (of at least one daily traffic fatality since November 2000) or Talk Text Crash appear to make a difference and seem to be helping, but more safety projects targeted towards rural areas are needed.

RESILIENCE AND INNOVATION

With the threat of climate change, a growing population, and restricted funding avenues there is a strong likelihood of increased service disruptions and damage to existing infrastructure. Without investments and improvements focused on increasing the resilience and expanding innovation in the state's road and highway network, the systems will lag in serving the growing population now and into the future.

TxDOT has implemented several innovative strategies promoted by the FHWA to improve traffic flow and safety. The Traffic Management Centers in the urban districts have upgraded their Intelligent Transportation Systems (ITS) to collect road clearance time and incident clearance time. This data can be used to alert drivers and identify intersections that might require additional improvements. TxDOT continues to investigate and implement alternative roadway delivery methods such as new toll roads and public-private partnerships that have been used over the past few years to facilitate development, provide additional funding mechanism, and speed up project delivery.

Many Cities and Counties are investigating options to expand and improve multi-modal options to improve safety and alleviate demand. The City of Austin has proposed an approximate \$500 million program for alternative transportation which includes improvements to urban trails, bikeways, intersection, and other safety measures.

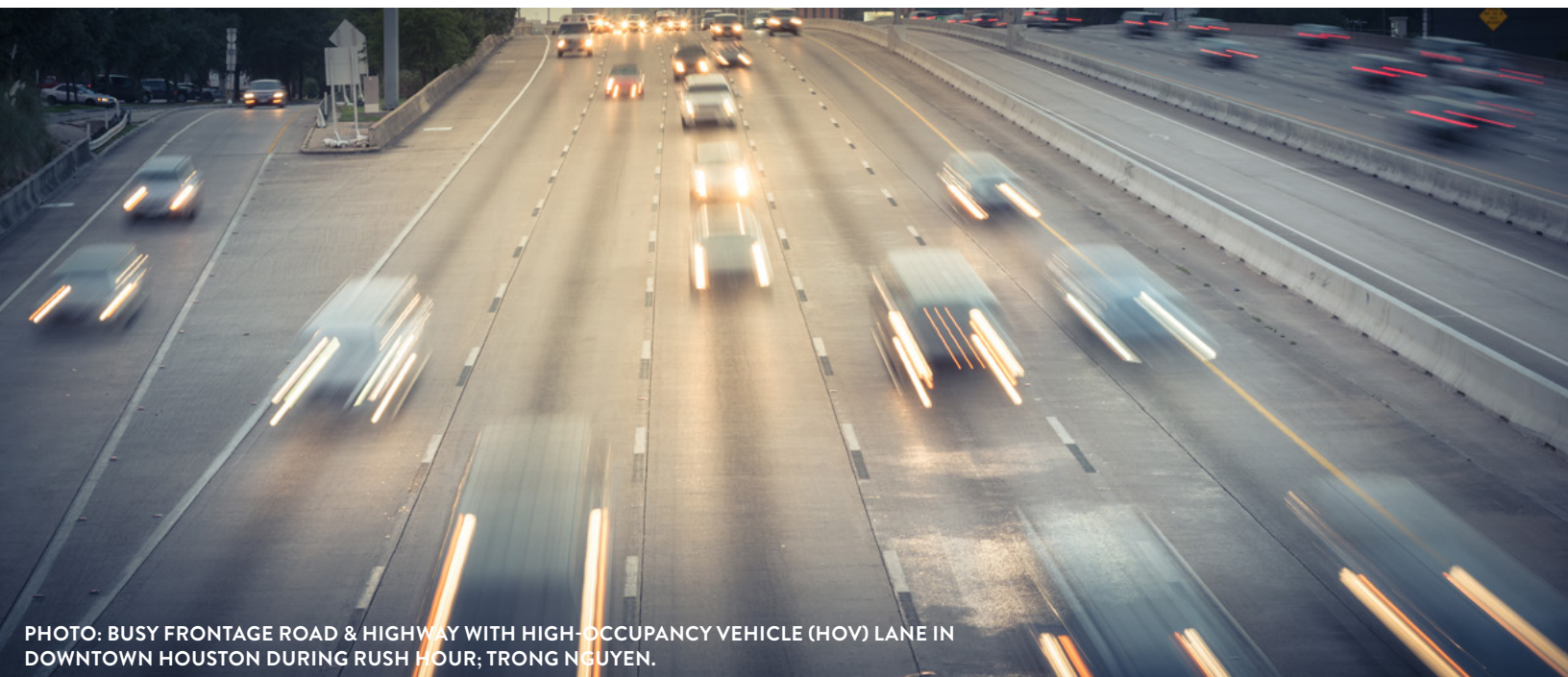


PHOTO: BUSY FRONTAGE ROAD & HIGHWAY WITH HIGH-OCCUPANCY VEHICLE (HOV) LANE IN DOWNTOWN HOUSTON DURING RUSH HOUR; TRONG NGUYEN.



RECOMMENDATIONS TO RAISE THE GRADE

- Increase Texas' Motor Fuel Tax to reflect the required need of the transportation system, or at a minimum index the values to current inflation levels.
- Research and pilot alternative methods to the Motor Fuel Tax, like mileage-based user fees, as a potential long-term source of funding for transportation improvements.
- Leverage managed lanes and toll roads to supplement funding; decrease congestion and stress on the underfunded government agencies.
- Emphasize route maintenance and improvements to maximize funds and utilize technologies that enhance the current road network and develop alternative multi-modal centric transportation system.
- Promote resilience and innovation through funded research and public education toward improved stakeholder involvement and modernized intelligent transportation needs.
- Expand, emphasize, promote, and implement enhanced safety practices toward decreased traffic accidents, particularly in rural areas.
- Leverage promising examples of toll roads and public-private partnerships that have recently facilitated development, provided an additional funding mechanism, and sped up project delivery.



HIGHWAYS
AND ROADS



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LEVEES



PHOTO: USACE GALVESTON DISTRICT LEVEE; USACE.



LEVEES

EXECUTIVE SUMMARY

Many areas of Texas are protected by a system of levees, man-made structures that provide hurricane, storm, and flood protection. There is no state levee program, yet more than 1 million Texans and \$127 billion dollars' worth of property are protected by levees. The Texas 2018 Levee Inventory Report lists 51 U.S. Army Corps of Engineers (USACE) levee systems with 291 miles protecting a population of 291,200 and 276 known non-USACE levee systems with 1,562 miles protecting a population of 707,700. Nearly 90% of the levees in Texas are constructed, inspected, and maintained by local governing agencies that oftentimes lack adequate resources for routine assessments. The average age of the state's levees is 47 years, while the national average is 56. Five levee systems (about 100 miles of levees) out of 41 assessed to date are classified as high to very high risk. Although levee failures in Texas are rare, increasingly frequent and intense storms have recently tested the capacity of the state's levees multiple times. Largely, condition-related data is unknown as most of the levees and the associated consequences from failure or poor performance is not well documented. More than 75% of Texas levee systems are without screened risk classification compared to 81% nationally. Without a clearer picture of the state's levee infrastructure and concerted funding to assist private owners, the vast majority of the state's levees will remain in the presumed deficient status, leaving it impossible to estimate needed funding.

BACKGROUND

A levee is a man-made earthen structure designed and constructed for the primary purpose to provide protection related to seasonal high water, storm surges, hurricanes, significant precipitation, and other weather events. They are normally subjected to water loading for only a few days or weeks during a year. A levee system may consist of one or more levees and their associated structures, such as floodwalls, closure, and drainage devices, which are constructed and operated in accordance with sound engineering practices. Privately owned levees can have multiple owners for the same levee, which can extend for miles. In this report, both *levees* and *levee systems* will be referred to as *levees*.

Levees have been built and used in Texas for over 100 years by various entities, often in response to catastrophic flood events but to date Texas has no state levee program overseeing levee infrastructure safety and quality. Levees are generally designed and constructed to reduce risk by controlling water up to a given elevation. Levee systems do not eliminate all risk, since storm events larger than their design capacity can still occur. Lately, private developers have constructed levees to protect developments for base floods through Levee Improvement Districts. The Federal Emergency Management Agency's (FEMA) National Flood Insurance Program (NFIP) plays an important role in the design capacity of levees by requiring 100-year flood level of protection (1 in 100 annual chance) to avoid high flood insurance rates. Any community seeking recognition or continued recognition of a levee system on a Flood Insurance Rate Map (FIRM) must provide FEMA with data and documentation, certified by a registered professional engineer, showing that the levee system is expected to provide 1% annual flood risk reduction (as compared to baseline). An accredited levee system is a system that FEMA has verified to meet the design, data, and documentation requirements listed within the Code of Federal Regulations (44 CFR 65.10) and can therefore be shown on a FIRM as reducing the base flood hazard.

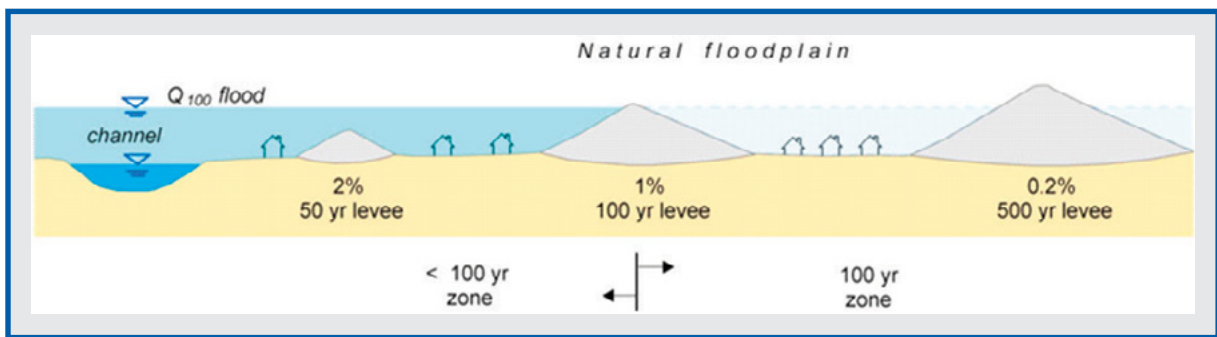


FIGURE 17. Illustration of the 1% annual chance flood and the impact on a natural floodplain with various levee heights. Source: National Research Council of The National Academies; *Levees and the NFIP: Improving Policies and Practices*; 2013.

CONDITION AND CAPACITY

The Texas 2018 Levee Inventory Report lists 51 USACE levee systems with 291 miles protecting a population of 291,200 and 276 known non-USACE levee systems with 1,562 miles protecting a population of 707,700. The average age of the levees maintained by the USACE is about 47 years per National Levee Database (NLD). Figure 18 shows data from the NLD. A small percentage, about 18 %, of levee systems in Texas are built and/or maintained by the USACE while remaining levees are locally owned and operated through Levee Improvement Districts (LIDs) and others. More than 1 million people and \$127 billion dollars' worth of property are protected from design floods, though only a third of the levee systems in Texas are accredited by FEMA.

The USACE Levee Safety Action Classification (LSAC) is one of several tools that are available to better inform all stakeholders. LSAC is a classification system that takes into consideration the existing condition and current and future maintenance of a levee in addition to the consequences if a levee were to fail or be overtopped. The LSAC system emphasizes consequences. LSAC risk categories range from 1 (very high) to 5 (very low). Five levee systems (about 100 miles of levees) out of the 41 levee systems screened to date are classified as high to very high risk based on consequence of failure and condition, as shown in Table 11.

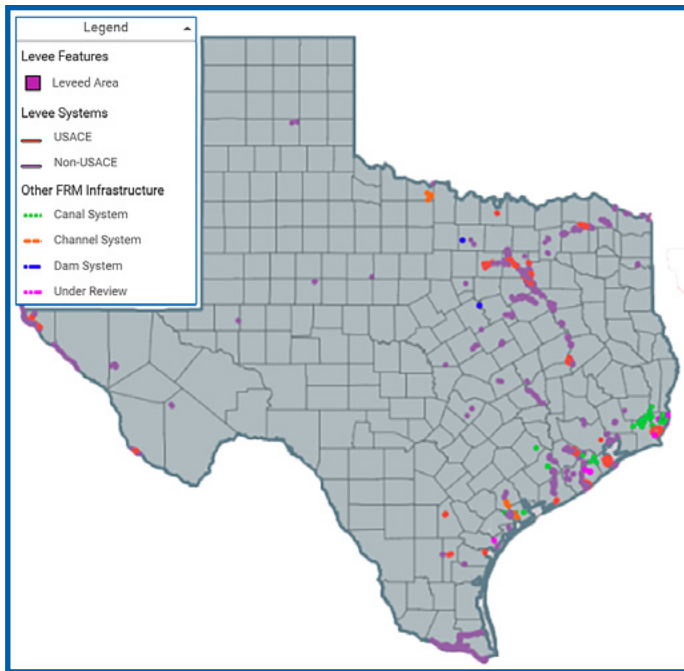


FIGURE 18. Map of Texas levees maintained by the USACE.
 Source: USACE; National Levee Database; 2020.

OPERATIONS AND MAINTENANCE

Regular operations and maintenance is necessary for a levee system to continue to function as designed. Inspection checklists are often used to document appropriate operation and maintenance. These actions are taken to preserve the condition of the levee system and initiate any the corrections to deficiencies that are identified. Over time the soil that makes up an earthen levee can consolidate, slowly lowering the top elevation of a levee. When the levee slopes become saturated, they can slough off or slide. High grasses can hide irregularities in the surface, so levees must be mowed and observed regularly. Water can also find its way along utility pipelines that cross through or under levees, or through permeable strata under the levee. Concrete structures along the levee can spall and crack or settle and rotate resulting in open spaces.

In many cases a special tax district is created to collect funds from the property protected by the levee system to fund operations and maintenance. Special districts are typically named “Levee District”, “Levee Improvement District”, “Flood Control District,” or “Municipal Utility District”, depending on the infrastructure that is included. In other cases, a city or county municipal government takes on the responsibility for operations

and maintenance. Annual funding is typically established at a level adequate to support normal operations and maintenance costs but does not support large capital improvements.

FUNDING

The Rehabilitation and Inspection Program (RIP) is a USACE disaster assistance program that provides for non-federal levee inspections and the repair of levees (and other flood control works) damaged in a flood or natural disaster. While this is not a direct funding program, the USACE’s RIP is accomplished under the authority of Public Law 84-99 and does not require a Federal Disaster Declaration for a levee to receive repair assistance. Furthermore, PL 84-99 has a program that provides ongoing maintenance of levees that were federally designed and constructed. A public sponsor, usually a government entity with authority to conduct assessments for maintenance, can participate in the RIP by requesting the USACE to conduct an initial eligibility inspection of their levee system. The public sponsor must continue to ensure the levee is operated and maintained to minimum RIP standards.

After Hurricane Katrina, the National Levee Safety Program (NLSP) was instituted by the USACE which establishes a shared responsibility with stricter inspection criteria. It is authorized for \$79 million annually but has consistently received only \$5 million each year for the nationwide inventory portion of the program. In FY20, it received triple the amount of funding, \$15 million per year (for the inventory portion). Of the 271 levee systems built throughout the state, approximately 0.6% are constructed, inspected and maintained by the USACE, approximately 9.5% are built by the USACE but sponsored by public agencies, and approximately 89.8% of the levees in Texas are constructed, inspected, and maintained by local governing agencies. A major key to the routine levee inspections is the development of a local asset management plan, to determine the level of need for repair.

After the devastation from Hurricane Harvey dumping over 60 inches of rainfall over the Houston and Beaumont areas in August of 2017, an unprecedented amount of federal funding has been proposed to protect these areas against hurricane storm surge. In the Governor’s Rebuild Texas request on October 31, 2017, over \$60 billion in projects were proposed, including almost \$17 billion in levee projects. Over \$5 billion has been proposed to raise the levees around Port Arthur and southern Jefferson County and over \$12 billion has been proposed for the Coastal Spine project. Much of the funding currently proposed for levee systems is to repair and improve levee systems in the most vulnerable areas affected by Hurricane Harvey and additional funding is needed to address levee systems in the remainder of the state.

FUTURE NEEDS

Levee systems are usually designed to protect against a 1% annual chance flood event plus 3 feet of freeboard, which is the difference between the top of the levee and the design water surface elevation. When the observed rainfall data statistics are updated, the 1% annual chance rainfall for a watershed can change. For example, in NOAA’s latest statistical rainfall update for Texas called Atlas 14, Volume 11, the 1% annual chance rainfall over a 24-hour period for the Houston area increased by 5 inches, from 13 to 18 inches. The resulting higher water surface elevations in the channels compared to the same top of levee elevations reduces the freeboard of levee systems, potentially to less than the 3 feet design criteria. These levees may need to be raised to restore their design freeboard to be re-certified.

Furthermore, the interior drainage system of levees will increasingly require more attention. For instance, as development occurs in the protected areas by levees, more impervious surfaces lead to more runoff. This runoff is either stored or pumped over the levee into the channel. As more runoff must be handled and levee heights are increasing, pump station improvements will be required to accommodate the evolving needs and keep communities safe.

PUBLIC SAFETY

Levees play a critical role in protecting many Texas communities from dangerous flooding. Approximately 1,900 square miles of land, over 1 million citizens, and more than \$127 billion in property value are protected from flooding by Texas levees. The areas protected by the levees contain many different economic assets such as homes, businesses, schools, and event centers, as well as major downtown areas.

The owner/operators of each levee system should have a levee safety program which includes an Emergency Action Plan (EAP) for breaches and instabilities. It is unfortunate that not all owner/operators have a plan in place or have the funding to implement such a plan. In such cases where there is an absence in a qualified safety program, the NLSP should help develop one to protect public safety. Areas such as the Dallas Floodway levee system have EAP which includes evacuation and repair.

Levee systems in Texas have performed admirably, and failures are rare. A levee in Kaufman County failed during the 2015 floods and in 2017 Hurricane Harvey tested many of the levees in southeast Texas, resulting in several levee failures including the Port Arthur levee system and the Columbia Lakes Levee in Brazoria County. The Kaufman County levee failure resulted from inaction by the owner (a LID), leaving no one to repair critical issues. Although the Texas Commission on Environmental Quality (TCEQ) sent several letters to the owner, the owner could not perform their responsibility due to lack of funds. Due to the large volume of floodwaters conveyed by a levee, when a levee breaches it can quickly inundate the protected area by four to eight feet of water or more, with little time for residents to evacuate. Hurricane Harvey also showed that heavy rainfall can overwhelm the pumping stations that pump stormwater runoff from protected areas into the river, resulting in flooding of protected areas even when the levees do not breach.

INNOVATION AND RESILIENCE

There have been few innovations in levee condition assessment and monitoring systems. With the limited availability of conditional data, it is difficult to determine the resiliency of Texas levee systems. Understanding current conditions is critical as these systems continue to age and as more extreme precipitation events are anticipated in the future.

System	LSAC Risk	Year Completed	Miles (Approx.)	Population	Structures	Property Value
Texas City Hurricane Flood Protection	Very High	1987	22	15,370	4,965	\$1 Billion
Port Arthur Hurricane Flood Protection	Very High	1982	29	35,600	11,439	\$1 Billion
Freeport Hurricane Flood protection	Very High	1981	44	16,000	17,572	\$560 Million
East Dallas Levee Trinity LB	High	1959	12	91,400	2,650	\$3.6 Billion
West Dallas Levee Trinity RB	High	1959	11	23,500	6,350	\$821 Million

Note: More than 75% of Texas levee systems have not been screened for LSAC risk classification.

TABLE 11. Texas levees classified as high to very high risk. Source: USACE; Levee Safety Action Classification; 2020.

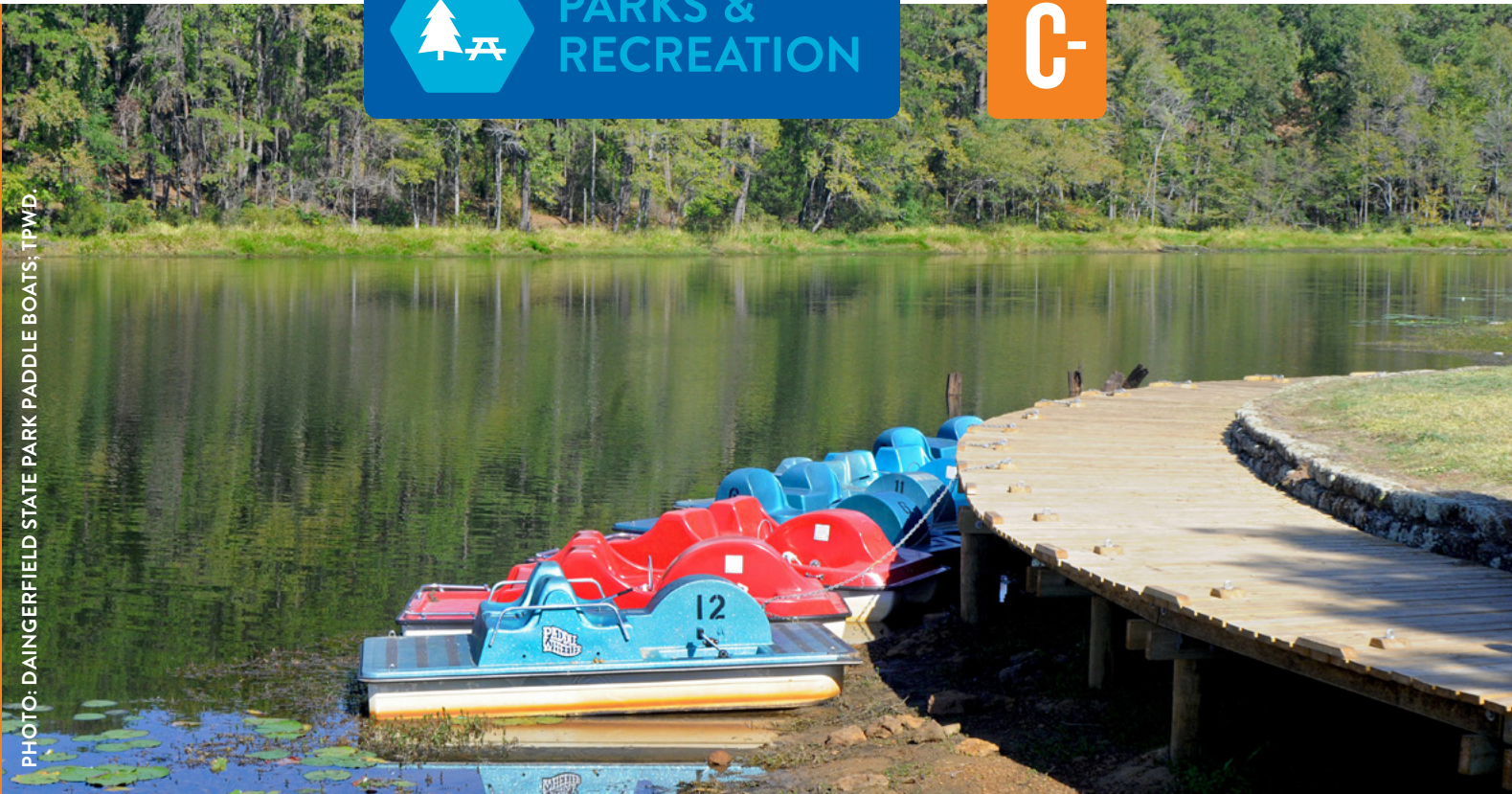


RECOMMENDATIONS TO RAISE THE GRADE

- Urge Congress to fully fund the National Levee Safety Program and urge the Texas State Legislature to establish a state Levee Safety Program within TCEQ, patterned after the Dam Safety Program, to identify and track the status of Texas' levee systems.
- Partner with levee system owners to provide more funding to the USACE to perform LSAC screening on more of the levee systems to identify problems earlier.
- TCEQ should conduct workshops as part of its Levee Safety Program for owners to provide training on the best practices for levee operations and inspections.
- Educate the public living in areas protected by levees about their residual risk, by conducting a public outreach campaign based on the “So You Live Behind a Levee” document and patterned after the “Know Your Watershed” efforts to help the public know what levee protects their home and who operates and maintains it.
- TCEQ should require Emergency Action Plans for all High- and Very High-risk levees in Texas.

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PUBLIC PARKS AND RECREATION

EXECUTIVE SUMMARY

Texas contains some of the most diverse public lands in the country, including 14 national parks and 88 state parks, covering 630,000-plus acres that showcase natural treasures, numerous county and city parks, and many community public green spaces. The Texas State Park System's funding includes multiple allocations and appropriations passed by the Texas Legislature. The Texas Parks and Wildlife Department (TPWD) is the state agency whose mission is to manage and conserve the natural and cultural resources of Texas and to provide hunting, fishing, and outdoor recreation opportunities for the use and enjoyment of present and future generations. The TPWD Fiscal Year 2021 budget is \$444.6 million. These funds are required to adequately operate, maintain, and protect parks. Unfortunately, history shows funding is all too often diverted. Texans, however, passed Proposition 5 in 2019, ensuring that 100% of sporting goods sales tax helps fund TPWD and the Texas Historical Commission (THC). Parks and green spaces energize communities and serve as retreat venues, creating memories and enjoyment of the outdoors. State parks serve as emergency shelters during crisis events, such as hurricanes and floods. Parks also preserve scenic natural treasures and conserve wildlife and their habitats, while allowing the public to enjoy recreational resources. With over 96% of Texas land privately owned, counties and cities depend upon donations to acquire properties and designate it for public use. Proposition 5 funding will help secure the future of local parks, state parks, and historic sites for generations to come. Dedicated park funding is extremely important given the \$800 million remaining in deferred maintenance projects.

CONDITION AND CAPACITY

State parks let us experience nature and preserve Texas history. Texas parks and historical sites include:

- 14 National Parks with 5,569,993 Visitors
- 120* State parks, historical sites, and natural areas (*operated by both TPWD & THC)
- 45 National Historical Landmarks
- 3,800+ Recorded Texas Historic Landmarks

Texas is a big state! When it comes to exploring Texas' historic and cultural treasures, the state is divided into 10 heritage trail regions (with major communities) as part of the THC's Texas Heritage Trails Program:

- **Brazos Trail Region:** Waco, Bryan, College Station
- **Forest Trail Region:** Beaumont, Nacogdoches, Tyler
- **Forts Trail Region:** Abilene, San Angelo
- **Hill Country Trail Region:** San Antonio, Austin, Uvalde
- **Independence Trail Region:** San Antonio, Houston, Victoria
- **Lakes Trail Region:** Dallas, Fort Worth, Wichita Falls
- **Mountain Trail Region:** El Paso, Van Horn, Alpine
- **Pecos Trail Region:** Midland, Odessa, Del Rio
- **Plains Trail Region:** Amarillo, Lubbock, Big Spring
- **Tropical Trails Region:** Brownsville, Corpus Christi, Laredo

County and city parks are owned and administrated by the public under the stewardship of elected officials. Over 96% of Texas, however, is privately owned, requiring counties and cities to depend on private landowners or the financial generosity of the public to acquire land and designate it for public use.

FUNDING

State Parks Funding

The state parks funding is 30.4% of the TPWD FY 2021 \$444.5 total budget, and has multiple allocations and appropriations passed by the Texas Legislature.

Unfortunately, on many occasions parks funding is diverted elsewhere. The TPWD FY2021 budget consists of funding sources that include general revenue funds, special funds, bonds, federal funds, foundations, and grants.

- The General Revenue Fund, or Fund 1; funding consists largely of allocations of sporting goods sales tax; used to fund state and local park-related needs
- Special Fund 9 (Game, Fish and Water Safety) and Fund 64 (State Parks) are the largest contributors; most of Fund 9 allocation is due to the revenue of license, permits, fees, and leases
- Federal funding – apportionments, grants, and contracts
- The remaining budget is made up of other organizations and foundations

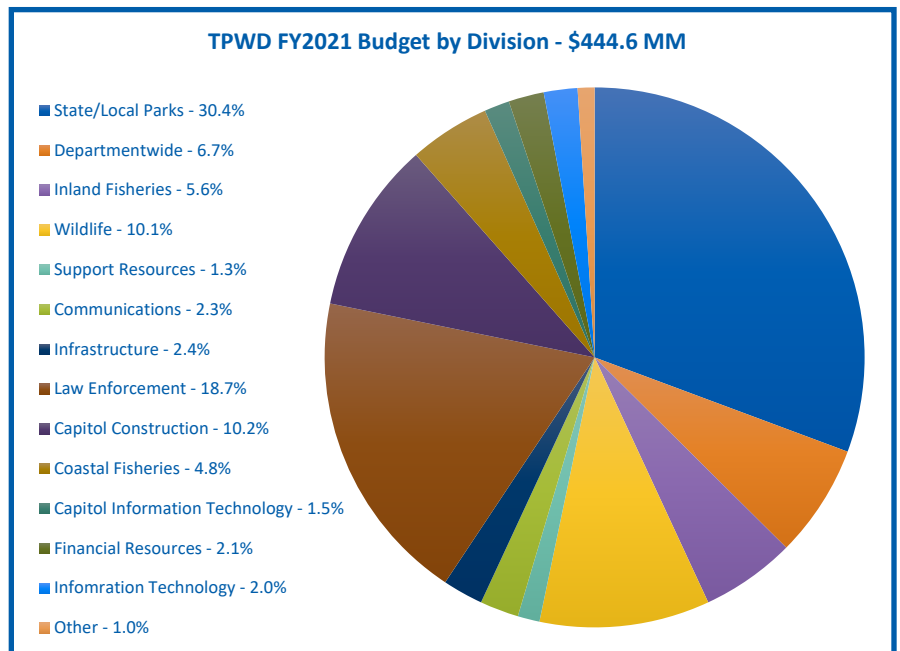


FIGURE 19. TPWD FY2021 budget by division.

Many of these allocation sources are anticipated values that may not be truly feasible since the funds are based on user fees and taxes. Budget shortfalls exist, and the Texas State Park System experiences demand increase and aging facilities which lead to increased operation and maintenance and improvement costs.

Municipal/County Funding

With growing populations, many Texas municipalities and counties are experiencing increased park demand to serve the public. Increased costs and budget shortfalls persist. Certain municipalities and counties have successfully passed bond programs to fund park expansions and improvement projects. These programs help assist in expanding and improving parks but do not contribute to their operations and maintenance budgets, which come from multiple sources such as general budgets, user fees, grants, and state and federal assistance. Even with the benefits these programs provide, many Texas municipalities and counties are seeing difficulties in funding operations and maintenance costs as demand increases and tax revenues are allocated elsewhere.

FUTURE NEED

Greater need exists to offer Texas residents well-planned parks and green spaces designed and constructed with sustainable infrastructure to provide meaningful outdoor experiences. The passage of State Proposition 5 will provide a reliable and sustained source of funding—**without increasing taxes.**

Numerous repair and improvement projects at Texas State Parks have been and are being funded due to the “Sporting Goods Sales Tax”. Examples include:

- Replacing outmoded utility systems and restrooms at many parks (Garner, Caddo Lake and more)
- Repairing roads, dams (Huntsville) and buildings damaged by wildfires (Bastrop) and flooding (Galveston, Goose Island)

And there still is \$800 million remaining in deferred maintenance projects that needs to be addressed in the future based on a capital construction plan created at the request of the State Legislature in September 2018.

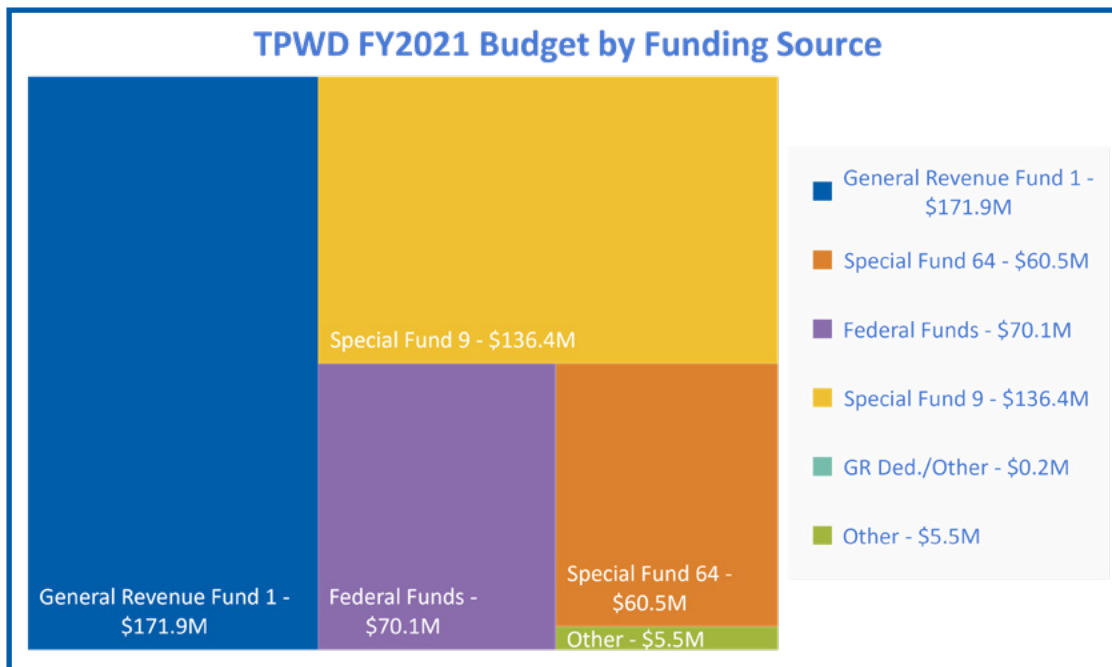


FIGURE 20. TPWD FY2021 budget by funding source.

OPERATIONS AND MAINTENANCE

Texas municipalities are in the process of creating, implementing, and/or revising strategic plans for their parks and recreation departments; with various programs and initiatives to repair, replace, and renovate public parks, facilities, and trails. A strong volunteer presence throughout also saves considerable time and funding for local governments while providing a sense of unity and ownership as residents clean, operate and repair within their capacity. While the strategic plans for improvements are progressive and community involvement in the operation and longevity of parks is critical, there are still noticeable gaps in the number of rehabilitation projects that are proposed but remain unfunded.

Within the TPWD, there has been success in the public’s opinion on the day-to-day operations and maintenance as well as annual goals for minor and major repairs achieved. However, only approximately 18% of the funds required for the estimated \$185M in backlogged maintenance, as noted by the TPWD, have been appropriated through FY2023. With pressing unmet maintenance needs, collaboration in the form of sharing equipment and staff expertise between TPWD and THC has occurred.

PUBLIC SAFETY

Access to parks and outdoor recreation improves quality of life for all Texans. More time spent in parks and green spaces can help individuals combat mental health issues such as depression, anxiety, and stress. In contrast, urban areas without parks and vegetation can negatively impact communities by increasing air pollution levels and urban-heat effect related illnesses and mortality. The 2018 Texas Outdoor Recreation Plan (TORP) recognizes that obesity and healthcare costs are on the rise statewide, partially due to an increasingly “indoor” culture. Well maintained parks and outdoor recreation are critical in helping individuals fight against the mental and physical health issues that Texas faces.

Texas State and National Parks protect much of the clean water on which the public relies. As Texas’ population continues to grow, investment in nature-based infrastructure and conservation of parkland can help conserve and protect drinking water for our communities, economies, and environment.



PHOTO: BLUEBONNETS IN BIG BEND RANCH STATE PARK, TPWD

RESILIENCE AND INNOVATION

Public agencies, community developers, and non-profit organizations are tuned into development of resilience plans for parks and greenspaces that includes steps to educate communities regarding their role to prepare for and minimize the short- and long-term risks caused by natural and man-made disasters as well as sustaining a healthier community.

An approach to achieve urban resilience is to encourage the creation of nature-based infrastructure. This approach increases permeable surfaces for greater soil infiltration, which results in a longer time and a decreased amount of flow to reach the storm drainage system.

Nature-based infrastructure includes:

- Rain gardens
- Green roofs
- Permeable surfaces
- Rainwater harvesting
- Detention basin systems

Nature-based infrastructure in parks help minimize the effects of climate changes due to extreme high temperatures and low moisture levels in the air. Effects include:

- Increased mean sea level elevations
- Recurrent storm events for prolonged periods of time
- Extreme drought conditions
- Wildfires within open lands

Nature-based infrastructure benefits include:

- Minimized flooding resulting from rainfall absorption (50 - 90 %) for storm events with lower intensities
- Replenished aquifers resulting from rainfall infiltration into soils
- Reduction of urban heat effect by the absorption of heat by green spaces in cities during the summer which results in reduced temperatures (10-15o F)
- Captured carbon dioxide by trees and green roofs
- Reduced risk of toxic algae blooms resulting from filtered pollutants which decrease the amount of nutrient laden runoff that enters waterways
- Increased aesthetics added by greenspaces which add value to the communities by improving the quality of life
- Improved water quality and mitigation of floods

The redesign and rehabilitation of parks and green spaces should be focused on the human centric nature of our communities. Post disaster events (e.g. hurricanes, floods, tornadoes, etc.), communities and public agencies should seize opportunities to restore, rebuild and improve neighborhood parks and green spaces. Communities are well served when agencies maximize these opportunities to re-think the land plan and enhance the affected neighborhood with considerations for development or improvement of parks and green spaces.



RECOMMENDATIONS TO RAISE THE GRADE

- **Collaborative Partnerships.** Identify other state programs and partners with similar missions and goals to increase exposure for potential fund grant award opportunities
- **Buy Texas Sporting Goods Advocacy.** Advocate for individuals and groups (e.g. sporting leagues, schools, recreational facilities, etc.) to buy sporting goods in Texas; the state sales taxes collected on those goods help to build new parks and improve and repair existing parks
- **Corporate Sponsorships.** Offer corporate partners an opportunity to support the communities by sponsoring park programs (e.g. nature learning focused on flora and fauna), park events (e.g. health expos, fun-runs, etc.), or infrastructure (e.g. trails, building structures, ponds, etc.)
- **Focus Resilience and Innovation.** Focus on nature based infrastructure will raise the grade by enhancing the Texas environment by supporting minimization of flooding, replenishment of aquifers, reduction of the urban heat effect, capture of carbon dioxide, reduction of the risk of toxic algae blooms in lakes and rivers, increased aesthetics, and improved water quality throughout Texas.

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SOLID WASTE



PHOTO: LANDFILL CELL CONSTRUCTION, EL PASO, TX; PARKHILL

SOLID WASTE

EXECUTIVE SUMMARY

Texans generated approximately 40.2 million tons of solid waste in 2015. Per capita each Texan generated 8 pounds of solid waste per a day, significantly higher than the national rate of 4.5 pounds. That same year, the recycling rate in Texas was 23%, marginally below the national rate of 26%.

The United States Environmental Protection Agency (US EPA) delegates the authority to permit and regulate all municipal solid waste (MSW) facilities in the state to the Texas Commission on Environmental Quality (TCEQ). Solid waste management in Texas is provided by a combination of public and private entities. Texas has a reasonable amount of waste disposal capacity in reserve, with the statewide average of 51 years of capacity in reserve. However, continued population growth will result in an uneven distribution of Texas' reserve waste disposal capacity. While there are parts of the state that have robust recycling collection programs and access to infrastructure to divert material from disposal, there is a significant portion in both urban and rural areas without access to these programs. The application of new solid waste management technology and techniques is very limited in Texas and largely applies to only waste disposal operations, not recycling.

Unlike other infrastructure, solid waste does not receive funding from the Federal government. Texas collects tipping fees from each ton of waste disposed. A portion of these funds are retained in reserves. With a reserve balance of \$112 million, as of January 2020, Texas could fund more innovative and resilient solid waste management practices for public and private industries, stretching existing landfill capacity by increasing reserve spending.

CONDITION AND CAPACITY

In 2018, approximately 37.8 million tons of solid waste was disposed of in Texas MSW landfills with an average disposal rate of 7.2 pounds per person per day, a slight increase from 6.8 pounds in 2017. More recent waste generation rates were not available at the time of this report.

So, how does Texas compare nationally in terms of waste generation? Looking at available data from 2015, Texans generated approximately 40.2 million tons of solid waste or approximately 15.3% of the total 262.1 million tons of solid waste generated nationwide that year. Per capita each Texan generated 8 pounds of waste per a day, significantly higher than the national rate of 4.5 pounds.

Table 12 shows the type and number of active landfills in Texas in 2010, 2015, and 2018. The total number of active landfills did not change significantly during these years. Table 13 shows the total disposal amounts and the remaining waste disposal capacities in Texas in 2010, 2015, and 2018. Largely due to the state’s population growth, the amount of waste increased over the period while the waste disposal capacity decreased.

Table 13 suggests decades of remaining capacity across the state. It is important to note that the excess capacity is not evenly distributed. Some areas of Texas do not enjoy as much future disposal capacity as others. There are 24 Councils of Governments (COGs) responsible for regional MSW management planning. The average reserve capacity of all 24 COG regions was 51 years.

At the time of this report, mandatory recycling data was not available. Recycling facilities in Texas are authorized by TCEQ’s notification process that allows them to operate without a full permit and furthermore, are not required to report quantities to TCEQ. However, a 2015 study on the potential economic impacts of recycling found that Texans recycled 9.2 million tons of MSW designated material.

In 2015, the recycling rate in Texas was 22.7%, marginally below the national rate of 25.9%. During the same year, recycling and material recovery facilities and composting/mulching facilities in the state had an economic impact of over \$3.3 billion. There are currently more than 30 recycling and material recovery facilities and more than 140 composting and mulching facilities.

Although Texas does not have any solid waste incineration facilities, several landfills use a process known as energy conversion to generate electricity from landfill gas.

Type of Landfill	Description of Landfill	Number of Active Landfills		
		2010	2015	2018
Type I	Standard landfill for MSW disposal	97	98	96
Type IV	Accepts brush, construction or demolition waste, and other similar non-putrescible (inorganic or organic waste that will not decay with obnoxious odors causing unhealthy and undesirable conditions)	20	22	23
Arid-exempt (AE)	Located in relatively dry parts of the state; exempt from liner and groundwater monitoring requirements	73	71	69
Monofill	Counties or municipalities with 12,000 or fewer people may obtain a renewable five-year permit by rule; generally accepts demolition waste	0	8	10
Total		195	199	198

TABLE 12. Active MSW landfill numbers and types in Texas in 2010, 2015, and 2018.

Year	Amount Disposed (million tons)	Remaining Capacity (million tons)	Average Remaining Capacity (years)
2010	28.6	1,722.3	60
2015	33.4	1,865.8	56
2018	37.8	1,916.4	51

TABLE 13. Total Disposal Amounts and Remaining Capacities in 2010, 2015, and 2018.

OPERATION AND MAINTENANCE

Permitted landfills in Texas are owned and operated by private entities, publicly traded companies, cities, municipalities, or counties. Landfills can recirculate leachate if they were constructed with a prescriptive liner approved by the TCEQ. For many landfills, this is not an option because the clay liner requirements are expensive to construct. The most common leachate collection and treatment method is via submersible leachate pumps that remove the liquids generated and sends it to an evaporation pond, or a municipal publicly owned treatment works (POTW).

In 1986, there were 790 authorized MSW landfills in Texas accepting waste, but by 1994 there were only 199. The 591 sites that did not upgrade their designs, operating practices, closure requirements, liner requirements and groundwater monitoring were “grandfathered” by the Resource Conservation and Recovery Act (RCRA) Subtitle D standards. These closed sites are not monitored. However, the State did commission a study to identify the locations of closed landfill and there is a statewide inventory of these facilities.

The TCEQ has extensive requirements for the closure and monitoring of landfills that have either reached capacity or are no longer open. The owner or operator is required to install a final cover to the system that is designed and constructed to minimize infiltration of rainfall and side slope erosion.

FUNDING AND FUTURE NEED

Unlike other infrastructure, solid waste does not receive funding from the Federal government. Texas collects tipping fees from each ton of waste disposed. In 2018, the average statewide tipping fee was about \$37 per ton. Larger facilities are capable of self-supporting their costs through tipping and collection fees; however, smaller facilities struggle to break even. Tipping fees are not generally used as an income source for the local governments.

Texas has a state disposal fee of \$0.94 per ton which the Texas Health and Safety Code requires TCEQ to collect and placed into a reserve fund known as FUND 5000. In addition to landfills, incinerators, composters, shredders, and similar facilities pay a state fee. In 2018, TCEQ collected approximately \$33.9 million from all waste disposal sources. Sixty-seven percent of that total is used to fund TCEQ’s solid waste management regulatory operations (FUND 0549). The remaining funds are retained in reserve. As of January 2020, the balance of that reserve was \$112 million. A portion of FUND 5000 is refunded back to regional COG’s. The money is then distributed to fund local solid waste management, recycling, or other waste minimization efforts. Texas could fund more alternative waste practices for public and private industries by increasing the spending out of the reserve fund. This money could further local efforts, such as:

- Encouraging the development of recycling infrastructure;
- Supporting local enforcement projects that contribute to the prevention of illegal dumping; and
- Creating a cleanup fund for illegally dumped tires.

PUBLIC SAFETY

Operational safety is a significant concern for solid waste utilities. According to the Bureau of Labor Statics, solid waste is the fifth most dangerous occupation that they track. A significant amount of a daily operations involves use of large trucks, containers, compactors, etc., all require constant vigilance for worker safety. Larger solid waste facilities utilize an asset management system to track heavy equipment (trucks, dumpsters, carts, etc.), to maintain inventory and to ensure that these assets are maintained, replaced, and removed from inventory on schedule. Some utilities also use a variety of GPS based systems to identify where their assets are in real-time to ensure service delivery and to ensure the safety of their staff.

TCEQ has a robust program that regulates the location, landfill liner protections, and closure processes that serve to protect underground drinking water resources. All landfills are required to monitor for methane, storm water, groundwater, and air emissions to ensure protection of public health and the environment. These sampling and monitoring requirements ensure the proper functioning of the facilities liner system.

Each COG maintains an inventory of closed landfills in their area. This inventory was developed to locate the closed landfill so that any impacts from them could be minimized.

When it comes to sustainability, the TCEQ does not set sustainability requirements for design and/or construction of landfills, and sustainability design processes have not typically been used for existing solid waste assets/infrastructure. However, many communities are individually pursuing sustainability goals. These goals are generally reflected in purchasing practices, design standards for facilities, among other practices. The 24 COGs have 20-year solid waste management plans that all address sustainability, waste diversion, and/or recycling goals. The counties and cities within the COGs have subsequently adopted similar goals.

Most communities in the state have some type of a recycling program ranging from curbside collection to drop-off facilities. Reducing and reusing efforts are largely grown out of education and outreach programs. Additionally, the TCEQ has a statewide program, Take Care of Texas that provides helpful information on Texas' successes in environmental protection and encourages all Texans to help keep the air and water clean, conserve water and energy, and reduce waste.

INNOVATION AND RESILIENCE

Diversion of yard waste and brush constitutes the largest quantity of materials diverted from landfills, accounting for about 36% of the diverted materials in 2018. Landfills that have specific design capacity and a non-methane organic compound emission rate at a specified level must control the methane gas by installation of a gas control and collection system. There are 27 facilities in Texas that utilize landfill gas for beneficial reuse.

Natural disasters can pose a variety of risks to municipal waste collection and disposal facilities. The normal operation of waste collections is disrupted when a community is impacted by a natural disaster, such as a hurricane, and the efforts of the collection operation shift the focus to removal of debris. Debris from a natural disaster can have a large impact on the disposal capacity of the facilities. However, most municipal solid waste operations are quite resilient during disasters.

Though relatively little academic innovation research is conducted in Texas, one bright spot is the University of Texas at Arlington (UTA). UTA's Solid Waste Institute for Sustainability is renowned for its solid waste research program that relies on area landfills to assist in funding.

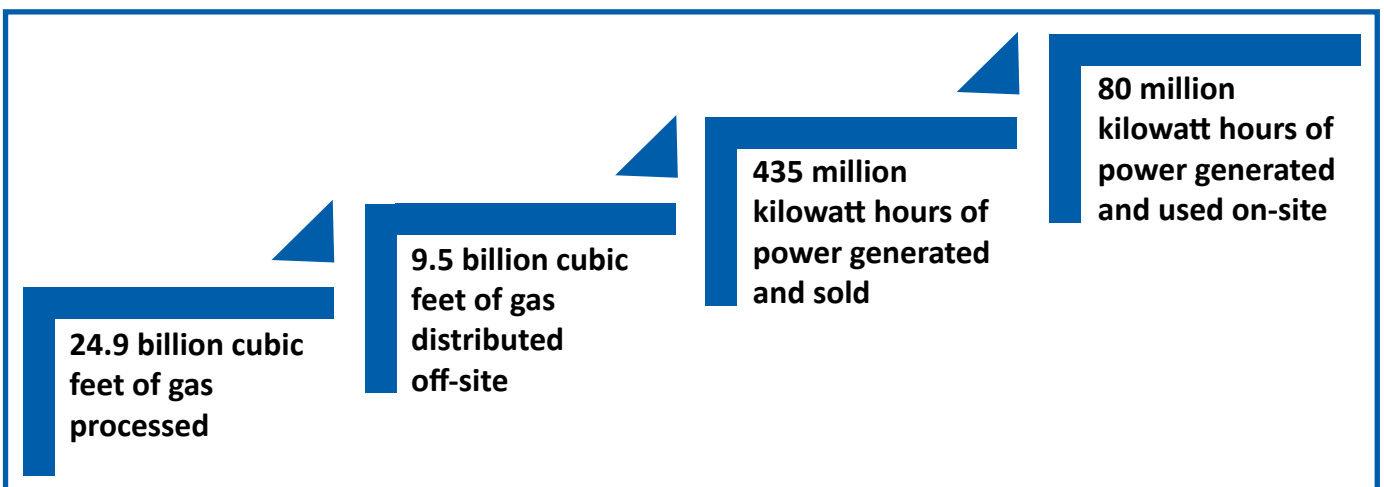


FIGURE 21. Gas collection and control re-distribution path.



SOLID WASTE



RECOMMENDATIONS TO RAISE THE GRADE

- **Sustainable Materials Management (SMM).** Encourage and promote the use and reuse of materials in the most productive and sustainable way across their entire life cycle. SMM conserves resources, reduces waste, and minimizes the adverse environmental impacts of material use.
- **Public policy and public education.** Sponsor more public policy public education programs that focus on reducing waste at its source, recycling, and minimizing disposal amounts to move closer to the national average of waste generation.
- **Innovation.** Develop technologies through funded research for treating and recycling solid waste.
- **Stretch landfill capacity.** Update statewide study on recycling and resource recovery efforts on an annual basis to evaluate progress and adjust processes toward continuing reduction of solid waste disposal to extend existing landfill capacity far into the future.

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TRANSIT

EXECUTIVE SUMMARY

Public transportation (transit) infrastructure in Texas predominantly includes roadway vehicles like buses and vans, while rail lines serve some of the state’s more densely populated areas, namely Austin, Dallas/Fort Worth, and Houston. From 2015 to 2019, reductions in asset failures were seen across the state with metropolitan transit authorities (MTAs) reporting an 8.9% reduction, urban transit systems (UTS) a 7.1% reduction, and rural transit systems (RTS) a 43% reduction. Although transit infrastructure provides safe and effective service—a trend that is expected to continue—the system competes with individually-owned vehicles and users’ preference to drive themselves. However, public support for transit has contributed to growing networks of interconnected urban centers in Dallas/Fort Worth (DFW), Houston, San Antonio, and other areas. These expansions are driven by significant local funding for regional initiatives to match Federal grants, increasing the steady growth in capacity, service type, and system improvements. Maintaining services and expansions desired by Texans will continue to require increased local investment in transit infrastructure.

CONDITION AND CAPACITY

Transit includes all multiple occupancy vehicle services designed to transport customers on local and regional routes. The majority of these services in Texas include private and public buses; vanpools; demand response services; light rail; commuter rail.

Texas Transit data is aggregated according to the following groups:

- MTA serving population centers greater than 200,000 (8 Agencies, eligible for 5307 funds)
- UTS serving populations of 50,000 to 200,000 (31 Agencies, eligible for 5307 funds)
- RTS for populations less than 50,000 (36 Agencies, eligible for 5311 funds)

The condition of the transit assets overall is good, and partially reflected by the decrease in transit vehicle failures in the Fiscal Year (FY) 2015-2019 period: MTA decreased 8.9%, UTS decreased 7.1%, and RTD decreased 43%. While not affecting current performance, challenges include legacy structures on commuter rail lines that will be very expensive to replace (e.g. Stemmons bridge on Trinity Rail Express Dallas-Ft Worth), federal funded systems that do not compliment local investments, and systems installed in the 1980’s that have vehicles approaching rebuild/replacement time lines.

The relatively young age of much of the rail infrastructure has provided a recent period of good condition and reliability. As the system ages, the need to rebuild portions of the guideway system and replace critical power systems, control systems, and vehicles will drive the need for more local and federal investment to preserve the assets.

Buses have become increasingly reliable. As demonstrated by generally decreasing numbers of transit vehicle failures while in service, bus condition has been sustained through the federal bus replacement programs and effective maintenance programs. Changes in funding may keep aging fleets on the roads longer which will significantly affect vehicle condition and service.

OPERATIONS

Key operations statistics include ridership (unlinked trips), operating costs (cost per revenue hour) and service provided (vehicle revenue miles). The Table 14 shows the trends in the FY15-FY19 period.

These continuing trends provide great challenges to agencies regarding affordability from increased costs of routine operations and maintenance as well as the need for system expansions and improvements.

MAINTENANCE

The maintenance of transit assets is the responsibility of each agency. While each agency has its own processes for maintaining assets and reducing its backlog, the Federal Transit Administration is implementing the Transit Asset Management system to provide a standardized measure of asset conditions across the country. Once fully implemented for a period of a few years, the trends are expected to reveal actionable data for funding decisions. In the intervening period, the Texas trends in declining service failures point to successful practices and procedures.

FUNDING AND FUTURE NEED

Texas is heavily dependent upon federal funding to develop and sustain public transit. Local matches are provided by a combination of local (city or municipal) and state funds. No transit authorities have direct access to ad valorem taxes.

The state’s public transportation systems receive federal and state funding through various programs and from various agencies. Most often funding is administered by, including but not limited to, the Federal Transit Administration, the Texas Department of Transportation, the Texas Health and Human Services Commission, as well as others. In 2019, Federal Funding appropriations (5307-5311) for public transportation in Texas totaled more than \$575 million, an increase from \$562 million in 2018. Additional resources come from the Texas

Agency Type	Ridership	Operating Cost	Service
MTA	-4.8%	-1.0%	-1.0%
UTS	-7.0%	+16.8%	-6.5%
RTS	-23.0%	+10.2%	-1.0%

TABLE 14. Operation trends for fiscal years 2015 to 2019.

Sobility Fund which can be used to develop and fund other mobility options, including public transportation.

MTA's: Urban Area MTA's are funded through sales taxes, ranging from 0.5% to 1% that provide a reliable, if somewhat volatile, funding stream. Current trends toward higher match requirements for capital programs drive the need for increased local investment in capital maintenance programs. Some of the smaller urban areas faced challenges with less reliable funding streams.

- The Houston METRO Next Transit System Plan, approved by referendum on November 5, 2019, provides for system expansion through the next 20 years. The next phase will expand upon the existing Light Rail and Bus Rapid Transit system completed in 2015.
- Dallas Area Rapid Transit (DART) 2045 Transit System Plan reflects doubling the size of their Light Rail Transit system completed in 2015 including the east connection to the DFW International Airport. Core Capacity projects such as the \$1.4 billion second alignment through the Central Business District subway are in the Environmental Impact Study phase. DART is also implementing the Cotton Belt Line (Silver Line) linking DFW airport and the Northeastern suburbs of Plano and Richardson.
- During the FY18, Austin Cap Metro's existing system demonstrated a 4% growth in ridership. Approved by public vote November 2020, Cap Metro's \$7 billion Project Connect Plan will add Light Rail and Bus Rapid Transit.
- Trinity Metro in Fort Worth has expanded their commuter rail system by adding the 27-mile Trail commuter line from Downtown Fort Worth to DFW International Airport Terminal B completing the link to one of the world's busiest airports in 2019. The expansion complements the Trinity Metro/DART Trinity Railway Express that connects Dallas and Fort Worth.

RTS's and UTS's: Most of these systems use annual appropriations for local funding, and the risk of losing these funds is a challenge for long-term planning. The Texas Department of Transportation (TxDOT), responsible for allocating funding for the rural transit programs, has made great strides in funding not only the span of service and frequency of service, but also the comprehensive procurement of small transit vehicles for consistency and greater efficiency. Funds are allocated based on needs and performance throughout the State.

Performance data for all systems indicates the agencies are maintaining the infrastructure at a reasonable level. Current funding levels support the maintenance, but challenges with increased costs to deliver service may force agencies to make decisions regarding the deferral of maintenance activities. Regulatory compliance is confirmed at many levels to include system safety oversight, triennial reviews by an outside evaluator, and Federal Transit Administration (FTA) and Federal Railroad Administration (FRA) requirements. The public transportation agencies in the State of Texas are in general compliance with required regulations.

PUBLIC SAFETY

Transit in Texas has seen a reducing trend of accidents and adverse safety incidents even with generally sustained levels of revenue service. Decreased safety incidents build public confidence and are indicative of good safety performance. Selected elements of aging infrastructure (legacy railroad bridges on commuter rail lines) will pose expensive challenges when replacement is required. To date, these specific elements are regularly inspected, and a safe overall system is maintained.

Positive train control is being implemented in Texas under the requirements of the FRA to prevent over-speeding, mis-aligned switches, worker protection/temporary speed violations and train vs. train collisions. The deadline of December 31, 2020 will be a clear challenge for some agencies, but all are on track to meet the regulatory requirements. All four agencies have (DART, Fort Worth T, Cap Metro, and DCTA) completed the necessary procurements and installations, and currently have system implementation plans under review by the Federal Railroad Administration.

Throughout the State of Texas, in FY19 there were 1,136 safety incidents reported across the state, a slight decline from FY18's total of 1,174 safety incidents. During the same period, reported fatalities increased from 13 to 16, while reported injuries decreased from 1,004 to 966.

RESILIENCE

The transit authorities in Texas work closely with law enforcement/fire agencies to monitor threats and prepare for incidents. The ability to recover from natural disasters has been demonstrated during Hurricane Harvey and the May 2015 flooding in the DFW area. Agencies have learned from these events and applied them to ice storms and other challenges building the institutional infrastructure to safely and efficiently react and respond to events – often working cooperatively between the agencies. Community access is addressed by each agency to best meet the needs of their most vulnerable populations and those most dependent on public transit for basic needs.

INNOVATION

Significant innovations in public transportation have been made over the past several years. Bike-sharing and ridesharing companies have challenged ideas of what public transit can be. Innovative services have fostered expansion and access to traditional public transportation systems by solving the “first mile-last mile problem” for riders who would otherwise find it difficult to get to the nearest transit station or to their ultimate destination after riding transit. Ridesharing companies (like Uber and Lyft) are becoming the preferred provider in many cases.

Many transit operators now provide real-time updates of the location of their vehicles, allowing riders to better time their journeys, resulting with innovative smartphone applications. In some cases, the transit application has incorporated rideshare applications so that the entire trip including first mile-last mile portion is included.

Additionally, Texas is leading in various areas of research and innovation when it comes to transit. For example, innovative initiatives in the planning stage will include the Texas Central Railway, a high-speed rail capable of up to 200 mph speed traveling the 240 miles between Dallas and Houston. A high-speed rail line to travel from the DFW Metroplex to Austin-San Antonio area is also being studied. Furthermore, the City of Arlington has implemented a pilot project using Automated Vehicles to move patrons among the various venues (Six Flags Amusement Park, Globe Life Park and AT&T Stadium) in its entertainment district. Lastly, an example from the private sector’s role in this industry, drive.ai (a subsidiary of Apple that uses artificial intelligence to make self-driving systems for cars) completed a pilot program in Frisco, Texas. North Central Texas Council of Governments (NCTCOG) includes a high-speed transportation study to evaluate innovative DFW area transportation solutions to improve regional interconnectivity in addition to that provided by Amtrak. Concepts being considered include next generation magnetic levitation/vacuum environment (e.g. Hyperloop) and high-speed short route rail systems to improve local transit and automobile traffic conditions.



PHOTO: METRORAIL TRAIN IN DOWNTOWN AUSTIN TRAFFIC, CAPITAL METROPOLITAN TRANSPORTATION AUTHORITY (CAPMETRO); A. KHITROV.



RECOMMENDATIONS TO RAISE THE GRADE

- Gain additional funding from all levels of government in relevant areas that focus on reducing the backlog of rehabilitation needs.
- Create an adequate and reliable federal funding source by fixing the Highway Trust Fund through raising the motor fuels tax and exploring alternative long-term financing mechanisms.
- Foster effective planning and budgeting for maintenance improvements critical to sustaining performance, assuring public safety, maintaining reliability and meeting service expectations.
- Promote asset management best practices to prioritize projects toward improvements in condition, security, and safety while optimizing lifecycle costs and benefits.
- Sustain service levels and condition. As the state continues to grow, the need for transit will grow as well. Positioning the agencies to seize fixed guideway routes and bus hubs in anticipation of this need and transit supported development will pay significant dividends in the future.

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WASTEWATER



PHOTO: MICROTUNNEL MACHINE SETUP, BACHMAN LAKE INTERCEPTOR REPLACEMENT, CITY OF DALLAS, STANTEC CONSULTING SERVICES, INC.

WASTEWATER

EXECUTIVE SUMMARY

Texas has an escalating population that depends on the state’s wastewater infrastructure to protect public health and the environment. Wastewater infrastructure includes a system of pipes to collect wastewater from homes and businesses and a network of treatment plants to clean the water before it is discharged to our rivers and bayous. The condition of these systems continues to decline, primarily because of their age. Federal and State funding is deficient, with a shortfall of more than \$200 million. Local resources for system expansions and planning are limited, and when tested by extreme events, many wastewater systems are not resilient. From 2016 to 2019, the number of sanitary sewer overflows (SSO) more than doubled from 2,500 to almost 6,000. Furthermore, some major municipalities have entered into consent decrees with the U.S. Environmental Protection Agency (EPA) to address SSO. As wastewater system performance decreases, Texas’ lakes, rivers, and beaches continue to suffer poor health due to ongoing threats from SSO. However, some initiatives are helping to curb the wastewater sector’s downturn by increasing SSO reporting and incentivizing fiscal and technical training for Asset Management Program for Small Systems (AMPSS).

CONDITION AND CAPACITY

Wastewater in Texas is generated from households, commercial businesses, and industrial operations. The Texas Commission on Environmental Quality (TCEQ) is responsible for permitting authorized wastewater discharges and monitoring waterways to ensure they meet state and federal water quality standards.

The TCEQ has over 3,100 active individual treatment systems permits. While data regarding the overall condition of wastewater treatment facilities and pipelines is not publicly available, the requests for funding and the increase in SSO generally describe a system in poor condition. Some wastewater treatment plants and collection systems in the state are subject to becoming overwhelmed by heavy rainfall events and stormwater flooding. As a result, the volume of wastewater can sometimes exceed the capacity of the wastewater sewer system or treatment plant and discharge untreated stormwater and wastewater directly to nearby streams, rivers, and other water bodies. Based on the increasing number of municipalities under state orders to improve their systems' dry weather and wet weather capacities, wastewater systems' conditions have not improved since 2016. For example, in the last few years, the City of Houston and the City of Tyler have entered into consent decrees with the EPA, and other cities like Corpus Christi are expected to enter into consent decrees soon. Consent decrees are tools for legally enforcing water quality compliance. These actions are expected to require funding for additional repairs over the next decade. As a result, several SSO elimination programs are underway across the state. As of 2019, TCEQ had 140 active participants in the voluntary SSO Initiative. While the major municipal systems are expanding capacity, there remained almost 6,000 SSO events in 2019 as compared to fewer than 2,500 events in 2016.

Texas' population is expected to increase more than 70 percent between 2020 and 2070, from 29.7 million to 51 million residents. These growth projections necessitate the construction of new treatment systems, capacity expansions, and operations and maintenance improvements within existing systems. In some counties, population growth exacerbates the density of septic tank systems. Approximately 20% of new homes use on-site sewage facilities (OSSF), also known as septic tanks, and approximately 67% of new wastewater treatment plant capacity is estimated to be small-scale "package" treatment plants. Both systems are more commonly used in growing, rural areas where centralized wastewater treatment plants or conveyance systems to regional facilities have not been constructed. These OSSFs, although suitable for protecting public and environmental health, typically rely on household owners for system operation and maintenance (O&M). When O&M practices are inadequate, a system's condition deteriorates and capacity diminishes, yielding inconsistent performance.

OPERATION AND MAINTENANCE

Despite the voluntary SSO Initiative, over the past three years, almost double the number of spills has been reported. Larger municipalities have additional maintenance resources, which are used for preventive cleaning, closed-circuit television (CCTV) inspections, and regular inspections of interceptor conditions.

AMPSS were funded by Texas Water Development Board (TWDB) to create a comprehensive plan for managing their systems in a financially and technically sustainable manner. Furthermore, beginning with the state fiscal year 2021, TWDB incentivized the adoption of AMPSS. In July 2019, the TWDB expanded some of the financial incentives to any eligible entity, not just small systems.

OSSFs account for approximately 20% of new wastewater treatment capacity in Texas, which is also the average rate for the United States. OSSF compliance is dependent on homeowners and local authorities. TCEQ provides basic operational guidance for package treatment plants, but ultimately local authorities oversee plant operations.

FUNDING AND FUTURE NEED

Funding sources include local revenues from rates (fees charged to individual consumers), state and federal grants, and state and federal loans. As of 2020, of cities reporting wastewater fees, the average residential fee for 5,000 gallons is \$35.19, an increase of 30% from 2016.

For the state fiscal year 2019, entities submitted needs amounting to \$786 million from the Texas Clean Water State Revolving Fund (CWSRF) federal loan program for planned water and wastewater treatment upgrade projects. Most projects were wastewater-focused and included rehabilitating and capacity increases of large wastewater treatment plants, replacing sewer collection pipes composed of outdated materials, and constructing package plants to replace communities' septic tanks. Approximately \$525 million is invested from the Texas CWSRF federal loan program each year, falling short of the requested funds by approximately \$261 million. Other sources of federal funding have been limited. With these funds, the Texas CWSRF federal loan program can accommodate many large projects, even those exceeding the available \$525 million, yet the annual program capacity is typically lower than the total cost of project needs each year. And, although TWDB matches project needs with funding options, most wastewater system owners and operators would prefer grants in lieu of low interest loans.

As shown by the State Revolving Fund requests for centralized systems to replace community-wide septic tank use, lack of upfront funding for capital improvements and planning may increase discharge violations and long-term spending.

PUBLIC SAFETY

According to the 2020 Texas Integrated Report of Surface Water Quality for the Clean Water Act Sections 305(b) and 303(d), Texas rivers continue to suffer poor health. The number of surface water bodies listed under Category 5 has increased from 979 in 2018 to 1,009 in 2020. A Category 5 means that at least one of the surface waterbody's designated uses is not being supported or is threatened, and regulatory water quality limits should be implemented to reduce impairment. Both point and non-point sources are responsible for these conditions.

A high number of septic tanks exist in rural Texas and present a public safety hazard. Most of these systems are not monitored on a regular basis, increasing chances of pollutants overflowing onto the ground surface or leaking into groundwater.

Texas beaches also continue to experience relatively high levels of contamination. Texas Beach Watch is a program funded by the EPA and the Texas General Land Office (GLO), which administers the program to monitor water quality at Texas' recreational beaches. The program monitors Texas' recreational beaches and when bacteria levels in the water exceed the acceptable standards established by the EPA, the GLO works with local governments to issue advisories and post signs provided by the GLO at beach access points warning the public not to swim in affected waters. Beaches are monitored year-round, with weekly monitoring from May to September for all monitored beaches and during the month of March at some beaches to coincide with spring break. Based on data downloaded from EPA's BEACON 2.0 system, beaches across the state had almost three times the number of contamination advisory days at 2,860 days in 2019 as compared to 1,130 days in 2016. Advisories typically last between one and seven days.

Emerging contaminants such as Per- and Poly-fluoroalkyl substances (PFAS) are a class of chemical compounds contained in numerous common products including cookware, clothing, packaging, and firefighting foams; and is believed to be in the bloodstream of 95% of all Americans. In 2016, the EPA issued a non-regulatory lifetime health advisory level of 70 parts per trillion (ppt) for two PFAS compounds, perfluorooctanoic acid (PFOA) and perfluorosulfonic acid (PFOS), individually or combined. Texas has promulgated rules outlined in the Texas Risk Reduction Program (Texas Administrative Code 30 Chapter 350) for ground water assessment and action in response to a PFOS/PFOA release. Around Texas, many utilities are undertaking sampling of water sources and evaluating the nationally recommended frequency for detection of these contaminants, with some of the larger utilities proactively implementing a more rigorous sampling frequency.



PHOTO: URBAN WASTEWATER TREATMENT PLANT. DMITRI MA

RESILIENCE AND INNOVATION

To determine the resiliency of the state's current wastewater infrastructure system, the capability of the system to prevent or protect against hazardous events must be considered. In 2017, Hurricane Harvey tested the performance of the system. Critical wastewater facilities proved to be incapable of withstanding and protecting against the flooding and high winds of the record-breaking storm. Many facilities were destroyed or inoperable due to flood inundation, resulting in record sanitary sewer overflows according to TCEQ reports:

- 1,522 SSOs were reported for a total discharge of 25 million gallons; and
- 45 Industrial discharges were reported for a total of 125 million gallons.

The ability to expeditiously recover and resume critical services with minimum disruption to public safety and health, the economy, the environment and national security will greatly depend on the state's ability to develop wastewater infrastructure projects which incorporate resilience in the planning, design, modeling, construction and maintenance of facilities.

Cities in Texas such as Austin, San Antonio, Dallas, and Houston are incorporating resilient infrastructure planning measures into climate action plans and resilient planning documents. For example, San Antonio's River Authority (SARA) Martinez IV Wastewater Treatment Plant in Saint Hedwig was planned and constructed with sustainability in mind: using the Envision framework the plan considered climate and resilience by placing the facility outside the 500-year floodplain limits and planned for drought conditions.

The wastewater treatment industry continues to explore innovative technologies to meet regulatory requirements. Direct potable reuse (DPR) has grown in popularity as water sources diminish and water prices rise. The cities of Big Spring and Wichita Falls currently operate DPR facilities, and El Paso Water will soon have the first direct-to-distribution DPR facility in the U.S. Industry leaders are also seeking ways to improve treatment technologies from energy efficient motors, advanced logic controls, and process equipment. Advanced technologies and equipment are constantly introduced to the market for operations and cost saving measures. Some of the Texas wastewater utilities participate in the Water Research Foundation Leaders Innovation Forum for Technology (LIFT) program.

Resource recovery from wastewater plants is a growing industry. The City of Dallas and the City of Fort Worth have both invested in biogas energy recovery facilities. Mining phosphorus for use as fertilizer or generating electricity from digester gas present opportunities to use the wastewater facility resources. However, these innovative technologies require large up-front capital expenditure investments. Biosolids, or organic materials resulting from the treatment of sewage, produced at some Texas wastewater treatment facilities are safely and beneficially used in composting programs or in beneficial land application (organic fertilizer) through partnerships with the agricultural community. These land application programs have been challenged, due to location and environmental views, making it difficult for larger utilities to locate viable disposal options for their biosolids.

The cities of Austin, Dallas, and Houston; Harris County; and San Antonio River Authority all have personnel recognized by the ASCE Institute for Sustainable Infrastructure (ISI) as Envision Sustainability Professionals (ENV SP). These team members are credentialed to design with the natural world and resiliency in mind, and are dedicated to the implementation of more sustainable infrastructure.



WASTEWATER



RECOMMENDATIONS TO RAISE THE GRADE

- Increase state and local funding by raising rates to reflect the true cost of service, which would supplement federal funds for wastewater infrastructure improvements that currently fall short of requested funds.
- Deliver resources and regulatory support for better community planning for centralized wastewater systems to reduce the need of septic tanks, reduce package plants, and drastically reduce incidents of sanitary sewer overflows (SSO).
- Modernize guidance on resilience planning, including natural systems combined with engineered systems, as more extreme weather events are anticipated.
- Increase wastewater treatment capacity in anticipation of significant population growth.
- Support technologies for reuse of biosolids, high efficiency equipment and processes.
- Encourage owners, operators, and designers to improve innovation in the wastewater industry through research and pilot studies.

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ACKNOWLEDGMENTS

ASCE Texas Section would like to recognize the following individuals for their contributions to the *Texas Infrastructure Report Card*:

GRISELDA GONZALES PE, LEED AP, ENV SP **2021 VICE PRESIDENT FOR PROFESSIONAL AFFAIRS**

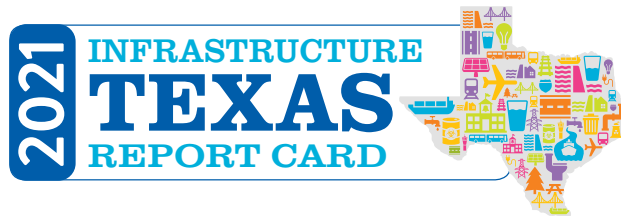
Mrs. Gonzales serves as the ASCE Texas Section 2021 Vice President for Professional Affairs and, as such, oversees the Infrastructure Report Card Committee. She is a Principal Engineer at the Goodman Corporation, joining the team in 2018 and bringing a diverse engineering background with experience in land development, water and wastewater planning studies, drainage studies and designs, traffic, transportation, and roadway reconstruction. Mrs. Gonzales initiated the ASCE Houston Chapter of the Transportation and Development Institute and recently served as the Government Affairs Committee Chair for the ASCE Texas Section. She is an alumnus of the 2014 Greater Houston Hispanic Chamber of Commerce Emerging Leaders Institute and Leadership Houston Class XXVI. Mrs. Gonzales earned her Bachelor of Science degree in Civil Engineering from The University of Texas at San Antonio.

SUSAN K. ROTH PE, PMP **2021 PAST PRESIDENT**

Mrs. Roth served as the ASCE Texas Section 2020 President and oversaw all activities of the Section. She has more than 25 years of experience in the water and wastewater engineering field. Mrs. Roth is President of Susan Roth Consulting, LLC where she works with municipalities, river authorities, and water districts in Texas. Mrs. Roth is a long-time member of ASCE, starting during her undergraduate years and holding numerous leadership positions throughout her professional career. She is a Past President of the ASCE Austin Branch and previously served as Vice President of Education for ASCE Texas Section. She also served as the primary consultant on the *2017 Texas Infrastructure Report Card* and developed the *2012 Texas Infrastructure Report Card* for the Texas Section's Centennial. Mrs. Roth earned her Master and Bachelor of Science degrees in Civil Engineering from The University of Texas at Austin and Texas A&M University, respectively. She is a graduate of Leadership Austin and has served on a number of board appointments and task forces for the City of Austin.

SEAN P. MERRELL PE, PTOE, RAS, F.ASCE **2021 PRESIDENT**

Mr. Merrell serves as the ASCE Texas Section 2021 President and oversees all activities of the Section. He also serves as a Region 6 Governor for ASCE. He has more than 20 years of experience in the transportation engineering field. Mr. Merrell is an Associate and Senior Project Manager at BGE, Inc., where he leads the traffic group for three North Texas offices. Mr. Merrell is a long-time member of ASCE, starting during his undergraduate years and holding numerous leadership positions throughout his academic & professional career. He is a Past President of the Texas A&M University ASCE Student Chapter and the ASCE Dallas Branch and previously served as Chair of the Texas Section's Centennial Celebration Planning Committee. Mr. Merrell earned his Master of Engineering and Bachelor of Science degrees in Civil Engineering from Texas A&M University. He currently chairs both the City of Frisco Parks and Recreation Board and the Collin County Planning Board. Prior to studying Civil Engineering, Mr. Merrell served in the U.S. Army as an Aeroscout.



ASCE TEXAS SECTION'S INFRASTRUCTURE REPORT CARD COMMITTEE

With each Report Card update, the ASCE Texas Section Infrastructure Report Card Committee—made up of 55 dedicated civil engineers from across the state with decades of expertise across all categories—volunteer their time to work with ASCE Texas Section leaders and staff to prepare the *Texas Infrastructure Report Card*. The Infrastructure Report Card Committee assesses all relevant data and references, consults with other technical and industry experts, develops summaries, and assigns grades based on the data collected. The following individuals—along with several members who wish to remain anonymous—are responsible for the successful completion of the *Texas Infrastructure Report Card*:

MARK K. BOYD PHD, PE, CAPM, D.WRE | COMMITTEE CHAIR

Dr. Boyd serves as Chair of the ASCE Texas Section Infrastructure Report Card Committee and oversees 11 subcommittees. While working as Principal Engineer of LCA Environmental, Inc. since 1998, Dr. Boyd has served ASCE in many leadership roles. He served as President of the ASCE Dallas Branch and as Co-Chair of the Texas Section's Centennial Celebration Planning Committee. Dr. Boyd has over 30 years of experience in civil and environmental engineering. He earned his Doctor of Philosophy degree in Civil Engineering from Southern Methodist University, where he currently serves as an Adjunct Assistant Professor of Civil and Environmental Engineering.

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Levees Subcommittee

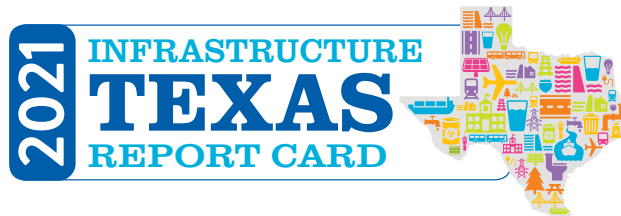
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AGENCIES AND ORGANIZATIONS

ASCE Texas Section would like to thank the following agencies and organizations for their assistance and reference material utilized during the research and preparation of the *2021 Texas Infrastructure Report Card*:

- Airports Council International – North America
- American Chemistry Council
- Association of American Railroads
- ASCE, Committee for America’s Infrastructure
- Association of State Dam Safety Officials
- Capital Metropolitan Transportation Authority
- Center for Transportation Research at The University of Texas at Austin
- City of Austin, Parks and Recreation Department
- City of Dallas, Parks and Recreation Department
- City of Fort Worth, Parks and Recreation Department
- City of Houston, Office of Sustainability
- City of Houston, Parks Board
- City of San Antonio, Parks and Recreation Department
- Congressional Research Service
- Dallas Area Rapid Transit
- Electric Reliability Council of Texas
- Environment Texas
- Federal Aviation Administration
- Federal Emergency Management Agency
- Federal Highway Administration
- Go RV Texas
- Houston-Galveston Area Council
- Metropolitan Transit Authority of Harris County, TX
- National Recreation and Park Association
- National Weather Service
- North Central Texas Council of Governments
- Public Utility Commission of Texas
- Railroad Commission of Texas
- Reasons Foundation
- Rebuild Texas
- The National Academies of Sciences, Engineering, and Medicine; Transportation Research Board
- The National Academies of Sciences, Engineering, and Medicine; Transit Cooperative Research Program
- Texas A&M Transportation Institute
- Texas Central
- Texas Commission on Environmental Quality (TCEQ), Office of Compliance and Enforcement
- TCEQ, Office of Waste
- TCEQ, Office of Water
- TCEQ, Dam Safety Program
- Texas Comptroller of Public Accounts
- Texas Department of State Health Services
- Texas Department of Transportation (TxDOT), Bridge Division
- TxDOT, General Aviation Division
- TxDOT, Maritime Division
- Texas Division of Emergency Management
- Texas General Land Office
- Texas Historical Commission, Texas Heritage Trails Program
- Texas Parks & Wildlife Department
- Texas State Soil and Water Conservation Board
- Texas Transportation Commission
- Texas Water Development Board
- Trinity Metro
- U.S. Army Corps of Engineers
- U.S. Department of Agriculture, Natural Resources Conservation Service
- U.S. Department of the Interior, National Park Service
- U.S. Department of Transportation
- U.S. Energy Information Administration
- U.S. Environmental Protection Agency
- The University of Texas at San Antonio
- VIA Metropolitan Transit



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ATTANASIO ENGINEERING SERVICES

Travis N. Attanasio PE, a sole proprietor with 20 years of private and public experience, served as the primary consultant for the *2021 Texas Infrastructure Report Card*. He is a member of the ASCE Fort Worth Branch and previously chaired ASCE Texas Section’s Infrastructure Report Card Committee, overseeing the development the *2017 Texas Infrastructure Report Card*. Travis served in the role of Vice President for Professional Affairs for ASCE Texas Section in 2017 and is a past committee member at the society-level, volunteering for ASCE Committee for America’s Infrastructure.



PHOTO: HOUSTON SHIP CHANNEL, PORT HOUSTON

COMPARISON OF TEXAS' PREVIOUS GRADES

Category	2004	2008	2012	2017	2021
Aviation	C+	C+	C+	B-	B-
Bridges	C-	B-	B-	B	B-
Dams	D-	D-	D-	D	D+
Drinking Water	D	D	D-	D+	C-
Energy	B+	B+	B+	-	B+
Flood Risk Mitigation	D-	D-	D	D	C-
Hazardous Waste	C	C	-	-	-
<i>Inland Waterways</i>	<i>Not evaluated by ASCE Texas Section</i>				
Levees	-	-	-	-	D
Ports (Navigable Waterways)	D	D	C	-	-
Public Parks and Recreation	-	-	-	-	C-
<i>Rail</i>	<i>Not evaluated by ASCE Texas Section</i>				
Highways and Roads	C-	D	D	D	D+
Schools	D-	D-	D-	-	-
Solid Waste	B	B	B+	-	B
Transit	C	C	C+	-	B-
Wastewater	C-	C-	C-	D	D
GPA	C-	C-	C	C-	C

SOLUTIONS TO RAISE THE GRADES

To raise the Texas infrastructure grade, ASCE Texas Section urges action on the following policy statement:

Infrastructure in Texas will be improved and restored through strategic and sustained investment, bold leadership, thoughtful planning, and careful preparation for the needs of the future.

This Report Card is a useful and powerful tool. Where infrastructure is not performing satisfactorily, whether that be in its current condition, future need, funding, or other capacity, immediate action should be taken by all members of the public and elected leaders to change the trend and improve the grade. ASCE Texas Section periodically updates the Report Card to inform the public and our elected leaders on where the State has improved and where more resources should be allocated. With this effort, we offer our knowledge and expertise to preserve Texas' status as an economic powerhouse and to continue improving the quality of life for all by building a stronger, more resilient State.

LEAD WITH VISION

Leaders from all levels of government, business, labor, and nonprofit organizations must come together to ensure all investments are spent wisely and mechanisms are in place to enforce maintenance, rehabilitation, and inspection requirements. For example:

- Remove or modify the current legislative exemptions to reduce the number of dams exempt from dam safety regulations and create legislation that helps fund the compliance cost of new drinking water treatment standards.
- Continue innovating and leading nation by capturing wasted resources.

By creating appropriate incentives and prioritizing projects, funding can be leveraged to ensure project success. Using a streamlined project permitting process and allowing involvement from the private sector or private-public partnerships can also bring projects to reality and generate cost savings.

EDUCATE THE PUBLIC

Promote public education and improve stakeholder involvement with all planned infrastructure projects. For example:

- Secure funds for enhanced safety practices, leading to decreased traffic accidents, particularly in rural areas.
- Outreach campaigns should be initiated to educate the public about their residual risk if they live in flood prone areas, downstream of dams, or in areas protected by levees.
- Sponsor public education programs that focus on reducing waste at its source, recycling, and minimizing disposal amounts create a greener Texas, extending the life of existing landfills, and align with national best practices.

SOLUTIONS TO RAISE THE GRADES

PREPARE FOR THE FUTURE

Utilize new approaches, design standards, and technologies and promote materials reuse to ensure our infrastructure is more resilient and sustainable. Success can be ensured by embracing emerging technologies and nature-based infrastructure as well as modernizing facilities and adapting to shifting social and economic long-term trends.

Modernize guidance on resilience planning, including natural systems combined with engineered systems, as more extreme weather events are anticipated. For example:

- Prioritizing national highway system improvements and supporting the resilience, maintenance and expansion of port infrastructure is critical to maintaining the flow of goods that keep Texas' economy rolling.

Additionally, increased amounts of energy storage resources will require new market rules and oversight to ensure readiness for the future.

MAINTAIN THE BALANCE

When considering land use planning at the local level, the function of existing and new infrastructure must maintain the balance between the built and natural environments now and into the future. This is obtained by supporting research and development of innovative new materials, technologies, and processes to modernize and extend the life of infrastructure, expedite repairs or replacement, and promote cost savings. In particular:

- Regulatory zoning and development reforms should be considered to improve strategic land planning.
- A blend of shovel ready and planning projects is recommended to show dedicated public dollars at work.

COLLECT AND UTILIZE QUALITY DATA

- Increase awareness of and data collection for the state's dams and levees to better gauge their condition and judiciously allocate resources for their improvement.
- Create legislation which requires Municipalities and Counties to utilize the most recent information and data about geographic rainfall patterns within a project's watershed(s).
- Infrastructure system designs need to consider environmental and climate impacts, sea level rise, subsidence, and future population growth, in addition to other factors.

LEVERAGE ASSET MANAGEMENT

Streamline and utilize asset management best practices across all infrastructure portfolios including the communication of long-term funding needs to Federal and State leaders. This includes projecting adequate maintenance funding needs and prioritizing needed capital improvements focused on security and safety while optimizing life cycle costs and benefits.

SOLUTIONS TO RAISE THE GRADES

For example:

- Comprehensive risk assessments should be incorporated into the operations and maintenance activities for drinking water infrastructure.

INVEST NOW FOR NEEDED, CRITICAL UPGRADES. RECOGNIZE DIVIDENDS LATER.

Infrastructure needs increased, long-term, State, and Local level investment now leveraging Federal and private dollars, as necessary. For example, significant investment is required for:

- The water and wastewater sector to reduce issues of non-compliance, update existing infrastructure, and ensure these critical systems are fit for the explosive future growth Texas anticipates.
- The implement the State's new flood infrastructure plans. Too often, plans are shelved due to the lack of implement funding.

Dedicated public funding sources on the local and state level need to be consistent and timely, with infrastructure trust funds never used to pay for or offset other parts of a budget. Key examples include:

- Approximately 45% of the State's Motor Fuels Tax is diverted to other programs. Surface transportation revenue from the state and local level should be safeguarded against non-transportation uses.
- The Texas Sporting Goods Sales Tax proposed in 1993 was intended to generate needed funding for Texas parks and encourage outdoor recreation in all communities. Until 2015, approximately 80% of the tax sat unappropriated to Texas Parks and remained in the general fund. Then, from 2015 to 2018, legislation was created to wholly dedicate 94% of the sales tax to Texas Parks. Finally, in 2019, legislation was created to dedicate 100% of the sales tax to Texas Parks, a mere 26 years after it was envisioned.

Infrastructure owners and operators must charge, and Texans must be willing to pay, rates and fees that reflect the true cost of using, maintaining, and improving infrastructure. For example:

- Increasing the caps on the Passenger Facility Charge and fuel tax will give Texas airports access to needed capital to support and improve the state's aviation infrastructure.
- Increasing the State's Motor Fuel Tax or adapting an alternative method like mileage-based user fees will give state and local agencies access to needed capital to maintain the reliability of and meet the public's service expectations for the state's highway, road, and transit infrastructure.

Identify collaborative opportunities across state programs, and offer corporate partner programs, to increase exposure for potential fund grant award opportunities.

ABOUT THE TEXAS SECTION OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS



The Texas Section of the American Society of Civil Engineers (**ASCE Texas Section**) represents 10,000 members Statewide. Headquartered in Austin, the Texas Section unites 15 Branches, 7 Technical Institute Chapters, and 20 Student Chapters—one at each major university.

ASCE Texas Section belongs to ASCE’s Region 6, which includes the Mexico, New Mexico, and Oklahoma Sections. ASCE has more than 150,000 global members in 77 countries.

ASCE TEXAS SECTION ADVANCES OUR COMMUNITIES THROUGH THE DEVELOPMENT OF CIVIL ENGINEERS AS LEADERS WHO CREATE A LEGACY OF SERVICE THROUGH TECHNICAL PROFICIENCY, EDUCATIONAL OPPORTUNITIES, AND PROFESSIONAL ADVOCACY.

Texas civil engineers are leaders in their communities, building a better quality of life across the street and around the world. We are constantly presented with the challenge of improving infrastructure. To fulfill our mission to protect public health and safety, and in keeping with the Code of Ethics all ASCE members adhere to, civil engineers must be involved in the policy making process at all levels of government. To contribute to the policy making process, ASCE Texas Section administers two major milestone projects: publishing the ***Texas Infrastructure Report Card*** approximately every four years and hosting a ***Texas Legislative Drive-In*** every two years. The Texas Legislative Drive-In allows members to continue building relationships with policy makers while providing feedback and educational tools based on the civil engineering industry’s state of practice and our technical understanding of infrastructure design, operation, maintenance, and the associated environmental impacts.

In addition to the *Texas Infrastructure Report Card* and the *Texas Legislative Drive-In*, ASCE Texas members routinely support the year-round technical work of state agencies and policymakers.

- In 2018, the **Post Hurricane Harvey Recommendations Task Committee** released a *report* summarizing a series of comprehensive policy recommendations to mitigate flood risk in Texas.
- In 2019, the **Government Affairs Committee** reviewed draft legislation and provided testimony at several Texas House Committee Hearings and hosted a free “Infrastructure Education for Legislators” webinar.



- In 2020, the **Flood Mitigation Advisory Task Committee** reviewed numerous documents drafted by the General Land Office and Texas Water Development Board and provided valuable stakeholder feedback.

To ensure there is an ever-growing number of exceptional civil engineers capable of leading the most complex projects and building better communities, ASCE Texas Section also hosts both the **ASCE Texas Student Symposium** and the **Texas Civil Engineering Conference (CECON)**. The Student Symposium is hosted each spring, gathering over 400 of the best and brightest civil engineering students from universities across Texas and Mexico for professional development and networking. The event includes regional competitions—such as the concrete canoe competition for university students, a career fair, power skills sessions for students, and continuing education sessions for local engineering professionals. It is a vehicle for idea exchange and networking between professionals and students preparing to enter the workforce, helping shape the future of civil engineers.

CECON is hosted every fall and is the premier conference for civil engineers in Texas and beyond. The conference is a gathering of professionals discussing and advancing civil engineering issues, by participation in networking, leadership development, and technical training opportunities. A legislative panel is held during CECON to discuss current infrastructure issues that Texas is facing.

ASCE Texas Section also provides a platform to fulfill our state’s science, technology, engineering, and math (STEM) based workforce needs through a variety of pre-college outreach events and programs. Our local branches work with schools and venues, such as science museums, to engage students in fun engineering activities and share insights about the career they love – civil engineering.

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PHOTO: HAY STREET BRIDGE, SAN ANTONIO; DECORATED FOR FESTIVITIES HAPPENING BELOW; VINCHENZO VILLANUEVA.





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ASCE Texas Section is one of the largest and most active sections of the American Society of Civil Engineers. Established in 1913, the Texas Section represents nearly 10,000 members across Texas. Headquartered in Austin, the Texas Section unites 15 Branches, 7 Technical Institute Chapters, and 20 Student Chapters—including one at each major Texas university. ASCE Texas Section belongs to ASCE's Region 6, which includes the Mexico, New Mexico, and Oklahoma Sections. ASCE has 150,000+ global members. **We support & encourage the equitable opportunity for participation by all.**

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