
TEXASTRANSPORTATION
PLAN2050
HERO
SCHOOL BUS
Texas
Department
of Transportation


Midpark Rd
Spring Valley Rd
Belt Line Rd - Main St
END
ROAD WORK

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June 25, 2020

Dear fellow Texans,

At the direction of the Texas Transportation Commission, I am pleased to present the Texas Transportation Plan 2050 (TTP 2050), the Texas Department of Transportation's new long-range transportation plan. Covering a 30-year planning horizon, it will guide the future of statewide multimodal transportation as TxDOT strives to fulfill its mission of Connecting You With Texas.

Building on the goals of TxDOT's most recent Strategic Plan, the new plan revises objectives and sets new performance targets. The TTP 2050 describes future planning and programming trends and issues, evaluates long-term investment priorities, identifies planned rural investments, presents implementation strategies, and consider s the performance implications of different investment strategies under potential future scenarios.

The plan was developed over a 20-month period, with the bulk of the TTP 2050 finalized prior to the outbreak of the COVID-19 pandemic. Therefore, any pandemic-related impacts – such as reduced fuel tax revenues or the effects of travel patterns on investment needs – are not reflected in the plan.

I would like to thank TxDOT's key planning partners and stakeholders– including local governments and metropolitan planning organizations –for their support, commitment, and close consultation. I would also like to thank the thousands of citizens across the state who participated in the planning process by attending open houses, completing surveys, and submitting comments. Through all their efforts, the TTP 2050 is not just TxDOT's long range plan: it is a true statewide vision that reflects the needs, interests, and priorities of the state's citizens and businesses.

Regards,

James M. Bass

Executive Director, Texas Department of Transportation

Executive Summary

What is the TTP 2050?

The Texas Transportation Plan (TTP) 2050 provides a federally- and state-mandated long-range vision for transportation in Texas. It reflects significant analysis and stakeholder input and is based on consideration of the performance implications associated with different investment strategy choices under potential scenarios of the future. The purpose of the TTP 2050 is to guide planning and programming decisions for the statewide multimodal transportation system. The TTP is not a comprehensive list of future projects or allocated dollars.

This update to the TTP has a 30-year horizon and reflects wide-ranging engagement with stakeholders and the public. The plan begins with the premise that safe, reliable, and multimodal transportation is foundational for quality of life and business growth in Texas and that TxDOT must make transportation decisions that suitably address wide-ranging challenges. Key challenges include:

Key Content of TTP 2050

- Details roles and responsibilities for the Texas Department of Transportation (TxDOT)
- Considers key trends and challenges likely to influence transportation in the future
- Sets goals, objectives, measures, and targets
- Evaluates long term investment priorities
- Identifies planned rural investments
- Analyzes the impact of emerging technologies and growing freight demand on statewide transportation in different scenarios
- Outlines plan implementation strategies

Safety Concerns

About 10 deaths and 48 serious injuries are reported every day on Texas roadways.

Economic Expansion

By 2046, gross state product will increase from about $2 trillion to $7 trillion.

Technological Advancement

Fast technological change in areas like connected and autonomous vehicles will create opportunities and challenges for transportation safety and efficiency.

Population Growth

Texas will grow from about 29 million people to over 47 million people by 2050.

Surging Freight Demand

Commodities moved through the Texas Multimodal Freight Network will double to about 4 million tons per year by 2045.

Systemic Risks

A resilient transportation system must be equipped to avoid, minimize and recover from unforeseen events like natural disasters or other major incidents.

How We Developed the TTP 2050

Completion of the TTP 2050 featured several major elements:

1. **Research and data collection** on a wide range of transportation areas;
2. **Strategic thinking** to define plan goals and objectives;
3. **Forecasting and analysis** to estimate available revenues and assess system performance;
4. **Scenario analysis** that considered the future implications of different emerging technology and economic scenarios;
5. **Outreach** to hear from TxDOT stakeholders and the public throughout the state; and
6. **Identification of strategies** that TxDOT is implementing now or will endeavor to in the future to ensure it achieves plan goals and objectives.

The resulting TTP 2050 Plan is designed to complement shorter-range statewide plans, including various modal and corridor plans, the Unified Transportation Program, and the Statewide Transportation Improvement Program.

Figure ES-1: Texas Transportation Plan 2050 Development Process

Goals, Objectives, Measures, and Targets

The TTP 2050 features six broad goals with supporting objectives and measures of performance that will steer policy direction and propel momentum toward desired outcomes while helping link TxDOT's strategic decisions with on-the-ground actions.

Promote Safety

Champion a culture of safety that reduces crashes and fatalities through the five "E's" of Evaluation, Engineering, Encouragement, Education, and Enforcement.

Preserve our Assets

Deliver cost-efficient preventive maintenance for the transportation system that keeps Texas roads, bridges, and other infrastructure and technology in good repair.

Optimize System Performance

Develop and operate an integrated transportation system that provides reliable and accessible mobility and enables economic growth.

Deliver the Right Projects

Ensure efficient use of state resources by implementing effective planning processes to help deliver the right projects on time and on budget.

Foster Stewardship

Integrate environmental considerations into all TxDOT activities so that future generations of Texans can benefit from the state's valuable natural, historic, and cultural resources.

Focus on The Customer

Ensure the public and stakeholders can see and understand TxDOT's decisions and provide feedback that is heard.

In addition, to comply with federal and state requirements, the plan identifies statewide measures and proposes targets that can be used to monitor progress towards goal attainment and inform planning and programming decisions through 2050.

Goals	State Measures	2030 Target	2050 Target
Promote Safety	• Fatality Count	2,280	0
	• Fatality Rate	0.70	0
Preserve Our Assets	• % Good or Better Pavement Lane-miles	90%	90%
	• Statewide Bridge Condition Score	90	90
Optimize System Performance	• Urban Congestion Index	1.2	1.15
	• Rural Reliability Index	1.12	1.12

More detail about these goals and their associated objectives and performance measures is included in **Chapter 2** of the TTP.

Texas Transportation System

The transportation system in Texas comprises infrastructure, operations, and programs that support movement of people and goods across the state. The Texas transportation system is multimodal. A combination of organizations, including TxDOT, metropolitan planning organizations (MPO), local governments, transit agencies, tollway authorities, and private companies share ownership and operation of these modal elements. More detail about these modes is included in **Chapter 3** of the TTP.

Roadways and Highways

Texas has 80,444 centerline miles of highways and more than 35,000 bridges owned by TxDOT; 540 million vehicle miles traveled (VMT) on TxDOT's roads annually; and a wide range of intelligent transportation system (ITS) components.

Bicycle and Pedestrian Transportation

TxDOT has a role in considering active transportation in design, supporting local active transportation projects, and improving safety for active transportation modes. About 0.3% of Texas commuters ride a bicycle to work, whereas about 1.6% walk.

Public Transportation

Texas is home to eight metropolitan transit authorities, 32 urban transit districts, 36 rural transit districts, 58 elderly and disability transit programs, with a total of 7,946 vehicles serving 275 million trips in 2018.

Ferry Operations

TxDOT operates two ferry routes (Galveston Ferry and Port Aransas Ferry) that function 24 hours a day 365 days a year, with 13 ferry boats carrying a total of 3.6 million vehicles and 7.7 million passengers between 2016 and 2018.

Freight

The Texas Multimodal Freight Network serves goods movement across the state; it includes nearly 22,000 miles of highway, 10,500 rail track miles, 21 water ports, six of the top 50 cargo airports in the U.S., 20 commercial international border crossings, and 448,446 miles of pipelines.

Passenger Rail

There are three Amtrak routes with stops in Texas featuring 1,539 track miles, 19 stations, and 381,615 boardings and alightings in 2018.

Aviation

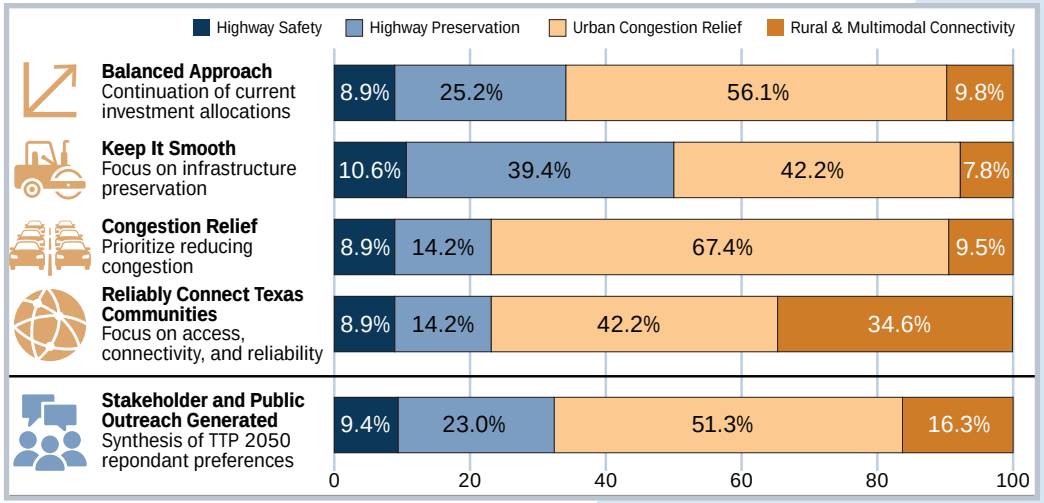
Texas has 26 commercial service airports, 278 general aviation airports, 24 reliever airports, 23 military airfields, and 56 public-use heliports that, together generate more than $94.3 billion annually in economic output.

Planning for the Future of Transportation in Texas

Scenario planning helps transportation decision-makers and their stakeholders consider performance implications associated with different investment strategy choices under different projections of what the future might look like. The TTP 2050 assesses the system performance outcomes of five different investment strategies on safety, congestion, asset conditions, the economy, and non-highway travel options in response to *expected* and *optimistic* scenarios of changes over time for emerging technology and freight volumes, which are considered to be the greatest uncertainties affecting transportation in Texas.

Performance results for each scenario under the five investment strategies are discussed in more detail in **Chapter 4** of the TTP.

Figure ES-2: TTP 2050 Investment Strategy Allocations

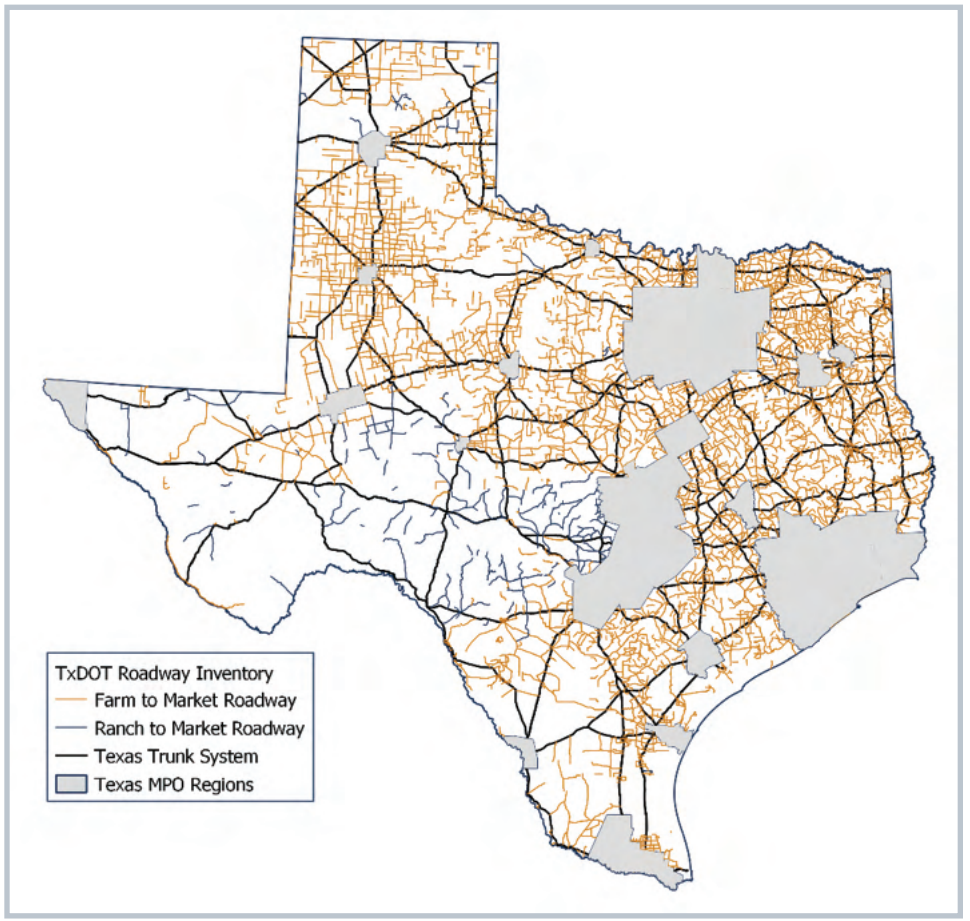


Rural Transportation in Texas

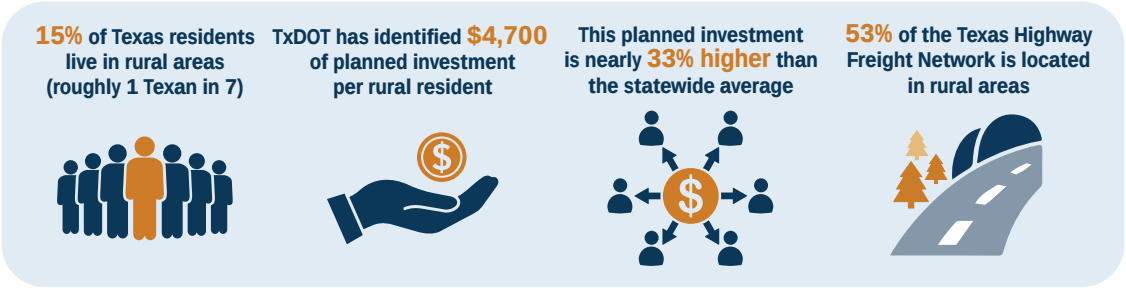
Recognizing, understanding, and addressing the unique multimodal transportation needs of people and businesses residing in or traveling the geographically large and socio-economically diverse rural share of Texas is an important element of this plan. Consideration of rural transportation concerns and identification of planned rural projects help TxDOT ensure an equitable allocation of limited resources.

- **Scope of Rural Texas Transportation System** – The multimodal rural transportation system connects diverse communities and markets across a vast geographic scale. With nearly 57,000 miles of on-system roadways and 24,600 bridges outside MPO boundaries, rural roadways make up nearly half of TxDOT-maintained roads and bridges. Rural roadways include nearly 10,500 miles of the TxDOT Trunk System and 50,000 miles of farm/ranch-to-market roads, which provide critical economic connections. The rural highway network contains 53% of the Texas Highway Freight Network, which supports most truck traffic in the state.
- **Rural Transportation Planning** – TxDOT determines transportation improvements in rural areas of the state in consultation with local leaders, rural transit providers and other transportation stakeholders, including rural planning organizations (RPOs), which are voluntary organizations created and governed by local elected officials.
- **TxDOT's Rural Transportation Programs** – Most transportation funding for rural areas of Texas is determined by needs-driven formulas. For example, preventive maintenance and rehabilitation funding are distributed based on pavement distress scores, on-system lane-miles, truck traffic volumes and on-system bridge deck area. Similar formula-based approaches are used to determine funding for bridges and safety. Bicycle and pedestrian projects are mostly funded through the TxDOT-administered Transportation Alternatives Program. Rural airports are funded in part through Federal Aviation Administration grants administered by TxDOT. Rural public transportation is funded through TxDOT's administration of Federal Transit Administration and other U.S. Department of Transportation grant programs. In addition, TxDOT has allocated $2.1 billion to the Energy Sector Program for fiscal years 2020 to 2029 to address specifically identified roadways affected by traffic in various energy development areas.

Figure ES-3: TxDOT Roadway Inventory



- **Planned Rural Transportation System Improvements** – TxDOT's *Project Tracker* system includes more than 6,400 projects which are predominantly located in rural areas of the state with an initial total cost of $22.6 billion and which are either currently under development (next 1-5 years), scheduled for development (next 6-10 years), being finalized for construction (next 10-15 years), or in the pipeline for long-term planning. With about 15% of the state population in rural areas, this corresponds to approximately $4,700 of planned investments per person, which is approximately 33% higher than the statewide average. Most planned investments outside of urban boundaries are for adding capacity, preserving infrastructure, or enhancing safety.



- **Key Rural Transportation System Considerations and Strategies** – As part of the TTP update, members of TxDOT's planning team provided virtual commenting opportunities and used open house events across the state to meet with rural- and urban-focused stakeholders including elected officials, local and regional government staff, advocacy organization representatives, members of the public, and social, economic and business leaders. The purpose of these efforts was to share information, build connections and understand perspectives. Engagement, in combination with thorough analysis of wide-ranging planning documents, led to identification of key rural transportation themes uniquely important for the future of transportation investment choices for projects and services in rural portions of Texas. The rural transportation system in Texas is explored in further detail in **Chapter 5** of the TTP.

Key Rural Transportation Themes

Road design standard upgrades – Special engineering and design considerations that deserve attention include those geared toward rural safety concerns like animal and vehicle conflicts or slow-moving commercial vehicles, integration of active transportation infrastructure in rural communities, and practical rural high way capacity addition options like passing lanes in congestion-prone areas or on steep uphill grades.

System ownership – Careful consideration of how ownership of rural highway elements is distributed between the state and local government units can help ensure the best use of state and local resources to meet transportation needs in a timely and cost-effective manner.

Safety – Less travel occurs on rural Texas roads than on roads in the state's major population centers, but each year almost half of all vehicle occupant deaths in Texas occur on rural parts of the transportation network, which demands a special focus on rural transportation safety issues.

Rest areas – Texas is a large state, with long stretches of isolated rural highway running between centers of commerce. Public rest areas along these routes are a vital safety feature that help reduce the risk of crashes caused by drowsy driving. Provision of sufficient rest area facilities along rural routes with significant amounts of long-distance traffic is a critical issue for the rural transportation network.

Resilient connections – In rural areas of Texas, population, economic activity, and supporting transportation infrastructure and services like transit or mobility-as-a-service are dispersed. As a result, rural communities typically experience lower levels of resiliency in terms of convenient transportation alternatives, which imposes economic costs and threatens public safety in rural areas.

Digital connectivity – Over the last decade, access to internet service has become an important catalyst for technological advances, quality of life improvements, and growth in economic prosperity. Rural regions often lag metro areas in provision of physical broadband infrastructure and a growing "digital divide" between rural and urban regions could put geographic limits on technological, social, and economic opportunities in the future without the right investments in rural digital connectivity.

Public Involvement

Stakeholder and public participation conducted by TxDOT throughout the 19-month development of the TTP helped educate the public and enabled TxDOT to better understand system use. It also enabled TxDOT to gather input on investment priorities and ensure every Texan had an opportunity to weigh in on issues important to them, comment on draft plan components, and understand the tradeoffs among different investment strategies. Target audiences for engagement included MPOs, RPOs, public transportation agencies, freight interests, private transportation services providers, state and federal resource agencies and Tribal governments, state and local elected officials, the public and traditionally underserved groups including disabled, low-income, minority, and non-English speaking populations.

- **Engagement Tactics** – Engagement included a multipronged approach featuring 56 open houses and workshops attended by 1,800 people, frequent postings to social media, 113 e-blasts, 4,116 survey responses, and live polling. The TTP 2050 public engagement effort reached stakeholders and citizens from all regions of Texas and ensured all key plan elements were explored including goals and objectives, funding needs, emerging transportation issues, and investment strategies.
- **Engagement Takeaways** – Through public engagement, several key themes emerged that had a significant impact on development of the TTP 2050. The plan goals and objectives were adjusted to better reflect the public's transportation interests and concerns. The scenario analysis process was influenced by the investment priorities Texans expressed in workshops and surveys. Lastly, the input from citizens, businesses, and stakeholders helped identify the implementation strategies TxDOT will need to continue or undertake to make the plan's goals and objectives a reality.

More feedback from the public and stakeholders are discussed in more detail in **Chapter 6** of the TTP.

Key Engagement Takeaways

- Sufficient and sustainable funding is critical
- Continue to balance investment between urban and rural areas
- Increase investment in technology, ports of entry, freight bottlenecks, and congestion relief
- More clarity on roles and responsibilities of TxDOT versus regional organizations
- More and better options for public transportation and active transportation that may require increased coordination and new funding sources to pay for them
- Mixed opinions about connected and autonomous vehicles (CAVs) on Texas roadways – many cannot wait for the conveniences, whereas others are skeptical about safety and reliability.

TTP 2050 Implementation Strategies

To put Texas on a path toward achieving the TTP 2050's goals, TxDOT will need to complement its current and planned policy, planning, research, intergovernmental coordination, and business process strategies with new strategies developed during the TTP 2050 process via a combination of agency coordination, review of plans and policies, and stakeholder engagement. These implementation strategies fall into seven broad categories:

Technology-based Systems

Emerging Transportation Technology Strategies

Focus on Transportation Systems and Management Operations (TSMO), ITS, and data collection and management-related strategies that improve the accessibility, affordability, and adaptability of the Texas transportation system.

Examples include:

- Develop organizational structures and workforce strategies to better support TSMO activities; and
- Consolidate traffic management centers to provide cost savings and improve regional ITS delivery.

Program-based Systems

Mobility Strategies

Use a combination of coordination and collaboration, analytical planning, project programming, and TSMO strategies to both increase the efficiency of existing infrastructure and add additional capacity where needed.

Examples include:

- Expand the use of performance-based, data-driven project prioritization;
- Explore development of selection criteria that consider non-motorized travel benefits; and
- Expand the use of active traffic management applications that reduce congestion.

Methodology-based Systems

Risk and Resiliency Strategies

Address the need for TxDOT to plan and prepare for hazardous disruptions caused by the increasing number of natural and human-made disasters throughout Texas by developing strategies to make the transportation system, as well as supporting infrastructure and operations more resilient.

Examples include:

- Create a cross-disciplinary organizational structure to coordinate resiliency efforts; and
- Conduct pilot studies to identify vulnerable assets.

Utility-based Systems

Preservation Strategies

Preserve the state's extensive system of pavement and bridges using strategies identified in the TxDOT *Transportation Asset Management Plan* to ensure it is efficiently and effectively maintained in a state of good repair.

Examples include:

- Use innovative data collection and analysis methods to maintain pavements and bridges; and
- Upgrade pavements to withstand the demands of transporting Texas energy sector products.

Solution-based Systems

Safety Strategies

Achieving a future with zero traffic fatalities and serious injuries is the department's top priority in terms of planning and investment. The *Texas Strategic Highway Safety Plan* outlines strategies TxDOT can implement to improve safety in Texas.

Examples include:

- Improve data systems and methods for targeting locations with a high probability of crashes;
- Test and implement apps that encourage distraction-free driving; and
- Use data to optimize areas and times for enforcement.

Mode-based Systems

Non-Highway Strategies

To improve the state's multimodal system, TxDOT is implementing or will explore a range of mode-specific strategies that can alleviate roadway congestion and improve overall mobility.

Examples include:

- Address transit service gaps identified in the 2019 Transit Needs Assessment;
- Develop a statewide bicycle network; and
- Identify and implement sustaining revenue sources for aviation.

Coordination-based Systems

Freight Strategies

Although freight movement is multimodal and includes trucks, rail, ports and waterways, aviation, and pipelines, TxDOT's primary role is accommodating highway freight movement.

Accordingly, most TxDOT freight strategies are associated with highway mobility improvements, such as the:

- Off-Peak and 24-hour Operation Pilot Program; and
- Statewide Freight Technology-based Solutions Program.

Given the comprehensive, statewide focus of TTP 2050, many entities will need to participate in its implementation. This includes TxDOT, the federal government, MPOs, transit authorities, regional mobility authorities (RMAs), localities, and the private sector. Plan implementation considerations are discussed in more detail in **Chapter 7** of the TTP.

New Transportation Vision for Texas

Long-range planning is an opportunity to look beyond current trends, conditions, and practices to think about what the future of transportation in Texas could look like. TxDOT brought together a diverse group of transportation experts from across the state to envision and evaluate what Texas could achieve in transportation over the next three decades. The results are a TTP 2050 that considers stakeholder and public priorities to achieve statewide transportation goals and objectives, as well as built-in considerations of what the future may bring for the Texas transportation system.

Figure ES-4: Progressive Range of Visions

Quickly Attainable

The Vision: Create a foundation for change by focusing on addressing "low-hanging fruit" that can be achieved through initiatives already underway and/or those that can be implemented in the near term.

- Improve safety and optimize the efficiency of existing infrastructure through rapid deployment of technology
- Establish policy direction and implement institutional changes to better facilitate multimodal investment in urban areas
- Continue to enhance the level of service in rural areas
- Expand outreach and education to communicate the benefits of multimodal transportation investment
- Expand coordination and collaboration across all transportation agencies in Texas

On-the-Horizon

The Vision: Transition to an emphasis on an adaptive, high-tech multimodal transportation system.

- Safety for all systems users, with separation between freight, connected and automated vehicles (CAVs), and other travelers as needed
- Shift in planning philosophy from moving vehicles on highways to moving people and goods on the transportation system
- Refinement of agency roles and responsibilities to facilitate multimodal solutions to transportation needs
- Establishment of new transportation funding mechanisms to replace the motor fuels tax
- Migration of system toward CAV use

Ultimate Dream

The Vision: The transportation system, services, and behaviors we should strive to realize 15 to 30 years from now.

- No transportation fatalities – the Road to Zero Initiative has been successful in cutting fatal crashes in half by 2035 and achieving zero deaths by 2050
- CAVs fully accommodated
- Transition of government transportation organizations from modal agencies to "mobility agencies"
- Transportation produces zero net emissions

CHAPTER 1

Introduction

Transportation is critical to ongoing growth and success in Texas. Providing a safe, reliable, and integrated transportation system ensures the state's citizens enjoy a high quality of life and enables businesses to prosper. Looking to the future, system demands are expected to grow as the Texas population increases and the business sector expands. To meet this growing demand and achieve its mission, the Texas Department of Transportation (TxDOT) will need to continue improving the system and expanding where needed. At the same time, transportation challenges may be met by emerging technologies we could barely envision just five years ago. The need to reduce transportation's carbon footprint is pressing and demand for more transportation choices is increasing. Together, this all means that TxDOT needs to plan wisely for how it invests the state's transportation resources over the next few decades.

Figure 1-1: TxDOT Planning

What is the TTP 2050?

As illustrated in **Figure 1-1**, the Texas Transportation Plan (TTP) is the primary mechanism TxDOT uses to evaluate its long-term investment priorities and drive the department's planning and project selection activities. It is a statewide, multimodal transportation plan, updated every four years. This plan (the TTP 2050) is TxDOT's most recent TTP update and looks out over a 2050 planning horizon.

> ***Connecting you with Texas.***
>
> *TxDOT Mission Statement*

Development of the TTP update is an opportunity for TxDOT to inventory the current statewide transportation system, further assess its performance, and research the various trends and issues that are affecting or may influence transportation infrastructure and service delivery. It provides an occasion to engage stakeholders and the public to both educate them about transportation issues and get their input on the state's investment needs and priorities, and it enables transportation experts to step away from day-to-day issues to explore the implications of alternative futures. And most importantly, it is a chance to create a future vision for transportation in Texas and establish a roadmap to guide TxDOT planning, program delivery, and decision-making to best achieve the vision.

How We Developed the TTP 2050?

Development of the TTP 2050 was completed over several phases. This approach ensured that findings and policies remain consistent with the priorities and judgment of TxDOT's subject matter experts and stakeholders, as well as Texans who participated in public meetings or through the TxDOT.gov website. The overall planning process is illustrated in **Figure 1-2**. This effort included research and collection of data on a wide range of areas associated with transportation, strategic thinking to define plan goals and objectives, and forecasting and analysis to estimate available revenues and assess system performance. The planning process also included considerable outreach to hear from TxDOT stakeholders throughout the state and incorporated a groundbreaking analysis that considered the implications of different emerging technology and economic scenarios. Lastly, the process included the identification of a broad range of strategies that TxDOT is implementing now or will endeavor to in the future to ensure it achieves plan goals and objectives.

The planning process included considerable outreach to engage TxDOT stakeholders throughout the state.

Figure 1-2: Texas Transportation Plan 2050 Development Process

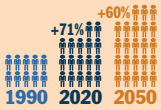
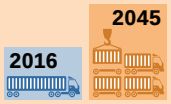
***TWG** = Technical Working Group*

Stakeholders are planning partners that bring external subject matter expertise to the plan development effort across a diverse range of topics including planning, program delivery, the natural and built environment, freight services, tribal concerns, and local transportation issues. Stakeholder groups were encouraged to inform and invite their organizations to participate in the public outreach activities as well as provide comments on the development process.

The Planning Context

Meaningful transportation planning cannot occur in a vacuum; thus, it is critical to contemplate a wide range of current and emerging trends and issues that influence transportation investment and program delivery decisions. **Table 1-1** explores some of the key factors that influenced TTP 2050 development, along with a brief description of their relevance for transportation planning.

Table 1-1: Keys to the Transportation Planning Process

Key Factor	Importance to Planning
 **System Conditions –** Texas highways are well-preserved, and the state's citizens expect system conditions to be maintained.	New highways require more maintenance and preservation spending in the future. In a fiscally-constrained environment, TxDOT will need to consider tradeoffs between highway expansion and preservation.
 **Population Growth –** The population of Texas increased 71% over the last 30 years to 28.7 million. It is expected to grow another 60% to 47.3 million by 2050.	Accommodating the transportation needs of the state's growing population will require both expanding highways and providing more travel options.
 **The Texas Economy –** The state's economy is projected to grow by over 250% between 2020 and 2046, from a gross state product of approximately $2 trillion to nearly $7 trillion.	The Texas economy and transportation infrastructure are inextricably linked. Economic growth both drives transportation investment needs and is enabled by productivity and accessibility improvements.
 **Freight Movement –** More than 2.2 billion tons of freight moved within Texas on the state's multimodal network in 2016. This figure is expected to grow to 4.0 billion tons per year by 2045.	The safe and efficient movement of freight is a foundation of the Texas economy that ensures the state's future prosperity. The Texas freight transportation sector itself supports 2.2 million jobs and $215 billion in economic activity.
 **Trade –** For the past 14 years, Texas has led the country in exports. The state's exports to Mexico grew in value from $62 billion in 2008 to $93 billion in 2016, and exports to Canada reached $20 billion in 2016.	TxDOT's preeminence in trade will continue to place strong demand on the transportation system and the need for improved mobility.
 **Technology –** The speed of technology being developed and deployed is accelerating, particularly in areas associated with automated and connected vehicles.	New and emerging technologies will both provide opportunities to improve the safety and efficiency of transportation and create new institutional challenges to planning and managing their deployment.
 **Safety –** On average, 10 deaths and 48 serious injuries are reported every day on Texas public roadways. While the annual number of traffic fatalities declined between 2002 and 2010, the state has seen an increase in recent years as the population and amount of travel has increased.	Promoting safety on the Texas transportation system is one of TxDOT's most important roles. In support of its strategic goal to "Promote Safety," TxDOT will continually seek and implement strategies to reduce crashes and fatalities through innovation, targeted awareness, and education.
 **Risk and Resiliency –** The transportation system has been negatively affected by several natural disasters in recent years such as flooding damage caused by Hurricane Harvey and wildfires in Bastrop and rural Texas.	Having a transportation system that resists and efficiently recovers in the face of disruptions will keep Texans safer, facilitate emergency management operations, and limit the extent of economic damages.

New Transportation Vision for Texas

Long-range planning is an opportunity to look beyond current trends, conditions, and practices to think about what the future of transportation in Texas could look like. To create a vision for the TTP 2050, TxDOT brought together a diverse group of transportation experts from across the state to develop a big picture, unconstrained view of what Texas could achieve in transportation over the next three decades. The discussion considered several strategic visioning questions, centered on the overarching importance of accessibility, affordability, and adaptability, and led to identification of progressive visions (**Figure 1-3**) for three time horizons between now and 2050: **Quickly Attainable** (next five years), **On-the-Horizon** (next 5 to 15 years,) and **Ultimate Dream** (15 to 30 years from now). These visions (described below) served as an important source of guidance and direction for development of the TTP 2050.

Visioning Questions

- What opportunities and challenges will be created by the deployment of new technologies such as connected and automated vehicles and electric vehicles?
- What can be done to move freight within the state more efficiently and effectively?
- How can emissions of greenhouse gases from transportation be significantly reduced?
- How can transportation be more accessible, affordable, and reliable for all citizens and businesses across the state?
- How can the connection between transportation and land use planning be improved, and will changing urban form require TxDOT to adapt?
- What needs to be done to achieve zero traffic fatalities and serious injuries by 2050 and incremental Road to Zero goals?

Figure 1-3: Progressive Range of Visions

Quickly Attainable

The Vision: Create a foundation for change by focusing on addressing "low-hanging fruit" that can be achieved through initiatives already underway and/or those that can be implemented in the near term.

- Improve safety and optimize the efficiency of existing infrastructure through rapid deployment of technology
- Establish policy direction and implement institutional changes to better facilitate multimodal investment in urban areas
- Continue to enhance the level of service in rural areas
- Expand outreach and education to communicate the benefits of multimodal transportation investment
- Expand coordination and collaboration across all transportation agencies in Texas

On-the-Horizon

The Vision: Transition to an emphasis on an adaptive, high-tech multimodal transportation system.

- Safety for all systems users, with separation between freight, connected and automated vehicles (CAVs), and other travelers as needed
- Shift in planning philosophy from moving vehicles on highways to moving people and goods on the transportation system
- Refinement of agency roles and responsibilities to facilitate multimodal solutions to transportation needs
- Establishment of new transportation funding mechanisms to replace the motor fuels tax
- Migration of system toward CAV use

Ultimate Dream

The Vision: The transportation system, services, and behaviors we should strive to realize 15 to 30 years from now.

- No transportation fatalities – the Road to Zero Initiative has been successful in cutting fatal crashes in half by 2035 and achieving zero deaths by 2050
- CAVs fully accommodated
- Transition of government transportation organizations from modal agencies to "mobility agencies"
- Transportation produces zero net emissions

Navigating the Plan

The remainder of this report documents the research, analysis, outreach, and findings from the TTP 2050 development effort and includes the following sections:

- **Chapter 2: Goals, Objectives, Measures, and Targets –** Provides the new TPP 2050 vision, goals, and objectives and describes their relevance for planning and programming priorities. It also presents performance measures that build on those in TxDOT's Performance Dashboard and will be used to monitor plan implementation.
- **Chapter 3: Texas Transportation System –** Describes the various modes and focus areas, including information on importance, TxDOT roles and responsibilities, related legislative requirements, system inventory and existing performance levels, associated TxDOT plans and programs, and applicable analysis and tools.
- **Chapter 4: Planning for the Future of Transportation in Texas –** Presents the methodology and findings from a scenario planning effort that evaluated the potential future implications of different technology deployment and economic futures, along with varying investment strategies for the Texas transportation system.
- **Chapter 5: Rural Transportation in Texas –** Describes the rural multimodal transportation network, TxDOT's role in rural planning, and current and forecasted performance levels. Also identifies planned Improvements in rural areas and special considerations associated with transportation in rural Texas.
- **Chapter 6: Public Involvement –** Describes the extensive outreach effort that supported TTP 2050 development and presents the associated input and findings.
- **Chapter 7: Implementation Strategies –** Identifies current and potential futures strategies that will enable TxDOT to make progress towards achieving plan vision.
- **Appendices:** Detailed documentation on development of the various TTP 2050 elements, along with other background information relevant to the plan. Appendices include:
  - **Appendix A –** An Electronic Notebook that provides a complete summary of the TTP 2050 public outreach effort
  - **Appendix B –** Technical reports and memorandums documenting research, analysis, and findings on a wide range of TTP 2050 development components
  - **Appendix C –** Lists of rural projects in TxDOT's Project Tracker


SCHOOL BUS
EXIT 251
Hesters Crossing
EXIT 250
TOLL ROAD
1¼ MILES
EXIT 251
Hesters Crossing
½ MILE
WRONG WAY
WRONG WAY
DO NOT ENTER
DO NOT ENTER

CHAPTER 2

Goals, Objectives, Measures, and Targets

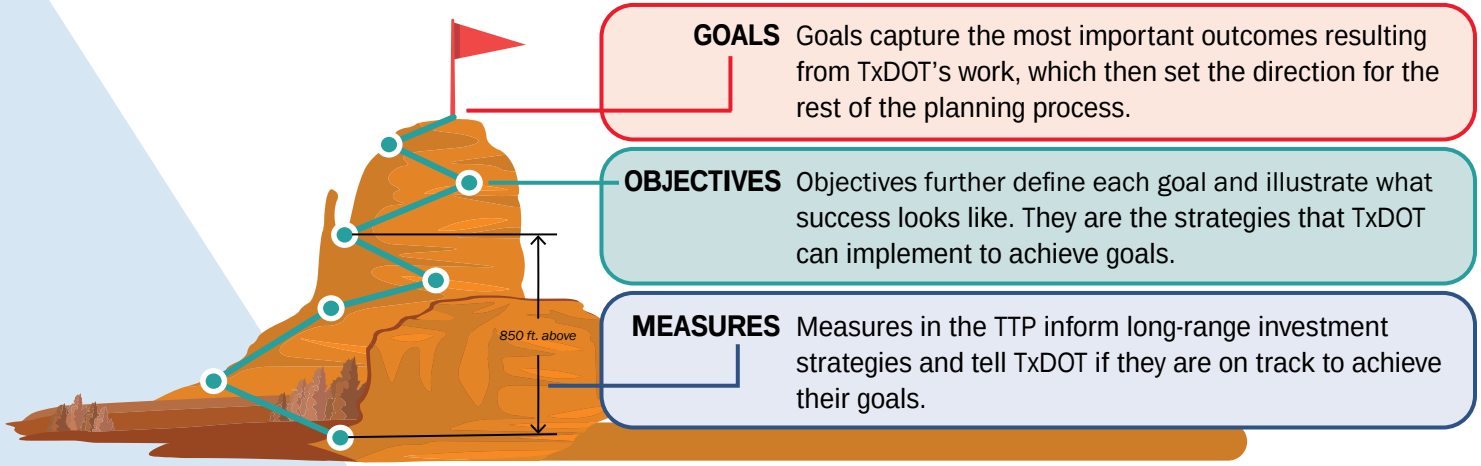
During each long-range planning cycle, TxDOT revisits its core strategic elements – goals, objectives, and performance measures – that will steer policy direction, propel momentum toward desired outcomes, and link the TTP to TxDOT's strategic decisions and on-the-ground actions. These strategic elements are updated through a collaborative effort that starts with the agency's existing strategic vision and expands to reflect evolving priorities, national transportation priorities, and insights from TxDOT subject matter experts, partners, and Texans across the state. Lastly, the process included the identification of a broad range of strategies that TxDOT is implementing now or will endeavor to in the future to ensure it achieves plan goals and objectives.

How TxDOT Identifies Goals, Objectives, and Measures

After research and discussion about trends, issues, and investment priorities, a Technical Working Group (TWG) comprised of TxDOT technical experts from a variety of disciplines recommends a draft set of goals and objectives. These draft goals and objectives are then presented to Texans during two rounds of public outreach and refined based on feedback.

Once goals and objectives are identified, the TWG identifies supporting measures that can be tracked statewide. Final versions of the goals, objectives, and measures are approved by TxDOT and formally adopted by the Texas Transportation Commission for the updated long-range plan.

What are Goals, Objectives, and Performance Measures?



GOALS Goals capture the most important outcomes resulting from TxDOT's work, which then set the direction for the rest of the planning process.

OBJECTIVES Objectives further define each goal and illustrate what success looks like. They are the strategies that TxDOT can implement to achieve goals.

MEASURES Measures in the TTP inform long-range investment strategies and tell TxDOT if they are on track to achieve their goals.

TTP 2050 Goals

The TTP 2050 Goals build from the TTP 2040 goals, with refinements to improve clarity and better align with the TxDOT 2019-2023 Strategic Plan. The resulting new goal areas are as follows:

- **Promote Safety**
- **Preserve Our Assets**
- **Optimize System Performance: Movement of People and Goods**
- **Deliver the Right Projects**
- **Foster Stewardship: Protect and Enhance the Human and Natural Environment**
- **Focus on the Customer: Communicate Effectively**

TxDOT's Vision, Mission, and Values

TxDOT's Strategic Plan outlines the agency's vision, mission, and values, which serve as an anchor for the TTP's goals.

Vision

Providing mobility, enabling economic opportunity, and enhancing quality of life for all Texans

Mission

Connecting You with Texas

Values

People

Accountability

Trust

Honesty

TTP 2050 Goals and Objectives

Promote Safety

Champion a culture of safety.

Improving the safety of the Texas transportation system has been and will continue to be TxDOT's highest priority. The safety goal focuses on TxDOT's efforts to reduce crashes and fatalities through the five "E's" of Evaluation, Engineering, Encouragement, Education, and Enforcement.

Objectives

- [Evaluation] Work with stakeholders to identify and develop proven and data-driven strategies, countermeasures, and programs
- [Engineering] Reduce crashes and lessen crash severity by implementing engineering solutions
- [Encouragement/Education] Use education and outreach to promote safe driving, bicycling, and pedestrian activities
- [Enforcement] Coordinate with first responders to improve incident response times

Preserve our Assets

Deliver preventive maintenance for the transportation system for the greatest overall efficiency and condition.

Proactively keeping Texas roads, bridges, and other infrastructure and technology in good repair protects our investments, lowers risks and costs associated with poor assets, and ensures that the assets Texans interact with are in good condition.

Objectives

- Preserve integrity of bridges and highway structure
- Provide roads that are smooth and structurally sound
- Keep other assets and technological devices operating
- Reduce long-term costs
- Mitigate asset risks

Optimize System Performance: Movement of People and Goods

Develop and operate an integrated transportation system that provides reliable and accessible mobility and enables economic growth.

People rely on the transportation system to get to school, to work, to obtain necessities or medical care, and for social reasons. Texas's growing population will increase demand for transportation into the foreseeable future, making it essential to address congestion and unreliable travel times.

Objectives

- Reduce congestion through both traditional and alternative strategies
- Enable reliable travel times
- Increase travel options/connections
- Ensure freight can move efficiently
- Increase access to jobs, services, and activity centers
- Leverage transportation assets to support economic growth and vitality

Deliver the Right Projects

Ensure efficient use of state resources.

As a state agency, TxDOT must be a good steward of its resources and promote fiscal responsibility by spending efficiently and strategically. Effective planning and forecasting processes help deliver the right projects on time and on budget.

Objectives

- Reduce user costs
- Identify and maintain reliable funding
- Improve analytic capabilities to maximize the value of investments
- Fairly distribute transportation benefits and costs
- Strategically deploy innovative technology to increase effectiveness and efficiency of the system
- Maintain sustainable funding

Foster Stewardship: Protect and Enhance the Human and Natural Environment

Integrate environmental considerations into all TxDOT activities.

Every day, teams of archeologists, historians and environmental scientists work with TxDOT engineers to build our transportation system around the state's valuable natural, historic and cultural resources so that future generations of Texans can benefit from them.

Objectives

- Enhance communities' quality-of-life through infrastructure and design choices
- Incorporate environmental resource considerations early in the planning process
- Avoid, minimize, mitigate adverse impacts to cultural, natural, and historic resources
- Design a resilient and future-focused transportation system

Focus on the Customer: Communicate Effectively

People are at the center of everything we do.

TxDOT is entrusted with making important decisions with public resources that greatly impact Texans' lives. Effective communication is a central part of maintaining that trust, so the public and stakeholders can see and understand TxDOT's decisions and provide feedback that is heard.

Objectives

- Communicate effectively with the public and partners
- Be accountable and transparent in decision-making
- Encourage feedback from the public and stakeholders
- Inform the public and stakeholders on TxDOT roles, costs, funding, and investment tradeoffs
- Improve communication/coordination with all planning partners and stakeholders

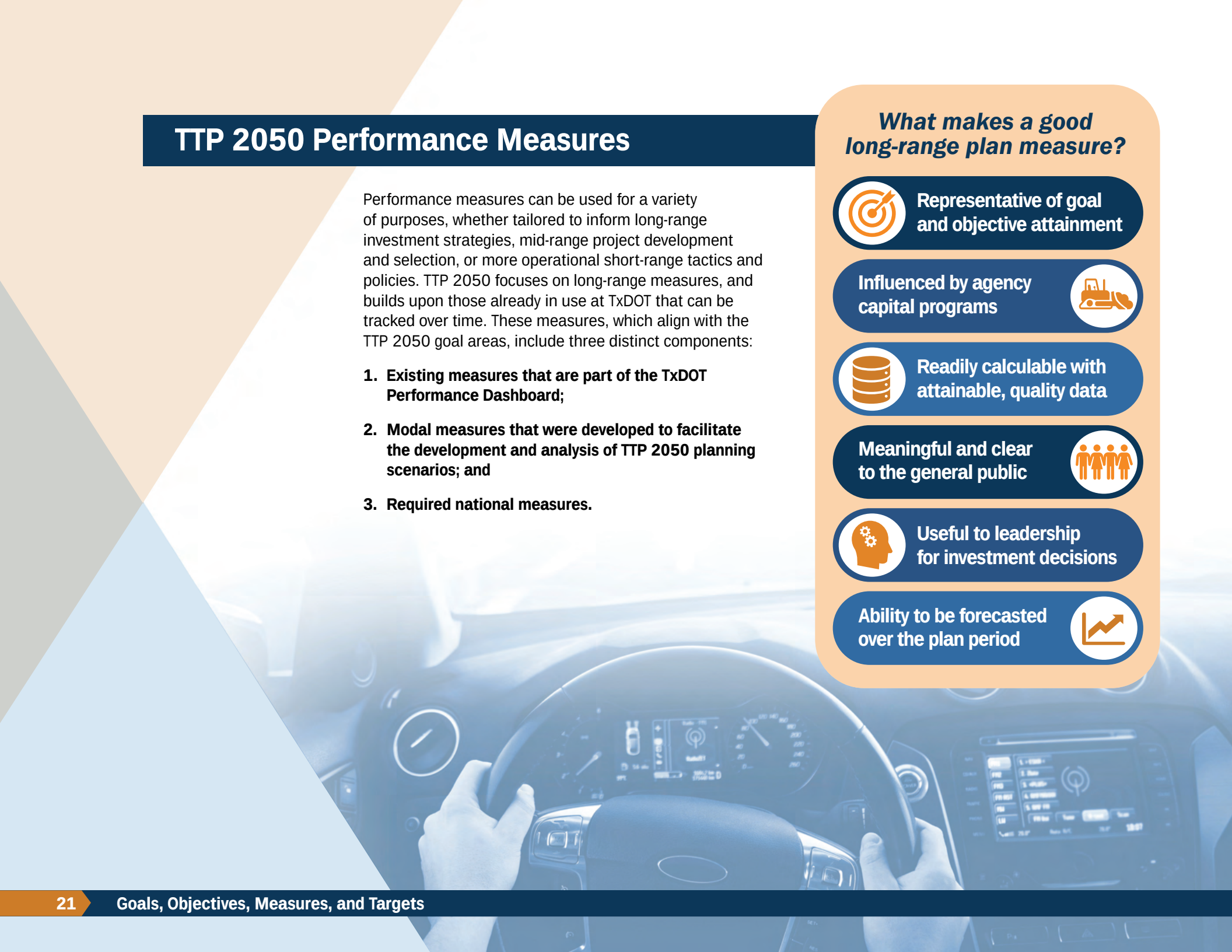
TTP 2050 Performance Measures

Performance measures can be used for a variety of purposes, whether tailored to inform long-range investment strategies, mid-range project development and selection, or more operational short-range tactics and policies. TTP 2050 focuses on long-range measures, and builds upon those already in use at TxDOT that can be tracked over time. These measures, which align with the TTP 2050 goal areas, include three distinct components:

1. **Existing measures that are part of the TxDOT Performance Dashboard;**
2. **Modal measures that were developed to facilitate the development and analysis of TTP 2050 planning scenarios; and**
3. **Required national measures.**

What makes a good long-range plan measure?

- Representative of goal and objective attainment
- Influenced by agency capital programs
- Readily calculable with attainable, quality data
- Meaningful and clear to the general public
- Useful to leadership for investment decisions
- Ability to be forecasted over the plan period



Texas Performance Dashboard Measures

TxDOT's performance dashboard builds from the department's strategic plan goal areas and is rooted in TxDOT's values, vision, and mission. The dashboard measures focus on system and organizational measures that are most critical for current and future success. These same measures also align with the TTP 2050 goal areas and provide transparency about TxDOT and Texas transportation system performance.

Table 2-1: TxDOT Performance Dashboard Measures

TTP 2050 Goal	TxDOT Performance Dashboard Measure*^	Recent Trend	Current Value	2030 Target	2050 Target
Promote Safety	Annual Fatalities and Fatality Rate	↘	3,645 (1.29)	*2,280 (0.70)	0 (0.00)
	Annual Serious Injuries and Serious Injury Rate	↘	14,922 (5.29)	–	–
	Fatality Associated with Emphasis Areas	Varies	Varies by Emphasis Area	–	–
	Employee Injury Rate	↘	1.01	1.00	1.00
Preserve Our Assets	Percentage of Lane Miles in Good or Better Condition	↗	88%	*90%	90%
	Bridge Condition Score	→	89	*90	90
Optimize System Performance: Movement of People and Goods	Urban Congestion	↗	1.25	*1.20	1.15
	Urban Reliability	↗	1.59	–	–
	Rural Reliability	→	1.14	*1.12	1.12
	Truck Reliability	→	1.37	–	–
	Annual Delay per Person	↘	32.46 hours	–	–
Deliver the Right Projects	Disadvantaged Business Enterprises (DBE) Attainment	↗	12.7%	–	–
	Historically Underutilized Businesses (HUB) Attainment	Varies	Varies by Contract Type	–	–
	Direct Transportation Funding	↗	$11.2 Billion	–	–
	Deliver on Budget	↘	79%	85%	85%
	Deliver on Time	↘	62.7%	65%	65%
Focus on the Customer: Communicate Effectively	Employee Engagement Score	↗	375	350	350
	Percentage of Customer Complaint Cases Closed on Time	↗	82.4%	–	–
	Customer Complaint Case Type	Varies	Varies by Case Type	–	–
	Average TxTag Call Wait Time	↘	12 min	–	–
	Average TxTag Call Handle Time	↘	6 min 24 sec	6 ½ min	6 ½ min

**Measures for "Protect and Enhance the Human and Natural Environment" are under development*
^Federal, Additional TTP 2050 Scenario Evaluation, and Vehicle Miles Traveled Measures not listed

**From 2021 UTP*

Trend legend

Red indicates a decline in performance

Green indicates an improvement in performance

- ↗ Performance improving (based on a higher value for the latest result)
- ↘ Performance improving (based on a lower value for the latest result)
- ↗ Performance declining (based on a higher value for the latest result)
- ↘ Performance declining (based on a lower value for the latest result)
- → Performance Stable (based on <1% change in latest result)

TTP 2050 Scenario Evaluation Measures

Scenario evaluation measures are specific to the long-range plan and used to assess the performance implications of possible futures. They therefore must be able to be aggregated at the state level and forecasted over the planning period. The TTP 2050 scenario evaluation measures give a holistic picture of overall transportation system performance through 2050.

Scenario Evaluation Measures by Performance Area	
Topic Area	**TTP 2050 Scenario Evaluation Measures**
Highway Safety	*For all publicly owned roadways ...* ■ Fatalities Count and Rate ■ Serious Injuries Count and Rate
Highway Mobility	*For on-system roadways ...* ■ Urban Congestion Index ■ Urban, Rural and Truck Reliability Indices ■ % Congested Urban and Rural DVMT
Highway Preservation	*For on-system roadways ...* ■ % Pavement Lane-miles in Good or Better Condition ■ Bridge Condition Score ■ % Poor Bridge Deck Area
Non-Highway Travel Options	■ % Completion of Long-Distance Bicycle Routes ■ % ITS, Transit, Non-Highway Freight, Ferry Operations and Aviation Spending Requests Met
Economy	■ Business Output ■ Value Added ■ Jobs Added ■ Labor Income Generated

National Goals and Performance Measures

To help ensure that federal transportation funding is spent efficiently and in service of the national interest, Congress established the following national transportation goal areas that need to be considered in development of statewide multimodal transportation plans:

- **Safety**
- **Infrastructure Condition**
- **Congestion Reduction**
- **System Reliability**
- **Freight Movement and Economic Vitality**
- **Environmental Sustainability**
- **Reduced Project Delivery Delays**

In conjunction with the creation of the nation transportation goals, the U.S. Department of Transportation has developed performance measures to advance state transportation performance management and provide a means for agencies to track and report on their contributions to achieving national goals and performance targets.

Consistent Performance Targets

The TTP 2050 enables TxDOT to attain federally reported performance targets. Progress towards national highway and transit performance measures for safety, system performance, infrastructure condition, and transit asset management are documented in TxDOT's System Performance Report. Federally reported highway performance data for Texas can be accessed at https://www.fhwa.dot.gov/tpm/reporting/index.cfm.

Highways

Safety (5-year rolling averages)

- Number of Fatalities
- Fatality Rate
- Number of Serious Injuries
- Serious Injury Rate
- Nonmotorized Fatalities and Serious Injuries

System Performance

- Level of Travel Time Reliability
- Peak Hour Excessive Delay
- Truck Travel Time Reliability
- Non-Single Occupancy Vehicle (Non-SOV) Travel
- Total Emissions Reductions

National Highway System (NHS) Infrastructure

- Pavement Conditions
- Bridge Conditions

Transit

Transit Safety

- Fatalities
- Injuries
- Safety Events
- System Reliability

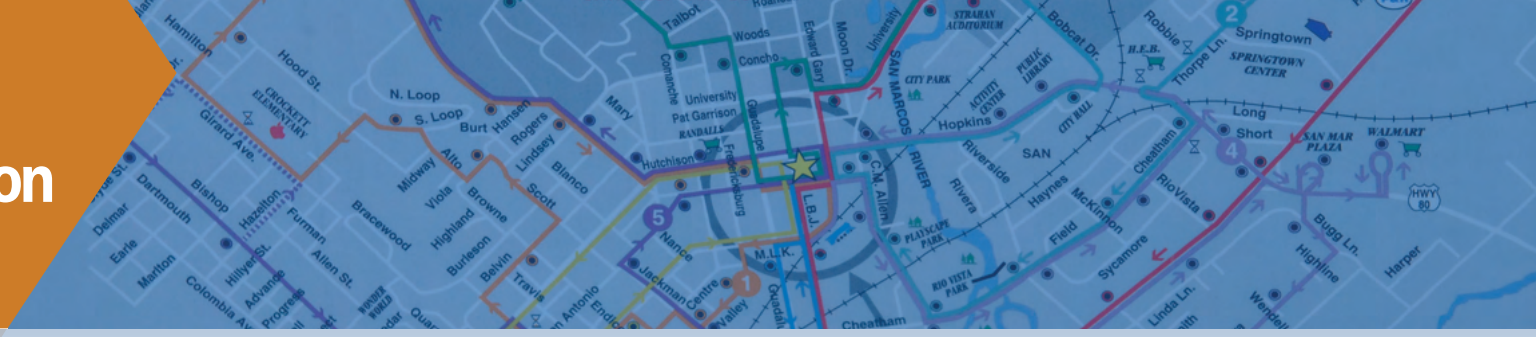
Transit Asset Management (TAM)

- Percentage of nonrevenue vehicles met or exceeded Useful Life Benchmark
- Percentage of revenue vehicles met or exceeded Useful Life Benchmark
- Percentage of track segments with performance restrictions
- Percentage of assets with condition rating below 3.0 on FTA TERM Scale*

**The Federal Transit Administration (FTA) Transit Economic Requirements Model (TERM) Scale is a condition measure which uses a 5-point scale in which 1 is poor and 5 is excellent.*

CHAPTER 3

Texas Transportation System



The Texas transportation system comprises the infrastructure, operations, and programs that allow for people and goods to move around the state. The system is multimodal in that it encompasses distinct ways of traveling and moving goods, such as the movement in cars and trucks on roads and highways, use of pedestrian or bicycle transportation, and various ways of moving freight. These modes are integrated: a person might use several modes for a single trip, and freight is often transferred to multiple modes before reaching its destination. The system is also owned and operated by a combination of public- and private-sector organizations that include TxDOT, local governments, transit agencies, tollway authorities, and private companies.

The functioning of the Texas transportation system affects the safety, cost, and reliability at which people and businesses can travel and transport goods. People use this system to travel to and from work, to access services and recreation, to visit family and friends, to make purchases, and for many other reasons. The system also provides for the movement of goods produced in Texas, those that are destined for Texans and Texas businesses, and those that are simply passing through. It permits Texans and Texas businesses to access all regions of the state, the rest of the country, and world.

This chapter provides an overview of the components that comprise the Texas transportation system. Due to the differences of each component, the sections vary by mode, but generally provide a description of the infrastructure element and its importance, define TxDOT's role and discuss associated performance, legislation, planning activities, and programs for the following areas:

- **Roadways and Highways** – Highway mobility, pavement and bridge preservation, safety, and intelligent transportation systems (ITS).
- **Freight** – The Texas Multimodal Freight Network and goods movement in and through the state.
- **Bicycle and Pedestrian Transportation** – Planning and programs associated with active transportation.
- **Public Transportation** – Scheduled transit and demand-response services throughout the state.
- **Aviation** – Airports, heliports, and related infrastructure that provide for air transportation in Texas.
- **Passenger Rail** – Current intercity passenger rail services and potential future high-speed rail investment.
- **Ferry operations** – Operations of coastal ferry routes.




Roadways and Highways

Roads and highways make all parts of Texas accessible to commerce and the traveling public. Texas has the largest road network and most bridges of any state in the country, with more than 314,000 centerline miles of public roads[3,4] and nearly 55,000 bridges.[5] TxDOT shares responsibility for building, maintaining and operating this infrastructure with other organizations.

Texans and Texas businesses depend on roads and highways for safe, reliable and efficient travel. Roads' and highways' condition and performance affect Texans' and Texas businesses' ability to undertake their daily activities. Roads and highways carry 92% of Texas commuters (in cars, trucks, vans, taxis, or motorcycles),[6] and trucks using Texas roads and highways carried 38% of freight movement originating in Texas in 2020 as measured by ton-miles.[7] This chapter discusses the following components of TxDOT's highway program.

- **Safety:** TxDOT is working toward "a future with zero traffic fatalities and serious injuries" on Texas roads, and in 2019 TxDOT formally enacted an ambitious goal of achieving zero deaths by 2050.[10,11]
- **Pavement:** TxDOT oversees 80,444 centerline miles of highways.[8] These "on-system" highways account for many of the busiest highways in the state.
- **Bridges:** TxDOT oversees more than 35,000 on-system bridges covering an area as large as 7,800 football fields.[9]
- **Highway mobility:** Movement of people and goods on Texas state highways are included in the term "highway mobility." On average, there are 540 million on-system VMT each day,[8] which is enough to circle the earth nearly 100 times every minute.
- **Intelligent transportation systems (ITS):** TxDOT uses ITS to help it manage transportation infrastructure and coordinate incident response, which increases highways' reliability, mobility, and safety. The systems and devices that support TxDOT's transportation system management include cameras, dynamic message signs above highways, vehicle detectors, and weather stations, among others.

Definitions

- **National Highway System (NHS):** Roadways classified as important to the nation's economy, defense, and mobility, including the Interstate Highway System.
- **Non-NHS:** All roadways not designated as on the NHS.
- **On-system:** All roads under the jurisdiction of TxDOT.
- **Off-system:** All roads not under the jurisdiction of TxDOT.
- **Urban roadways:** All roadways within metropolitan planning organization (MPO) regional boundaries.
- **Rural roadways:** All roadways outside MPO regional boundaries.
- **Centerline miles:** Length of a road or highway regardless of how many lanes it has.[1]
- **Lane miles:** Length of road in miles multiplied by the number of driving lanes.
- **Vehicle miles traveled (VMT):** Measures the amount of travel for all vehicles over a given time period.[2]

Pavement and Bridge Preservation

Pavement and bridge preservation refer to actions that keep road infrastructure in a state of good repair and protect the public's investment. Broadly speaking, pavement and bridge preservation include routine and preventive maintenance, rehabilitation, and reconstruction activities.[9]

Importance of Investment

TxDOT has designated "Preserve Our Assets" as one of its strategic goals[12] in recognition of the importance of keeping the state's highway network in good condition. Texas residents, businesses, and visitors use the state's roads for purposes such as commuting, recreation, freight, and commerce. Good pavement conditions make traveling safer,[13,14] lower vehicle operating costs,[15] and increase traveler comfort because of smoother roadways.[16] Good bridge conditions protect the traveling public's safety, avoid traffic interruptions, and minimize the need for diversions.

TxDOT Plans and Programs

The *Transportation Asset Management Plan* (TAMP) is TxDOT's primary planning mechanism for developing strategies to optimize investment in pavement and bridges by identifying a sequence of activities to continue or reach a state of good repair at minimum cost.[17] The department implements pavement and bridge preservation projects through financially constrained programs. This includes the Unified Transportation Program (UTP), which allocates funding to TxDOT's pavement and bridge preservation efforts, the maintenance program for more routine pavement activities,[9] and several bridge-specific funding programs.[18,19,20]

TxDOT Roles and Responsibilities

TxDOT shares responsibility for keeping the state's pavement and bridges in a state of good repair with other local and state partners. TxDOT supervises the planning, policy, construction, maintenance and operation of on-system bridges and pavement.[9]

- **Pavement** – TxDOT manages the inspection, evaluation, preservation and restoration of on system roads.[21] The department also supports partners by contracting vendors to collect pavement condition data for the off-system NHS to inform federal reporting.[9]
- **Bridges** – TxDOT supports preservation of all bridges in the state (regardless of ownership) by overseeing inspections, reviewing plans, and developing design standards, manuals, and guidelines.[22,9]

Legislative Requirements

TxDOT's management of pavement and bridges is influenced by both state and federal requirements. The Texas Legislative Budget Board sets performance targets every other year for routine system maintenance measures related to pavement and bridge condition.[23] Texas statutes also require TxDOT to report progress toward TTP goals every year, which include pavement and bridge preservation goals.[24] In addition, federal laws and regulations mandate that TxDOT develop a TAMP to manage risks to roads and bridges, and set performance targets for pavement and bridge condition. They also require TxDOT to establish performance targets for the NHS and report progress toward achieving them.

Pavement

System Inventory and Existing Performance

If the 314,000 centerline miles in the Texas public network were placed end-to-end, they would extend from the Earth to 75,000 miles beyond the Moon.[25,4] The on-system road network contains more than a quarter of the state's roads, and these on-system roads carry three quarters of motorized travel activity in Texas as measured by VMT.[26,27] As of 2018, 88% of pavement on TxDOT's on-system road network is in "good" or "better" condition (**Figure 3-1**).[28] TxDOT aims to continue improving on system pavement conditions, as demonstrated by its target goal for 90% of lane miles to be in "good" or "better" condition by 2028.[29]

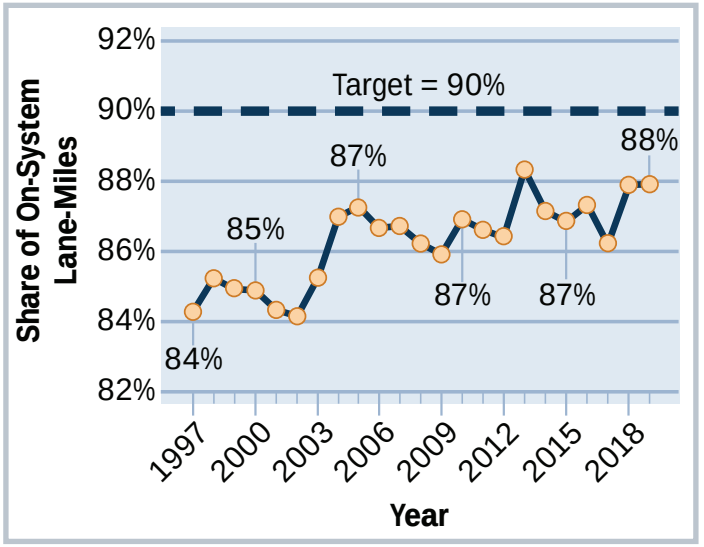
Analysis and Tools

TxDOT has found that investing in extensive maintenance strategies can lower long-term costs by reducing the need for more costly rehabilitation and reconstruction activities. In 2016, TxDOT implemented a new software solution called Pavement Analyst to support pavement management. Pavement Analyst stores pavement condition data and related inspection information, forecasts future pavement condition, allows for scenario analysis, and develops work plans to maximize systemwide pavement condition at a given funding level.[9] TxDOT used Pavement Analyst in developing the TAMP, which forecasts that investing an average of slightly more than $1.95 billion each year is required to achieve the 2028 target for pavement condition.[9]

Pavement-Specific Planning and Funding

In addition to the TAMP, TxDOT publishes a *4-Year Pavement Management Plan* with details for using pavement preservation funds appropriated by the Texas Legislature.[30] Both the UTP and TxDOT's maintenance operations program fund pavement activities. UTP pavement funding is expected to total $15.0 billion between fiscal years (FY) 2020 and 2027, and maintenance operations program funding is expected to total $5.7 billion over the same period.[9]

Figure 3-1: Historic "Good" or "Better" On-System Pavement Condition



Source: *Based on data from Texas Department of Transportation (2019), Conditions of Texas Pavements: PMIS Annual Report FY 2016–2019, Full Report.*

Bridges

System Inventory and Existing Performance

About two-thirds of the 55,000 structures in Texas are owned and maintained by TxDOT.[31] TxDOT focuses on three objectives to manage this network and to keep bridges safe and open to vehicular traffic:

1. **Maximize "good" bridge deck area** – TxDOT tracks the overall health of the system using a 0 (worst) to 100 (best) point rating system. The Texas bridge condition index has consistently remained around an overall score of 89. TxDOT has a goal of achieving a score of 90 by 2027.[29]
2. **Minimize "poor" bridge deck area** – Corrective action is needed as bridges age or traffic requirements change.
3. **Reduce costs** – TxDOT designs and constructs bridges to require minimal maintenance while still providing for a long service life.

TxDOT also tracks the share of bridges statewide that are in "good" or "better" condition, which correlates with the absence of routine maintenance issues, weight limitations, or failure to meet current design criteria for select topics. The share of "good" or "better" condition bridges has improved over the past decade and exceeds TxDOT's target of more than 80% of bridges statewide being in "good" or "better" condition (**Figure 3-2**).

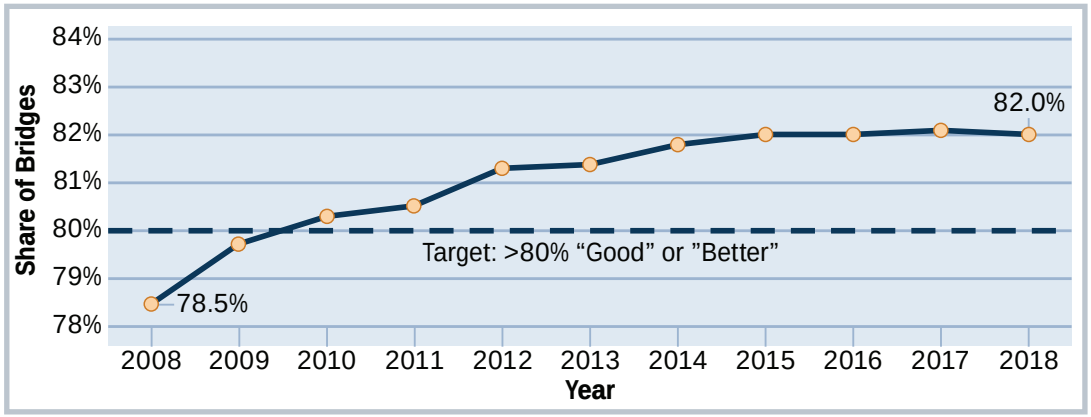
Analysis and Tools

Similar to pavement, TxDOT has found that investing in extensive maintenance strategies can reduce long-term bridge costs by reducing the need for more costly rehabilitation and bridge reconstruction. As part of TTP 2050, TxDOT used a custom asset management tool to analyze the effects on bridge performance of different levels of bridge spending. Based on this model, present investment levels are generally sufficient to maintain current performance. TxDOT is also investing in AASHTOWare Bridge Management software to forecast deterioration and identify candidate bridge work activities.

Bridge-Specific Planning and Funding

Bridge funding programs include maintenance operations, the Bridge Preventive Maintenance Program, and the UTP Category 6 sub-programs like the Highway Bridge Program and the Bridge Maintenance and Improvement Program. UTP bridge-related funding between FY 2020 and 2027 is expected to total $4.3 billion, and maintenance operations are expected to total $0.3 billion. Typically, TxDOT allocates 92% of bridge funding to the on-system network, with about two thirds of all funding going toward the NHS.[9]

Figure 3-2: Historic Share of Bridges Statewide in "Good" or "Better" Condition



Source: *Texas Department of Transportation (2018), Report on Texas Bridges.*[32]

Highway Mobility

Highway mobility refers to the sufficiency of the Texas road system to accommodate the safe, efficient, and reliable movement of people and goods. As the Texas economy continues to expand, cities and towns throughout the state will experience both the benefits of growth and the challenges that population and job increases create for maintaining and improving mobility in Texas.

Strategic Importance

Congestion and travel delays result when travel demand increases more than roadway capacity, operational efficiencies, or access to alternative modes. These forces, along with collisions, special events and other causes of day-to-day variations in the number of travelers, can also reduce travel time reliability. Investment to increase roadway capacity as travel demand grows and address disruptions is thus critical to minimize the cost and time that road users must dedicate to travel.

TxDOT Role and Responsibilities

TxDOT strives to achieve the "Optimize System Performance" goal in TxDOT's *2019-2023 Strategic Plan*[12] by working to relieve congestion and improve highway mobility. The department promotes mobility by planning, programming, managing design, overseeing construction, and operating and maintaining on-system highways and bridges. It implements specific programs that aim to relieve congestion. TxDOT shares responsibility for highway mobility with regional organizations and local governments, working with these entities to ensure the optimization of highway mobility investments across the state.

Fast Facts

- In 2018, traffic delay on the 100 most congested road sections in Texas was equivalent to 60,000 person-years and cost the state economy more than $11 billion.[33]
- 2017 annual congestion costs per auto commuter were $1,508 in Houston, the most congested Texas region.[34]
- As of 2020, an estimated 23% of travel in Texas urban areas and 2% of travel in rural areas occurs in congested conditions.[35]

TxDOT Plans and Programs

TxDOT addresses mobility through planning initiatives and system improvement programs. Relevant planning activities, which are developed in close coordination with MPOs, include:

- ***Transportation Systems Management and Operations (TSMO) Strategic Plan*** – Identifies technology deployments that can improve capacity of the existing system and mitigate congestion.
- ***Texas Freight Mobility Plan*** **(TFMP)** – Defines freight bottlenecks and proposes strategies to address them.
- ***Texas-Mexico Border Transportation Master Plan*** – Identifies projects to improve mobility and reduce congestion associated with border crossings.
- **Corridor Plans** – Help TxDOT understand the mobility needs of specific roadways and identify staged improvements to meet future travel demand.

Several TxDOT programs directly or indirectly support investment to reduce congestion and improve mobility. TxDOT authorizes funds for transportation projects in the UTP, which identifies projects over the next ten years that contribute to achieving the department's performance targets. Although all investments help improve mobility, project types with the greatest impact include new road capacity, roadway widening, interchange modifications, and ITS.[36] In addition, TxDOT launched the Texas Clear Lanes initiative in 2015 to counter congestion in the state's five largest metropolitan areas (i.e., Austin, Dallas, Fort Worth, Houston, and San Antonio). As of 2018, TxDOT has authorized about $1.6 billion of the total $6.8 billion expected to be allocated to the program.[37]

Tools

The Statewide Analysis Model – Version 4 (SAM-V4) is TxDOT's statewide travel demand model. It forecasts travel activity for highway passengers and trucks, intercity rail ridership, freight train tonnage, and air passenger travel. SAM-V4 allows TxDOT to analyze highway mobility and other transportation modes under different future scenarios to identify and address potential problems in the transportation system.

Legislative Requirements

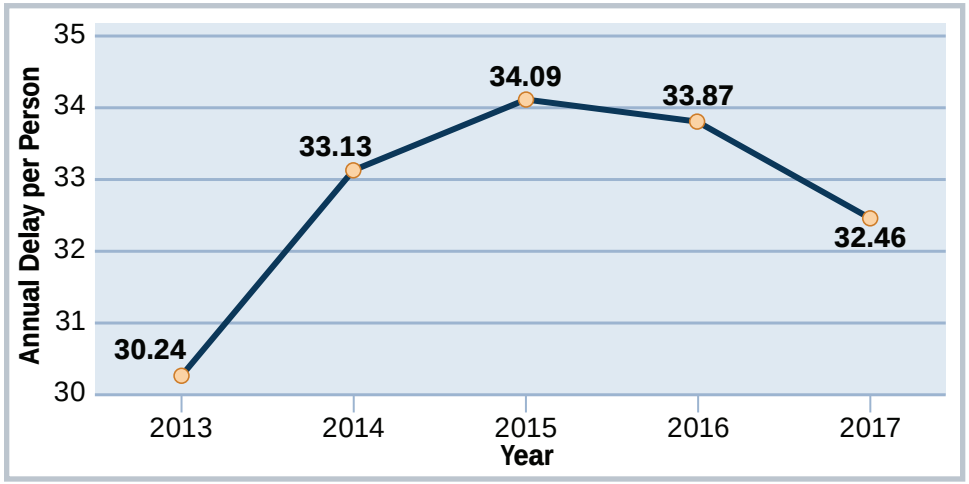
Texas law establishes rules that affect highway mobility by shaping the ways in which highway projects are planned, developed, designed, financed, and built. TxDOT also works with the Federal Highway Administration (FHWA) to meet state priorities related to highway mobility. In exchange for receiving federal funding, TxDOT must fulfill the requirements mandated by federal laws and regulations, including establishing performance targets related to highway mobility and reporting on progress toward meeting them. In 2020, the federal government allotted about $4 billion for Texas Federal-aid Highways through various programs that have separate requirements for how the funds can be used. For example, TxDOT receives $187 million from the Congestion Mitigation and Air Quality Improvement Program (CMAQ),[38] which may be spent on projects or programs that reduce congestion and help a metropolitan area meet or continue meeting relevant national air quality standards.[39]

System Performance

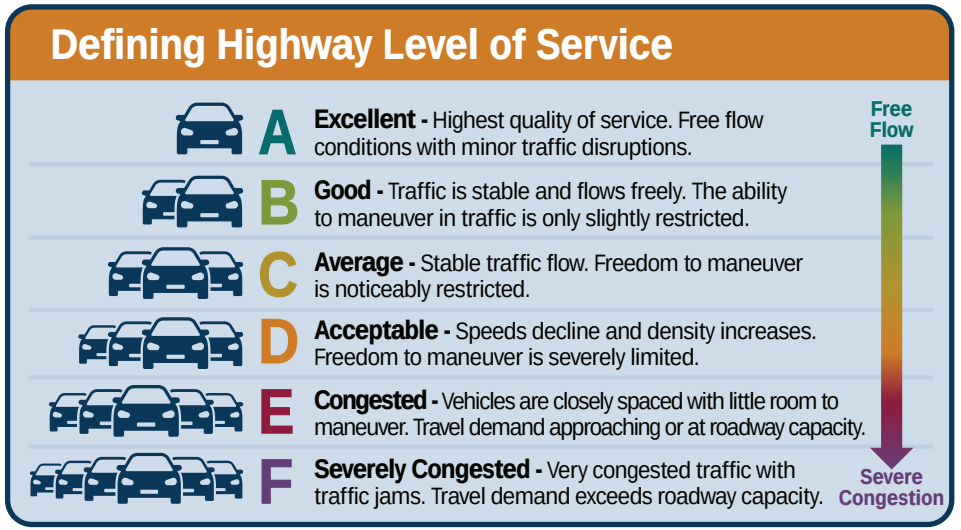
TxDOT monitors state and national performance measures that encompass different aspects of highway mobility, including congestion, reliability, and system usage to track its progress toward highway mobility goals. Although urban congestion and annual delay per person both increased during the five-year period between 2013 and 2017, the annual number of hours of delay per person peaked in 2015 and declined through 2017 as shown in **Figure 3-3**.

Congestion primarily affects urban transportation since some 23% of vehicular travel in urban areas takes place in congested conditions as graded by a level of service (LOS) of E or lower, whereas 2% of vehicular travel in rural areas takes places in congested conditions as graded by a LOS of D or lower (**Figure 3-4**).

Figure 3-3: Statewide Annual Delay Per Person (Hours)



Source: *Texas Department of Transportation (2018), Performance Dashboard: Optimize System Performance.*[40]

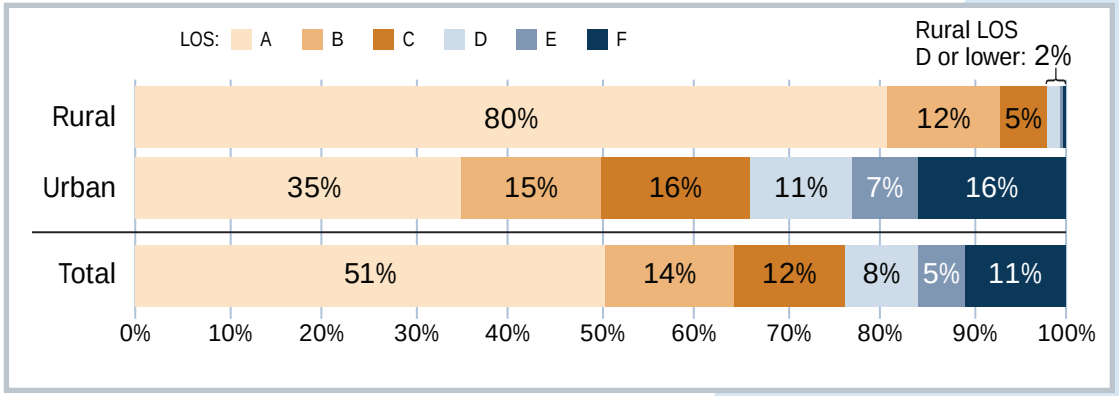


Look Ahead

Population growth, new transportation technologies, and extreme weather may present challenges to maintaining highway mobility in Texas in the future. Conversely, new developments in industry practices and technology may create chances for innovative solutions. To address these challenges and capitalize on opportunities, TxDOT will need to work with its local, state and federal partners, track emerging trends, and adopt investment strategies that continue to improve highway mobility. Examples of emerging issues include the following trends:

- The number of people living in Texas is expected to increase by 60% between 2020 and 2050,[41] and population growth tends to increase personal travel and freight demand.
- Growth in electronic commerce (e-commerce) may require more home deliveries while also generating concentrated trucking activity on the roads and highways around e-commerce distribution centers.
- Autonomous vehicles (AVs), which can drive with limited or no human intervention, may encourage longer distance travel and more automobile travel[42] by facilitating the use of in-vehicle travel time for activities aside from driving.[43]
- Increased hurricane intensity, storm surge, rainfall, sea level rise, and other extreme weather events like drought and extreme heat are potential disruptors to the Texas transportation system.[44,45]
- Ride-hailing may also complement existing transit systems by facilitating first- and last-mile connections,[46] and AVs may also regain mobility for those who cannot drive due to age or health impairments.

Figure 3-4: 2020 Daily Percentage of Vehicle Miles Traveled by Geography and Level of Service (LOS)



Source: *SAM-V4 Statewide Travel Demand Model (Results for Base-Year 2020)*

Highway Safety

Highway safety refers to actions to avoid deaths or injuries on public roads involving anyone who is using those roads, including occupants of cars, trucks and motorcycles; pedestrians and bicyclists; and construction zone workers. Safety also is linked with the concept of security, which includes protection against intentional disruption, emergency response during natural disasters or disruptions, and keeping evacuation routes clear and open.

Strategic Importance

Promoting safety is one of TxDOT's most critical roles as it works toward "a future with zero traffic fatalities and serious injuries."[10] The importance of safety is highlighted in the TxDOT mission, where safety is the first characteristic of the transportation system that TxDOT seeks to provide, and as the first goal in TxDOT's *2019-2023 Strategic Plan*.[12] As a result, safety is a key consideration in every TxDOT project, program, and decision.

TxDOT Role and Responsibilities

TxDOT performs several important functions associated with highway safety:

- Planning, designing, and constructing safety countermeasures for on-system roadways.
- Promoting safety on all public roads by educating the public on traffic safety, such as the "End The Streak" campaign which highlights the importance of safe, sober, and undistracted driving.[47]
- Collecting crash reports submitted by law enforcement officers.[48]
- Analyzing data to inform or dashboards, safety reports, and heat maps that guide safety improvement efforts.[49]
- Partnering with law enforcement in matters related to traffic safety and supporting initiatives related to security and emergency operations.[10]

Covers of Safety-Related Plans

Source: *Texas Department of Transportation 2020 Texas Strategic Highway Safety Plan,[10] 2018 Texas Freight Mobility Plan,[53] and Texas Highway Safety Plan Annual Report.[54]*

TxDOT Plans and Programs

The *Texas Strategic Highway Safety Plan* (SHSP) identifies emphasis areas, strategies to address safety issues, and performance targets for performance measures that TxDOT uses to track progress toward making highways safer. Other safety-related plans include the *Texas Highway Safety Plan* (HSP)[50] and the TFMP,[51] both of which are used by TxDOT's Traffic Safety Division to identify candidate safety projects for the UTP.[52]

Source: *Texas Department of Transportation (2020), #EndTheSTreakTX.[47]*

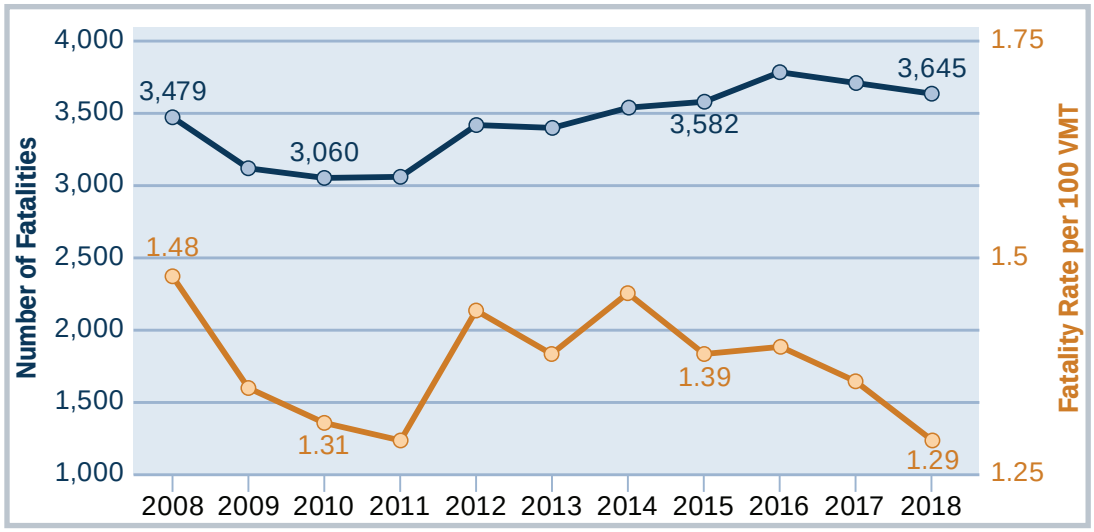
Legislative Requirements

State law requires TxDOT to collect and analyze crash reports submitted by law enforcement officers.[48] The Texas Legislature uses this information and other analysis to set short-term performance targets for annual fatality rates every other year. Federal regulations also require TxDOT to set and report on progress toward statewide targets for safety performance associated with the number and rate of motorized and non-motorized fatalities and serious injuries on public roads. This federal performance reporting then influences TxDOT development of policies and strategies to support federal safety programs, such as the Highway Safety Improvement Program (HSIP).[55]

System Inventory and Existing Performance

TxDOT reports safety performance for all public roads in Texas. On average, 10 deaths and 41 serious injuries were reported every day in 2018 on Texas public roadways.[56] Annual fatalities on Texas roads have risen by 5% since 2008, while VMT has increased by 20% (**Figure 3-5**). The fatality rates fell by 13% from 2008 to 2018 to 1.29 per 100 million VMT because of the fast growth in VMT.[57,58] The serious injury rate fell by 22% between 2008 and 2018 to 5.29 per 100 million VMT.[58]

Figure 3-5: Historically Observed Annual Fatalities and Fatality Rate in Texas between 2008 and 2018



Source: *National Highway Traffic Safety Administration, NCSA Data Resource Website, Fatalities and Fatality Rates by State, 2000-2002,[57] Texas Department of Transportation, Comparison of Motor Vehicle Traffic Deaths, Vehicle Miles, Death Rates, and Economic Loss, 2003-2018[59] and Performance Dashboard — Promote Safety.[58]*

Investment in Safety

In May 2019, the Texas Transportation Commission directed TxDOT to work toward the goal of reducing the number of deaths on Texas roadways by half by 2035 and to zero by 2050.[60] One way in which TxDOT seeks to bring the highway system closer to this vision is through its safety investment. Safety investment supplements TxDOT's other safety programs and initiatives, as well as investments and actions by other state agencies, local governments, and the private sector. TxDOT primarily funds safety projects through its "safety" category of UTP funding (Category 8). The 2020 UTP increased funding in Category 8 to about $4.03 billion over the 10 years between FY 2020 and 2029.[52] Additionally, between FY 2020 and 2021 TxDOT will authorize an additional $300 million per year in UTP Category 8 funding to support its work to reduce traffic fatalities to zero by 2050.[60] Beyond this direct safety investment, there is even more spending that indirectly improves safety, because almost every construction project has a safety element.

The 2020 UTP increased funding in Category 8 to about $4.03 billion over the 10 years between FY 2020 and 2029.[52] Additionally, between FY 2020 and 2021 TxDOT will authorize an additional $300 million per year in UTP Category 8 funding to support its work to reduce traffic fatalities to zero by 2050.[60]

Intelligent Transportation Systems

Intelligent transportation Systems (ITS) include the devices, facilities, communications media, and systems that use technology to make traveling in Texas safer and more reliable. ITS services can be leveraged to provide travel demand management capabilities (i.e., improving traffic congestion by offering travel choices). They also can assist with system-level highway operations for corridors and regions, and can facilitate the efficient movement of freight and goods along strategic, high-volume freight corridors, including border crossings. By collecting and processing large amounts of data, ITS enables TxDOT to manage and operate its transportation infrastructure more effectively and safely, and ITS helps it to coordinate incident response activities.

Strategic Importance

Investment in ITS improves the effectiveness of TxDOT's incident management, traffic control, emergency management, and evacuation efforts. By deploying ITS in locations experiencing repeated collisions and areas of high congestion, ITS provides a cost-effective means for TxDOT to achieve its department-wide strategic goals of "Promote Safety" and "Optimize System Performance."[12]

ITS in Texas

TxDOT deploys and maintains a wide range of ITS devices across the state. Examples of these technologies include:

- Surveillance cameras
- Portable and permanent Dynamic Message Signs
- Detectors (loops, microwave, video, and Bluetooth)
- Weather stations
- Flood, ice and fog detection systems
- Closed-loop, central or adaptive signal controls
- Computer-aided dispatch for transit and emergency vehicles
- Security cameras, Automatic Vehicle Location (AVL) devices and data terminals
- Global Positioning Systems (GPS) on buses
- Mobile data terminals and AVL devices on transit and emergency vehicles
- Traffic signal preemption
- Wired (including fiber) and wireless (Wi-Fi and radio-based) communications
- Weigh-in-motion stations
- Highway advisory radio
- Warning systems (signal ahead, speed on curves and school zones)

Plans and Programs

The TxDOT *ITS Strategic Plan* provides a framework to guide the development and deployment of an integrated statewide ITS program and defines TxDOT's role in deploying ITS solutions across the state system. ITS overlaps with several other TxDOT program areas, such as Traffic System Management and Operations (TSMO), freight and safety. It is guided by plans for these areas and funded through a range of programs. TxDOT has invested heavily in ITS in recent years, with total current spending estimated at about $50 million annually.

TXDOT Roles and Responsibilities

TxDOT owns and maintains thousands of ITS devices deployed along the on-system network, striving to incorporate ITS into every aspect of traffic management activity. TxDOT plays a key role in ITS deployment beyond the state system by providing advocacy and technical assistance, performing oversight for federally funded projects, and establishing standards that can be used by local governments.

The Future of ITS in Texas

TxDOT has numerous initiatives focused on key trends and issues related to ITS, including connected and autonomous vehicles (CAVs), TSMO, broadband connectivity, and unmanned aerial systems (UAS).

- The CAV Workgroup is TxDOT's central CAV planning forum. It provides TxDOT leadership and staff with a coordinated source of information on CAVs, including research, grant applications, deployments, resources, and recommendations for long-term CAV strategies.
- TxDOT activities related to CAVs include Light Detection and Ranging (LiDAR) data sharing with original equipment manufacturers, managing the GPS enhancement network, advanced network strategies, exploring 5G and dedicated short-range communications technology deployments, and supporting the Texas Connected Freight Corridors project through investment in cellular modems.
- The Connectivity Network Strategy (CNS) will provide the basis for TxDOT's strategic approach to connectivity. The goal of the CNS is to expand on this work to investigate and pilot new agreements with private telecommunications providers through either revenue-based or in-kind agreements.
- In July 2019, TxDOT lifted a moratorium on departmental use of UAS and authorized contractors and approved service providers to operate UAS on a six-month trial basis in support of TxDOT operations.

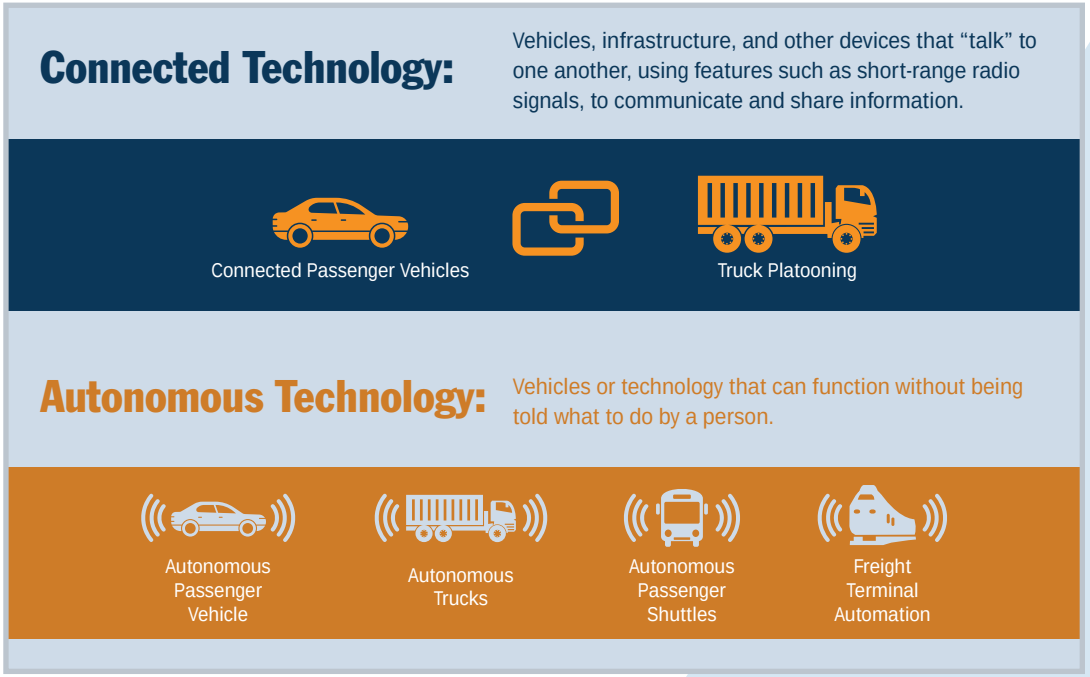
TxDOT ITS Planning Efforts

Existing Plans

- ***ITS Strategic Plan –*** Provides a framework to guide the development and deployment of an integrated statewide ITS program.

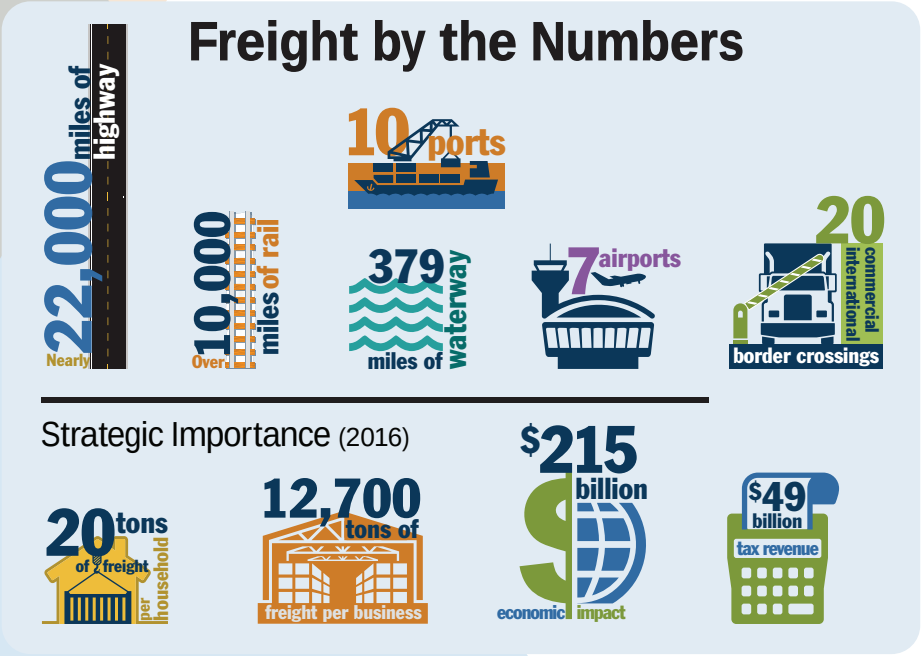
Plans in Development

- ***Emerging Transportation Technology Plan –*** Will identify implementation strategies to integrate emerging technology into state planning practices.
- ***Texas-Mexico Border Master Plan –*** Currently being developed in partnership with the Border Trade Advisory Committee, and will identify border-crossing challenges associated with goods and people.
- ***Texas Freight Network and Operations Plan (TFNOP) –*** Will build on a recommendation on the TFMP to develop and implement a statewide, technology-based freight safety and operations program.



Freight

The topic of freight involves infrastructure, policies and programs that support the efficient and safe movement of goods in Texas on the state's multimodal freight transportation system. This system includes the newly designated Texas Multimodal Freight Network (TMFN), which consists of key transportation system components associated with freight movement in the state. As Illustrated in **Figure 3-6** the network includes nearly 22,000 miles of highway, more than 10,000 miles of rail, 10 ports, 379 miles of waterway, seven airports, and 20 commercial international border crossings.[61] Pipelines are not part of the TMFN, but also are critical to goods movement.



Strategic Importance

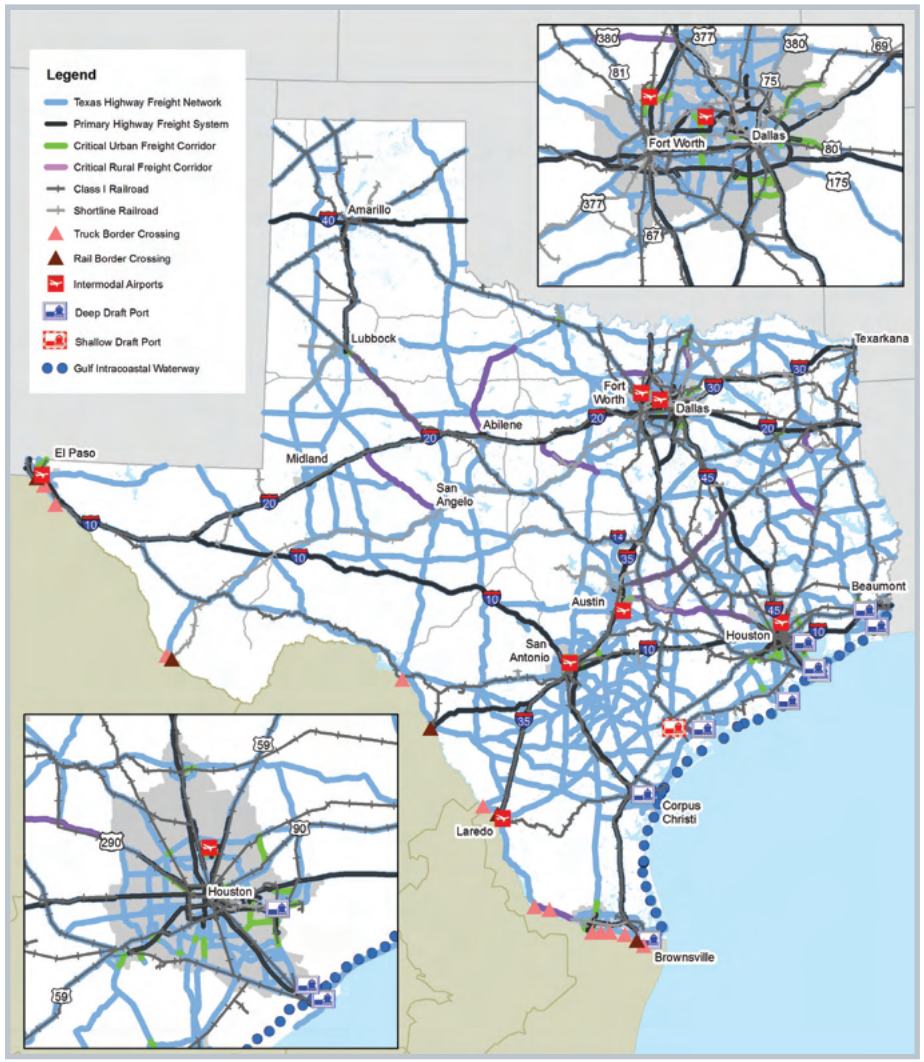
The reliable movement of goods is a critical component for the Texas economy, supporting major industrial sectors such as energy, agriculture, and manufacturing. As identified in the Texas Freight Mobility Plan (TFMP), the Texas transportation system delivered 20 tons of freight per household and 12,700 tons of freight per business in 2016, generating $215 billion of economic impact and $49 billion in tax revenue.[61] The freight transportation industry in Texas is a large employer, supporting an estimated 2.2 million full-time jobs and $145 billion in wage income.[61] To ensure continued opportunity for all Texans as the state's population grows, it will be essential to maintain a transportation system that keeps Texas competitive both nationally and globally.

TxDOT Roles and Responsibilities

TxDOT's roles and responsibilities for freight vary by system component and whether it is on- or off-system. Overall, the department leads statewide freight planning through development of the TFMP, which establishes statewide freight goals and performance measures. TxDOT also uses several committees to facilitate communications with a range of freight stakeholders on project development and funding, which guide freight planning and policymaking. TxDOT's specific roles for individual freight modes include:

- **Highways** – Planning, development, funding, construction, and management for the on system highway component of the TMFN.[62]
- **Rail** – Rail planning and safety oversight, rail grant administration, and South Orient Railroad management.[63]
- **Ports & Waterways** – Promotion of intermodal connectivity.[64]
- **Air Cargo** – Assistance to cities and counties to obtain federal and state aviation funds.[65]
- **Pipelines** – Coordination with the Texas Railroad Commission on permitting.

Figure 3-6: Texas Multimodal Freight Network



Source: *Texas Department of Transportation (2018), Texas Freight Mobility Plan 2018.*

Freight Goals & Performance Measures

Promote Safety

- Truck-related crashes per truck-miles traveled on the THFN
- Percent of all fatal motor vehicle crashes involving trucks on the THFN
- Number of rail-related crashes

Deliver the Right Projects

- Number of meetings held with non-TxDOT agencies responsible for freight system investment
- Percent of projects on the THFN delivered on time and within budget

Focus on the Customer

- Completion of annual update of educational materials related to freight by TxDOT

Optimize System Performance

- Annual hours of truck delay on the THFN
- Number of airport cargo/port access issues addressed

Preserve Our Assets

- Percent of pavement miles in good repair on the THFN
- Percent of intermodal connectors in fair or better pavement condition

Foster Stewardship

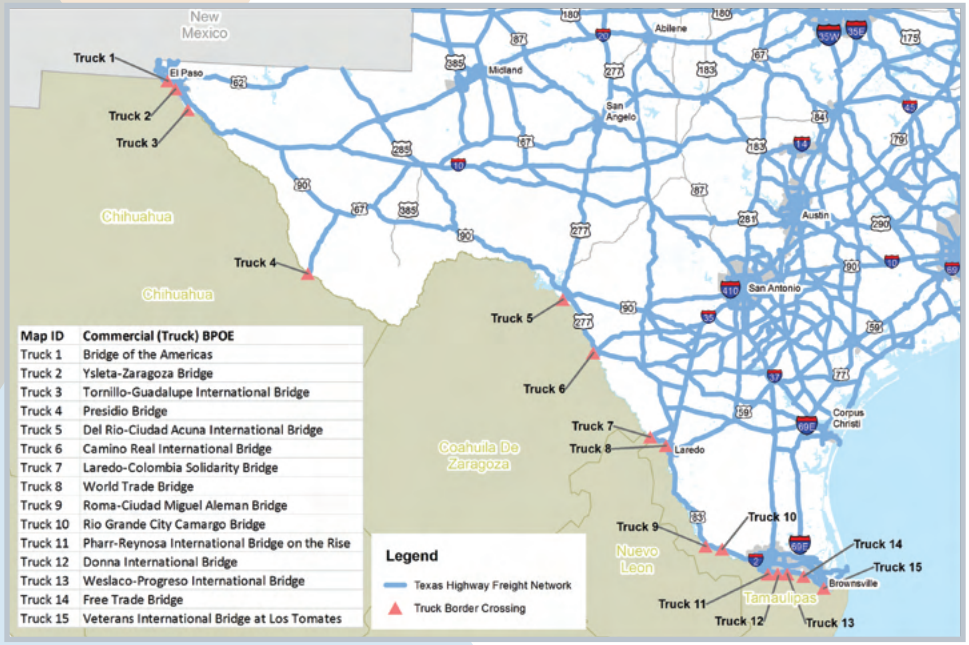
- Amount of new funding for freight projects
- Number of public private partnerships for freight

Source: *Texas Department of Transportation (2018), Texas Freight Mobility Plan 2018 Appendix.*[66]

Truck Freight

The Texas Highway Freight Network (THFN) is the state's primary system for moving goods through and within Texas. The THFN includes the Texas portion of the National Highway Freight Network (NHFN), a federally defined network of the country's most important freight highways that includes the Interstate Highway System. It also includes the Texas Highway Trunk System, a nearly 10,500-mile network of rural highways,[67] that helps provide connectivity between NHFN routes, intermodal facilities, Mexican ports of entry, and other major freight generators. The THFN includes 15 commercial vehicle crossings that connect the United States' and Mexico's transportation systems (**Figure 3-7**).[61] Goods moving across the border travel on 14 international bridges, which accommodate 68% of all trucks coming from Mexico into the U.S.[61] Additionally, a 15th facility, the Donna International Bridge, serves empty containers moving across the border.[61]

Figure 3-7: Texas-Mexico Commercial Vehicle Border Crossings



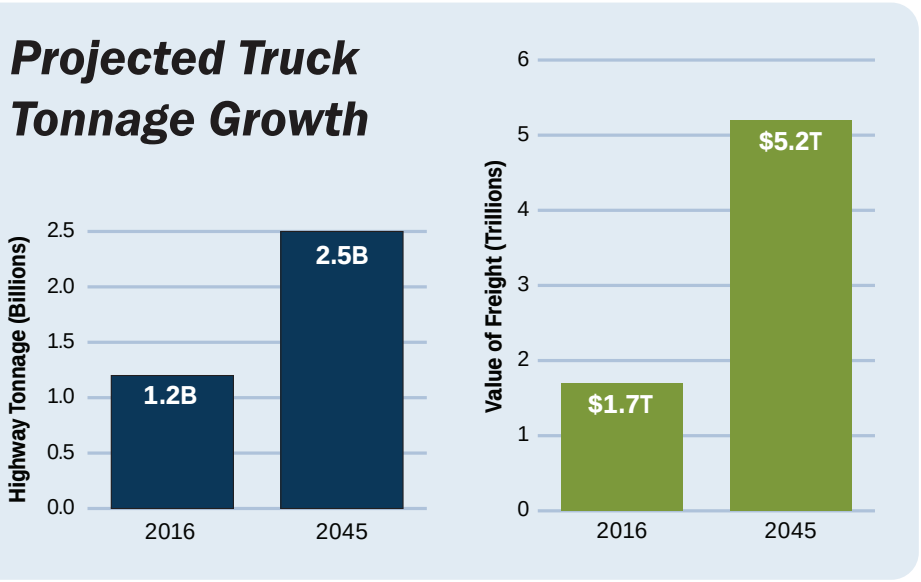
Map ID	Commercial (Truck) BPOE
Truck 1	Bridge of the Americas
Truck 2	Ysleta-Zaragoza Bridge
Truck 3	Tornillo-Guadalupe International Bridge
Truck 4	Presidio Bridge
Truck 5	Del Rio-Ciudad Acuna International Bridge
Truck 6	Camino Real International Bridge
Truck 7	Laredo-Colombia Solidarity Bridge
Truck 8	World Trade Bridge
Truck 9	Roma-Ciudad Miguel Aleman Bridge
Truck 10	Rio Grande City Camargo Bridge
Truck 11	Pharr-Reynosa International Bridge on the Rise
Truck 12	Donna International Bridge
Truck 13	Weslaco-Progreso International Bridge
Truck 14	Free Trade Bridge
Truck 15	Veterans International Bridge at Los Tomates

Source: *Texas Department of Transportation (2018), Texas Freight Mobility Plan 2018.*[61]

By 2045, congestion and truck tonnage are projected to increase significantly on interstate highways throughout the state, particularly those located in what is known as the Texas Triangle (the "megaregion" connected by I-10, I-35, and I-45). The border gateways of Laredo, El Paso, and the Rio Grande Valley will also be heavily impacted, along with major manufacturing and distribution hubs, and agricultural and energy development areas such as Midland-Odessa, Amarillo, and Lubbock. The highest increase in truck volumes are projected to be on I-35, I-10, I-45, and I-40.[61]

The state's growing truck tonnage will lead to increased daily truck trips and truck miles traveled, which in turn will further exacerbate congestion. In 2016, an estimated 745,800 daily truck trips occurred on Texas' roadways. This figure is projected to increase by nearly 50% to more than one million daily truck trips by 2045. This increase in truck trips will in turn mean more truck miles traveled on Texas roadways.[61]

Highway tonnage is expected to double from 1.2 billion tons in 2016 to 2.5 billion tons in 2045, a projected increase of 1.3 billion tons and growth of 108%. During this period, the value of freight moved in Texas is forecasted to grow by 213% from $1.7 trillion to $5.2 trillion.[61]



Freight Rail

With more than 10,000 track miles, Texas has more miles of rail than any other state.[53] Three major (Class I) railroad companies operate within Texas: BNSF Railway, Kansas City Southern, and Union Pacific. Additionally, there are 49 shortline railroads that serve as important first- and last-mile connections for the Class I railroads, Texas ports, and numerous industries.[53] In total, rail accounted for just over 20% of the tonnage moved in Texas in 2016, which equated to 440 million tons.[62]

Texas is home to five of the seven rail border crossings between the U.S. and Mexico: The West Rail Bypass International Bridge in Brownsville, Bridge of the Americas in El Paso, Texas Mexican Railway International Bridge in Laredo, and the Camino Real International Bridge in Eagle Pass. In addition, the Presidio Rail Bridge is expected to reopen within the next five years.[53]

With more than 10,000 track miles, Texas has more miles of rail than any other state.[53]

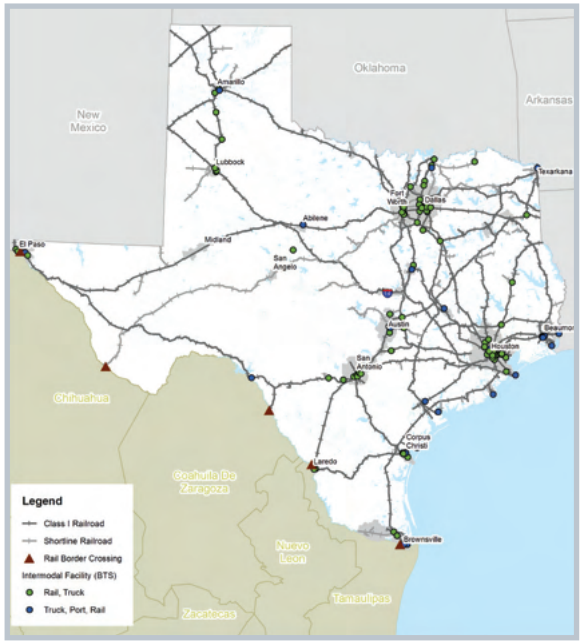
Ports and Waterways

Texas has 12 deep draft and nine shallow draft commercial ports (deep draft ports have channel depths greater than 30 feet).[61] The ports are connected by the Gulf Intracoastal Waterway (GIWW), which runs from Texas to Florida and was designated as Marine Highway 69 in 2016. Between 2014 and 2016, an average of 80 million short-tons per year were transported along the Texas portion of the GIWW.[68] Cargo carried on the GIWW helps reduce congestion and wear and tear on the state's highway and rail systems, which decreases maintenance costs and extends the lifespan of inland infrastructure. Furthermore, transporting goods on the GIWW is the most fuel-efficient mode of transportation, producing less air pollutants per ton of cargo carried than any other mode.[69]

Ports and waterways on the TMFN handled more than 476 million tons of freight or about 22% of the total tonnage for all modes in 2016.[62] As of 2017, six Texas ports ranked in the top 50 ports in the U.S. for total tonnage. The Port of Houston had the second highest tonnage of any port in the U.S. in 2017.[70] The National Multimodal Freight Network (NMFN) includes all U.S. ports handling two million or more short-tons of cargo annually. TxDOT adopted the same criteria in designating facilities for the TMFN.[61]

Texas has 12 deep draft and nine shallow draft commercial ports (deep draft ports have channel depths greater than 30 feet).[61]

Figure 3-8: Railroads on the Texas Multimodal Freight Network



Source: *Texas Department of Transportation (2018), Texas Freight Mobility Plan 2018.*

Table 3-1: National Port Rankings by Tonnage

Port	National Rank
Houston	**2**
Beaumont	**5**
Corpus Christi	**6**
Port Arthur	**17**
Texas City	**18**
Freeport	**31**
Galveston	**59**
Brownsville	**61**
Victoria	**80**
Calhoun Port Authority	**81**

Source: *U.S. Army Corps of Engineers (2018), Principal Ports of the United States.[70]*

Air Cargo

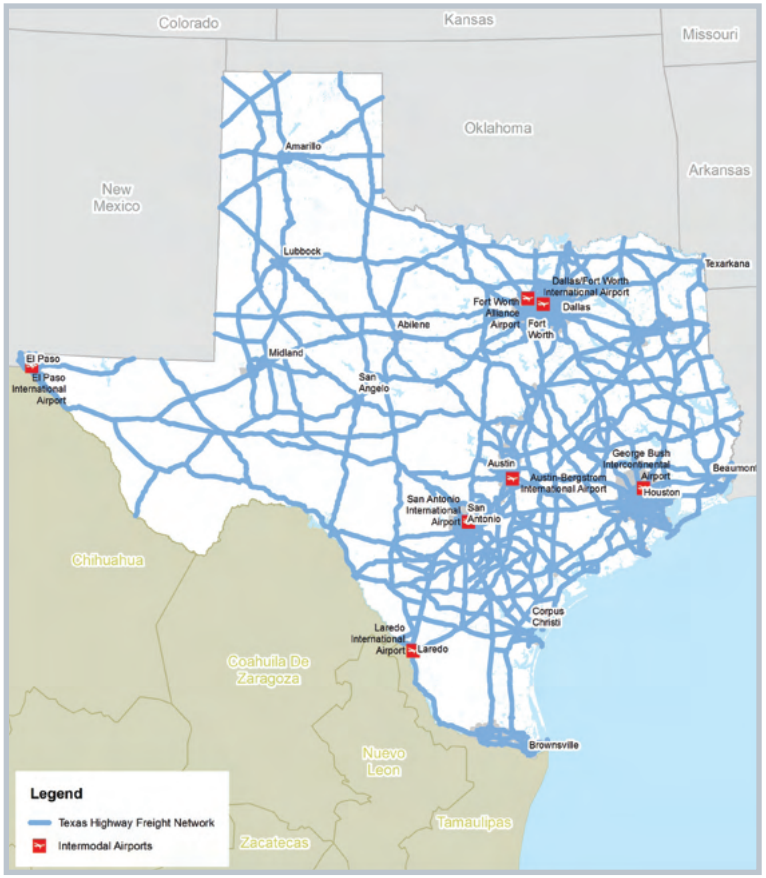
Air cargo is a key component of the TMFN, particularly for shipping high-value and/or time-sensitive goods. In 2018, Texas was home to six of the top 50 cargo airports in the U.S. in terms of landed weight. Those airports include Dallas/Fort Worth International, George Bush Intercontinental/Houston, San Antonio International, Fort Worth Alliance, El Paso International, and Laredo International.[71] Air cargo tonnage is expected to grow at a higher rate than any other mode due to the proliferation of e-commerce paired with expectations of one- or two-day shipping among other market changes.[61] In 2016 air cargo accounted for more than 1.1 million tons of landed weight in Texas.[62]

Landed weights for airports included in the TMFN (**Figure 3-9**) have been increasing in recent years. Dallas-Fort Worth International Airport, the ninth largest cargo airport in the U.S., saw a remarkable 40.5% increase in landed weight from 2013 to 2018.[71]

Airport connectivity to the surrounding transportation network and built environment enables goods to move to their final destinations. Successful air cargo operations require freight-supportive facilities (e.g., cold storage, warehousing) within proximity to facilitate multimodal freight movement. Transportation infrastructure such as arterial and local roadways, which provide "first-mile/last-mile" connections to the main freight network, are also crucial for air cargo movement.

Dallas-Fort Worth International Airport, the ninth largest cargo airport in the U.S., saw a remarkable 40.5% increase in landed weight from 2013 to 2018.[71]

Figure 3-9: Texas Airports on the Texas Multimodal Freight Network (TMFN)



Source: *Texas Department of Transportation (2018), Texas Freight Mobility Plan 2018.*

Pipelines

Pipelines play a critical role in moving crude oil, natural gas, petroleum products, chemicals, and a variety of other fluid commodities. Texas has a total of 448,446 miles of pipelines, which carried more than 826 million tons of cargo in 2016.[72] These pipelines are privately owned and managed by more than 1,280 companies. Pipelines in Texas are operated at or near their capacity levels to meet the growing demand for oil, natural gas, and other commodities.[61]

Pipelines are generally considered the safest method for transporting energy products, although when incidents occur, they can present significant risks to the public and the environment. The scale and speed with which the energy industry has grown in Texas, particularly within the Permian Basin and Eagle Ford Shale regions, has challenged many pipeline companies to respond quickly.[61] Improvements to the privately owned pipeline infrastructure will be critical to performance of the TMFN as the role of pipelines grows.

Bicycle and Pedestrian Transportation

Bicycle and Pedestrian

TxDOT plays a multifaceted role in both improving the Texas bicycle and pedestrian network and in supporting regional and local entities to safely provide active forms of transportation. These responsibilities include supporting local projects and programs through the allocation of state and federal funding, as well as requiring TxDOT design engineers to consider bicycle and pedestrian accommodation on all construction and reconstruction projects on the state roadway system. The department also provides design guidance for bicycle and pedestrian facilities like bicycle lanes, pedestrian separations, and ramps.[73] Finally, TxDOT works to improve and promote safe bicycle and pedestrian behavior, evaluates how bicycle and pedestrian facilities need to connect with other transportation modes, and integrates bicycle and pedestrian needs into the department's planning processes.

Strategic Importance

Statewide investments in non-motorized travel and micromobility technologies are important for several reasons. Active transportation, including walking and bicycling, encourages physical activity which has been linked to a reduction in the risk of chronic disease and health care costs, improving overall human health and quality of life.[74] Continued investment in safe infrastructure also helps decrease motor vehicle-related bicycle and pedestrian injuries and fatalities, making roadways safer for all users. Further, multimodal networks attract tourists, connect people to parks and other destinations, and create unique economic development opportunities in cities and towns across the state.

Fast Facts

- Nationwide, Austin and Houston have the 20th and 30th highest rates of active transportation use respectively, with San Antonio, El Paso, and Dallas close behind.[75]
- Texas is currently ranked in the middle of the pack among states for bicycle friendliness at 27th.[76]
- About 0.3% of Texas commuters ride a bicycle to work, whereas about 1.6% walk.[77]
- Texas had a bicyclist fatality rate of 2.08 per million residents in 2017, slightly below the US average of 2.40 per million residents.[78]
- From 2013-2018, pedestrian and bicyclist traffic fatalities have been rising along with statewide VMT.

Sources: The Alliance for Bicycling and Walking, NHTSA, TxDOT

TXDOT Plans and Programs

TxDOT supports bicycle and pedestrian facility investment for local and MPO projects. Local governments implement projects and maintain the infrastructure for facilities and segments outside of state right of way. Cities, counties, and MPOs can also propose bicycle/pedestrian projects in state right of way (using local, state and/or federal funds), and TxDOT coordinates with these entitites on project implementation and maintenance responsibilities.

TxDOT uses three federal funding sources for bicycle and pedestrian improvements. These programs are managed by the main TxDOT office, in partnership with the 25 local district offices, and regional and local governments.

Federal Funding for Bicycle and Pedestrian Investment	
Program	**Investment Level**
Transportation Alternatives Program (TA)	Current annual TxDOT and MPO allocations are $45.5 million.
American's with Disabilities Act (ADA)	Anticipated FY 2020 spending is $48.8 million.
Highway Safety Improvement Program (HSIP)	Annual funding for pedestrian-related projects varied between $0.5 million and $2.5 million between 2013 and 2017. It increased significantly in 2018 to $15.7 million after the Pedestrian emphasis area was added to the *Strategic Highway Safety Plan* in 2017.[79]

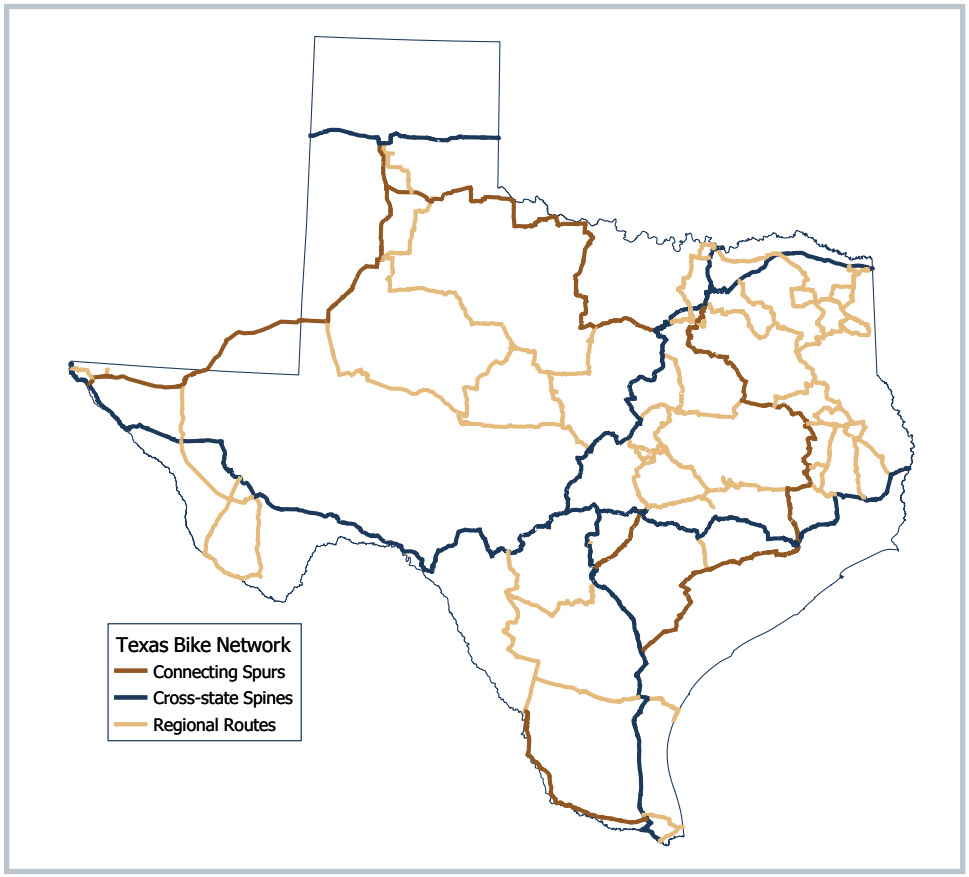
Statewide Long-Distance Bikeways

In coordination with the state's Bicycle Advisory Committee, TxDOT identified an example network of statewide long-distance bikeways for tourism (**Figure 3-10**). These "cross-state spine routes" could be developed as part of an interstate network of U.S. Bicycle Route (USBR) corridors being established across the country. Examples of spine routes that overlap with conceptual USBR alignments include:

- USBR 66 across the Texas Panhandle;
- USBR 90 from El Paso to Beaumont; and
- USBR 55 through the Dallas-Fort Worth Metroplex and the Texas Hill Country to the Lower Rio Grande Valley

A statewide network of cross-state spine routes could be further developed with connecting spurs and regional routes, funded through other sources or through partnerships with local governments as opportunities arise.

Figure 3-10: Example Bicycle Network from the Bicycle Tourism Trails Study



Source: *Texas Department of Transportation (2018), Texas Bicycle Tourism Trails Study. Final Report.*[80]

Public Transportation

Public Transportation

Public transportation services, which include urban and rural bus systems, provide people with a safe travel alternative to driving. These modes are often more affordable than automobile travel and are thus crucial to providing an equitable multimodal transportation system.

Texans use public transportation for many reasons. These include traveling to work, visiting friends and family, accessing healthcare, shopping, attending school, and countless other activities.

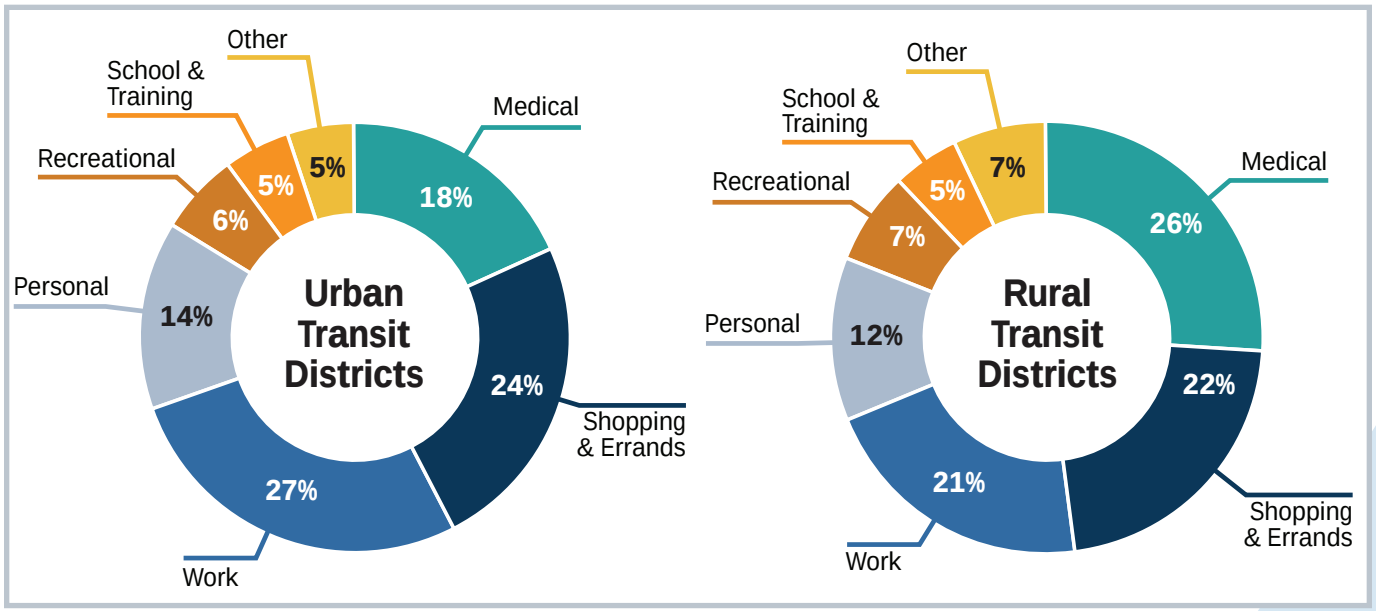
Strategic Importance

In the populous and growing urban areas around Texas, transit contributes to lowering highway congestion and improved air quality. Many citizens rely on transit to commute to and from work in cities of all sizes. Good access to public transportation has been shown to support increased employment. It also improves access to education and other destinations, and helps people travel to receive preventative health care, which may result in cost savings in health care services.[81]

Trip Purpose

Work-related commuting is the most common trip type among urban transit riders. In rural Texas, roughly one quarter of transit trips are for travel to or from healthcare (**Figure 3-11**).

Figure 3-11: Share of Transit Riders by Trip Purpose



Source: *2017 Texas Transit Rider Survey.*

TxDOT Roles and Responsibilities

TxDOT collaborates with local agencies to support safe, reliable transit that increases customers' travel options. Travelers complete trips through services provided by several dozen local transit authorities, districts, and programs. Some people use a single transit service to complete the trip while others use multiple services.[82]

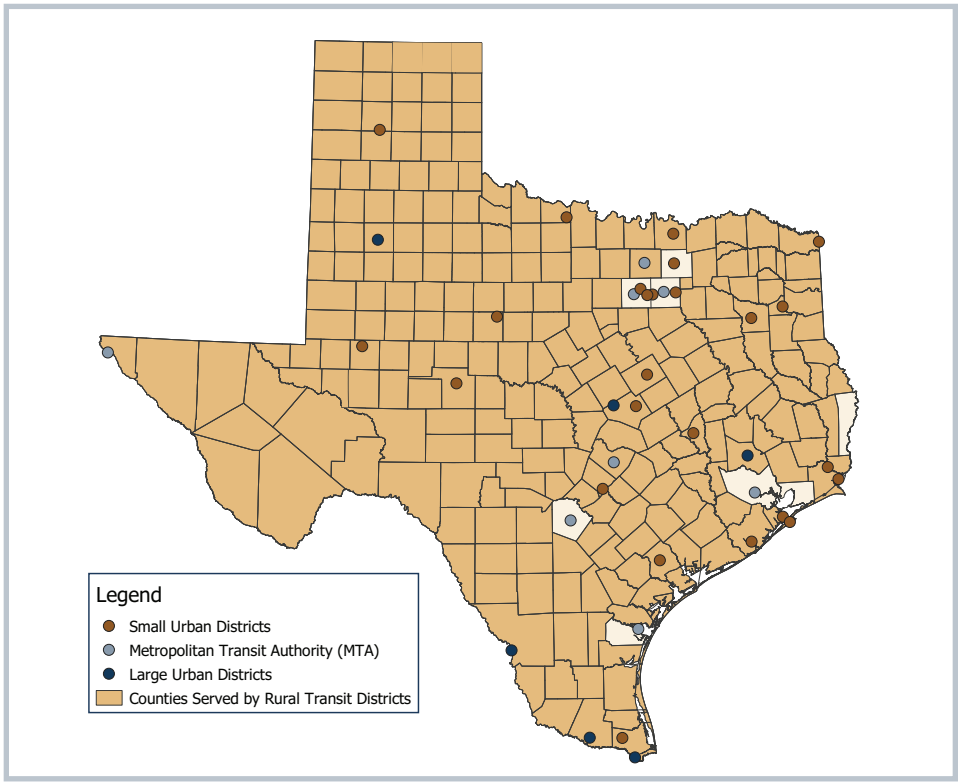
TxDOT's Public Transportation Division (PTN) administers federal grant funding from both the FHWA and the Federal Transit Administration (FTA). In addition, the state provides some funding for activities such as operation, administration, planning, and capital expenses.[83] These grants are awarded to small urban (populations of 50,000 to 199,999 people) and rural districts (populations of fewer than 50,000 people) through a competitive application process managed by PTN. Federal and state apportionments for TxDOT-funded transit providers totaled about $109 million in FY 2019.[84]

Fast Facts

- **8** Metropolitan Transit Authorities
- **32** Urban Transit Districts
- **36** Rural Transit Districts
- **58** elderly and disability transit programs (Section 5310)
- **275** million public transportation trips in 2018
- **7,946** vehicles

Metropolitan Transit Authorities, which serve urban areas with populations of more than 200,000 people, are funded through a dedicated sales tax and are not eligible for state funding. In addition to these transit entities, 58 elderly and disability transit programs throughout the state are operated by either public or nonprofit private entities and provide specialized services to Texans with unique transportation needs.[85]

Figure 3-12: Texas Public Transportation Agencies and Districts



Source: *Texas A&M Transportation Institute (2020), Texas Transit Performance Dashboard.*[86]

Aviation

Aviation

Aviation includes the airports, heliports, and associated infrastructure that allow for the movement of people and goods by air, and enable activities like disaster relief, evacuation and emergency medical services. Airports range from small turf airstrips to major commercial airports that connect the traveling public and businesses to destinations and markets worldwide.

Strategic Importance

Airports play an important role connecting communities and businesses, especially given the size of Texas. Improving air system performance and promoting safety directly align with the TxDOT's strategic goals.[12] Each year, Texas airports generate more than $94.3 billion in economic output and contribute more than $30.1 billion in payroll across nearly 780,000 jobs.[87]

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Legislative Requirements

State and federal laws define criteria and conditions for funding eligibility, reporting, spending, and program administration requirements. For example, airports included in the Federal Aviation Administration's (FAA) National Plan of Integrated Airport Systems must have a pavement maintenance and management program that meets certain standards to qualify for federal funding.[88] These requirements help maintain consistent performance across airports and promote good stewardship of public funds.

TxDOT Roles and Responsibilities

TxDOT manages planning, funding, grants and project delivery for the statewide aviation network. The department identifies necessary improvements in collaboration with airport sponsors and community leaders through the *Texas Airport System Plan* (TASP).[89] TxDOT also assists cities and counties with obtaining and using state and federal funds, and administers several state and federal airport funding programs.[65]

TxDOT Plans and Programs

TxDOT identifies airports and heliports with essential air transportation roles in the TASP.[89] The department also develops a three-year schedule of airport development projects each year and through TxDOT's Aviation Capital Improvement Program, which matches project costs with anticipated state, federal and local funding.[90]

Investment

The current TASP contains more than $1.2 billion in improvements over the next five years, which translates to $255 million of improvement projects per year.[91] TxDOT is currently updating the TASP together with local partners.

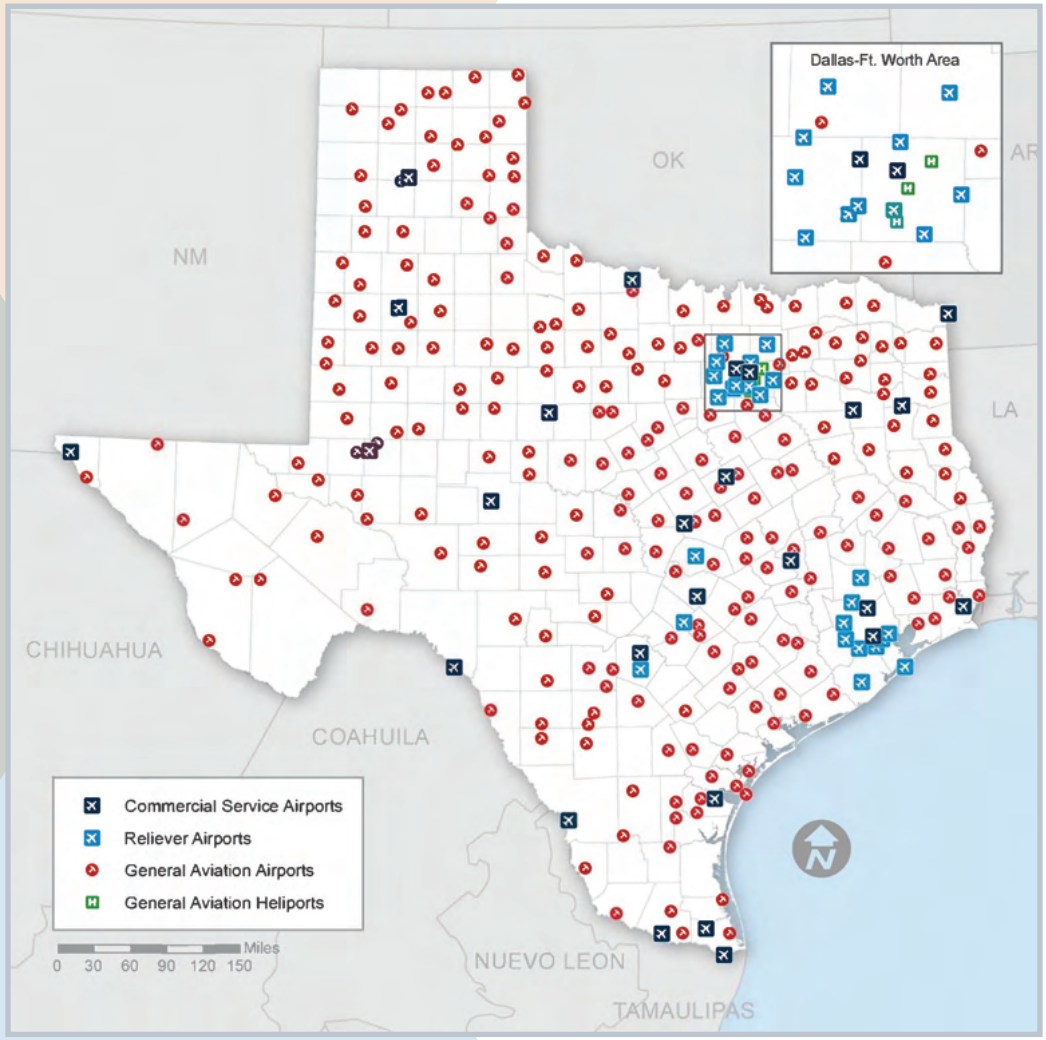
Key Definitions

- **Commercial Service Airports:** Publicly owned airports that have at least 2,500 passenger boardings each calendar year and receive scheduled passenger service.
- **Primary Airports:** Commercial service airports that have more than 10,000 passenger boardings each year.
- **General Aviation Airports:** Public-use airports that do not have scheduled service or have fewer than 2,500 annual passenger boardings annually.
- **Reliever Airports:** Airports designated by the FAA to relieve congestion at commercial service airports.

System Inventory and Existing Performance

Texas has a large airport system and more registered aircraft than any other state, with 9% of all registered aircraft in the country.[92] Additionally, Texas has more passenger boardings each year than all other states except California and Florida.[93]

Figure 3-13: Non-Military Texas Airport System Locations



Source: *Texas Department of Transportation (2018), Texas Aviation Economic Impact Study.*[92]

Fast Facts

In Texas, there are:

- **26** primary airports (commercial service airports)[94]
- **278** general aviation airports[95]
- **24** reliever airports[96]
- **23** military airfields
- **56** public use heliports[97]

Passenger Rail

Passenger Rail

Passenger rail services provide both longer-distance linkages in the transportation network and alternatives to congested roadways.

Known as intercity passenger rail, this type of rail serves multiple cities over long distances (typically 100 miles or more) and operates on tracks that are part of the existing national railroad network at conventional passenger train speeds.[98]

Strategic Importance

Intercity passenger rail offers a safe, high-capacity transportation option for Texas travelers that helps reduce roadway congestion and improve air quality. Intercity passenger rail connects rural Texas communities with urban centers and facilitates interstate travel. It also provides economic development and tourism opportunities by linking Texans to destinations like cities, historical sites, parks, and employment centers.

Fast Facts

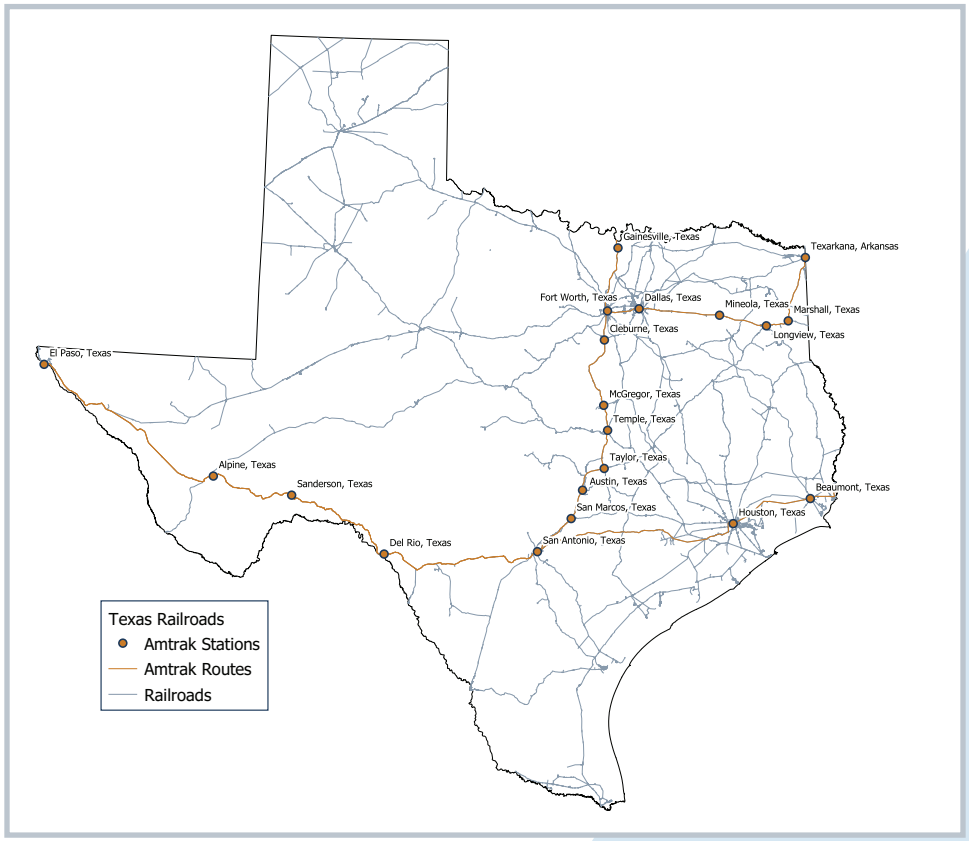
- 1,539 miles of Amtrak track miles in Texas
- 19 active Amtrak stations
- 381,615 boardings and alightings in Texas in 2018
- 2018 boardings and alightings were down 3% from 2017
- All-station on-time performance was down across all three routes 2017-2018.
  - Heartland Flyer 85%-->64%
  - Texas Eagle 48%-->40%
  - Sunset Limited 36%-->30%

System Inventory

Intercity passenger rail service in Texas is provided by Amtrak, which operates three routes in Texas:

- **The Heartland Flyer** – Travels daily between Fort Worth and Oklahoma City. This route is partially supported by state funds from both Texas and Oklahoma.
- **The Sunset Limited** – Travels triweekly between Los Angeles and New Orleans.
- **The Texas Eagle** – Travels between Chicago and San Antonio daily with triweekly connecting service to Los Angeles.

Figure 3-14: Amtrak Texas Intercity Passenger Rail Routes



Source: *Texas Department of Transportation (2019), 2019 Texas Rail Plan.*

TxDOT Roles and Responsibilities

Although TxDOT does not directly oversee intercity passenger rail service in Texas, the department provides support for services and has a role in long-term planning, monitoring service quality, and facilitating and advocating for intercity passenger rail improvements in the state. TXDOT has had a minor financial role supporting Amtrak's Heartland Flyer service. Since FY 2015, TxDOT has contributed about $2.5 million (nominal dollars) annually to support Heartland Flyer operations.[99]

TxDOT Plans

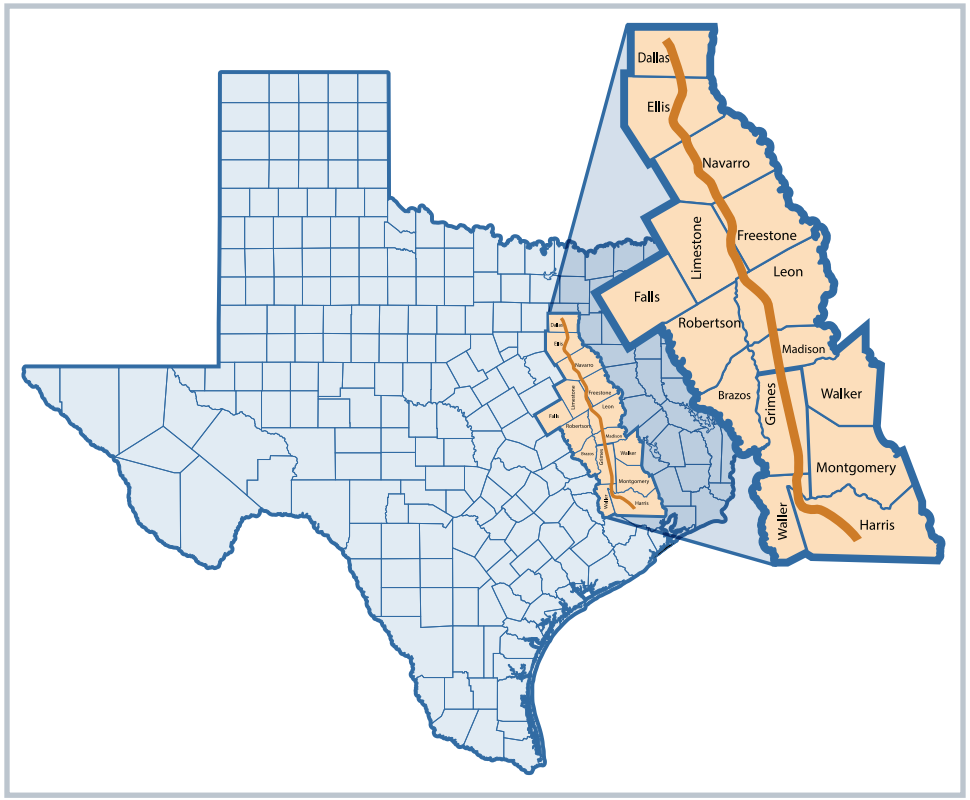
The Passenger Rail Investment and Improvement Act of 2008 requires states to develop a statewide rail plan. TxDOT publishes a stand-alone plan, which includes a description of the Texas rail system inventory, potential freight and intercity passenger rail improvements and investments, rail-specific goals and objectives, and an overview of outreach efforts.

High-Speed Rail in Texas

High-speed rail (HSR) is defined as rail services operating at speeds of at least 125 mph. It provides non-stop or limited-stop transportation between cities and is usually faster than automobile travel. There is currently no HSR operating in Texas. However, HSR has been explored by private entities over the past few decades. In the 1990s, the Texas High-Speed Rail Authority was tasked with determining whether high-speed rail was in the public interest. It awarded a private company the right to build a service connecting Dallas to Houston, but the effort dissolved due to the inability to secure funding and the opposition of various parties.[100]

Currently, a Texas Central Railway Initiative is being promoted by Texas Central Partners, LLC and is in the final stages of design and approval for a Dallas-Houston line. The Federal Railroad Administration (FRA) signed a draft Environmental Impact Statement (EIS) for the project on December 15, 2017 and released a final EIS on May 29, 2020). The 240-mile railroad[101] will use the Japanese Shinkansen technology, and tracks will not be shared with other services. No state or federal funds are being used for the study or potential project development. Construction could potentially begin following the release of the FRA's Record of Decision, expected in summer 2020. The estimated construction cost for this project is about $16 billion.[102] Potential ridership for the Texas Central Railway Initiative is estimated at nearly 6 million annual passengers by 2029 and more than 13 million annual passengers by 2050.

Figure 3-15: Proposed Route of the Texas Central Railway



Source: *Texas Central Railway (n.d.), "The Project."* [101]

Ferry Operations

Port / Waterways

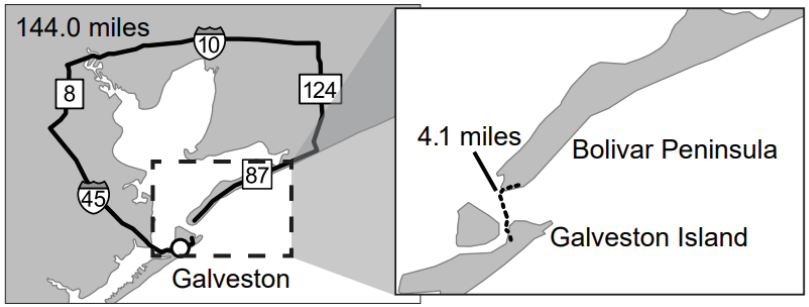
Ferry services enhance connectivity to emergency services, and to recreational and economic opportunities while alleviating congestion on Texas roadways. They also provide residents and tourists with additional options to reach their destination, which can reduce travel times and fuel consumption, and help optimize system performance.

System Inventory and Existing Performance

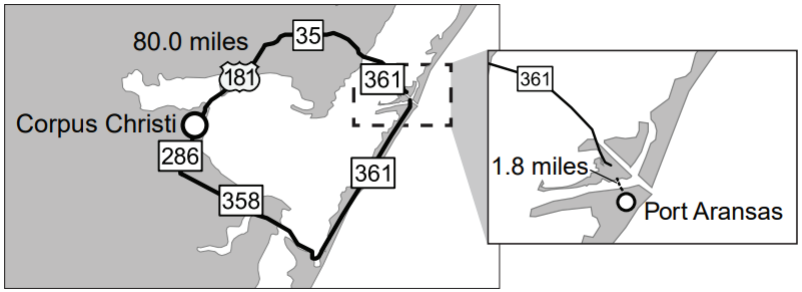
TxDOT operates two free ferry routes that provide shorter travel distances than road-only approaches from Port Aransas to Harbor Island and from Galveston to Port Bolivar. Both services operate 24 hours a day, 365 days a year.[103]

- **The Galveston Ferry** provides the only direct connection between Galveston Island and the Bolivar Peninsula, connecting two segments of SH 87 in a small fraction of the two or more hour required by the land route.[103]
- **The Port Aransas Ferry** connects Mustang Island and the mainland via Harbor Island through Aransas Pass.[104]

Port Bolivar to Galveston Highway vs. Ferry Route



Aransas Pass to Port Aransas Highway vs. Ferry Route



Source: *Legislative Budget Board Staff (2019).*

Ferry	Fleet Size	Fleet Capacity
Galveston	6 boats	500 passengers 70 vehicles
Port Aransas	5 boats	149 passengers 28 vehicles
	3 boats	120 passengers 20 vehicles

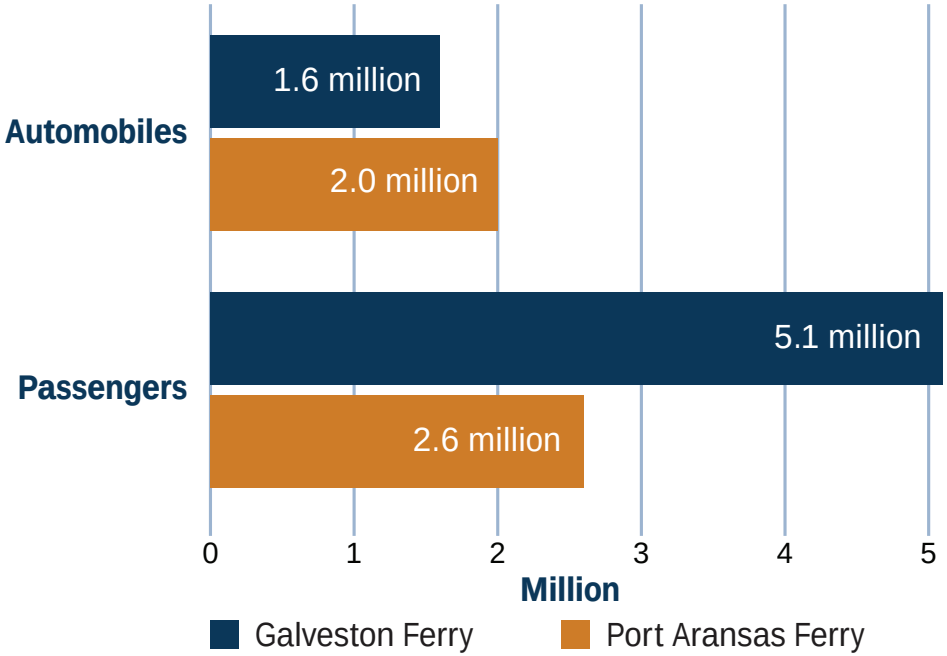
Source: *Legislative Budget Board Staff (2019), Overview of State Ferry System Operations.*

Investment

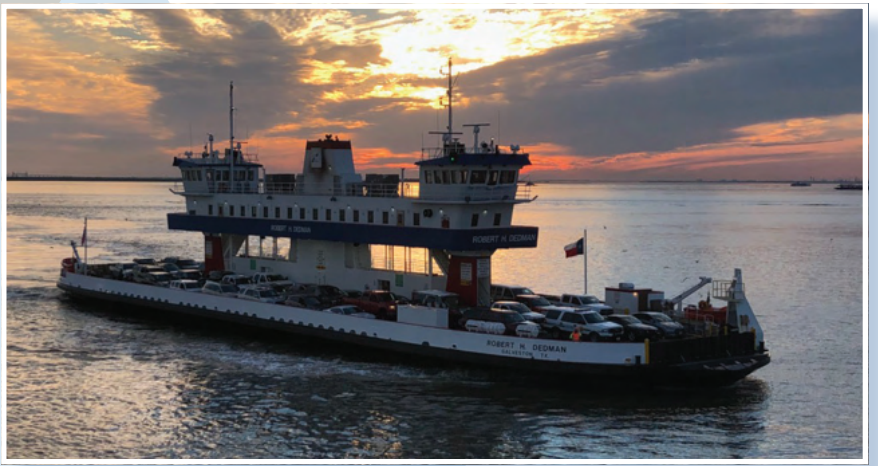
Ferry operations are funded through the State Highway Fund. The 2020 state operating budget for the two ferry routes is $53.8 million, which represents a slight increase from the $41.7 million and $48.3 million expended by TxDOT in FY 2018 and FY 2019, respectively.[106]

TxDOT supplements state funding by pursuing federal grants through the Construction of Ferry Boats and Ferry Terminal Facilities Formula Program.[107] In FY 2015-2016, TxDOT received a total of $11 million in grants to support the Port Aransas Ferry.[107] TxDOT leveraged these funds to support the construction of two of the three planned new 28-car passenger vessels, which are now in operation.[108,109]

Figure 3-16: 2016-2018 Annual Ferry Operations



Source: *Texas Department of Transportation, Galveston and Port Aransas Ferry Operations.*[105]



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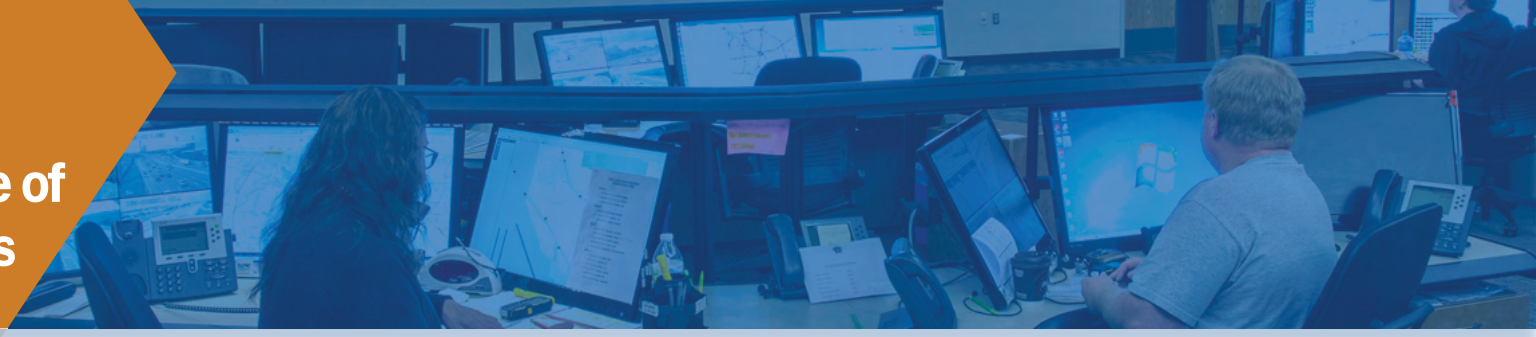
CHAPTER 4

Planning for the Future of Transportation in Texas



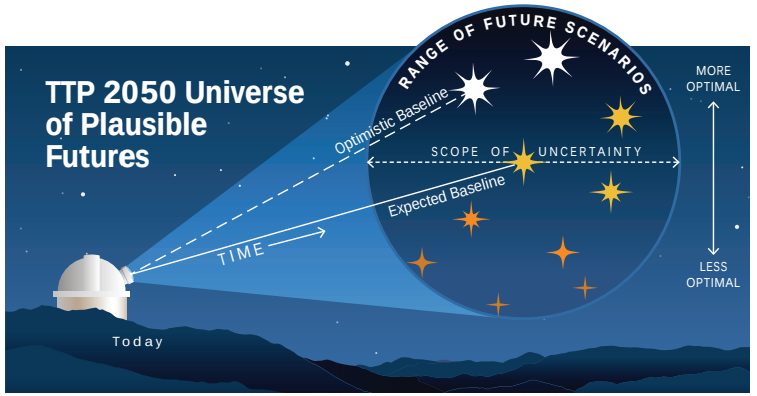
Over the next 30 years, population and economic growth in Texas are forecasted to outpace growth for the rest of the country. This growth will translate to more vehicles on Texas roadways, requiring TxDOT to implement innovative solutions to achieve and maintain targeted performance levels. At the same time, the emergence of transformative transportation technologies presents both challenges and opportunities to enhance how people and goods move about the state. To prepare for what the future may hold for transportation in Texas, TxDOT uses the Texas Transportation Plan (TTP) as an opportunity to analyze different scenarios.

Scenario planning enables transportation decision-makers to explore the potential performance implications of different policies and possible futures. By assessing how the transportation system may be affected over the long-term by external factors such as technology development and the global economy, TxDOT will be better prepared to adapt its strategies as needed to achieve statewide goals and objectives.

Defining Possible Futures

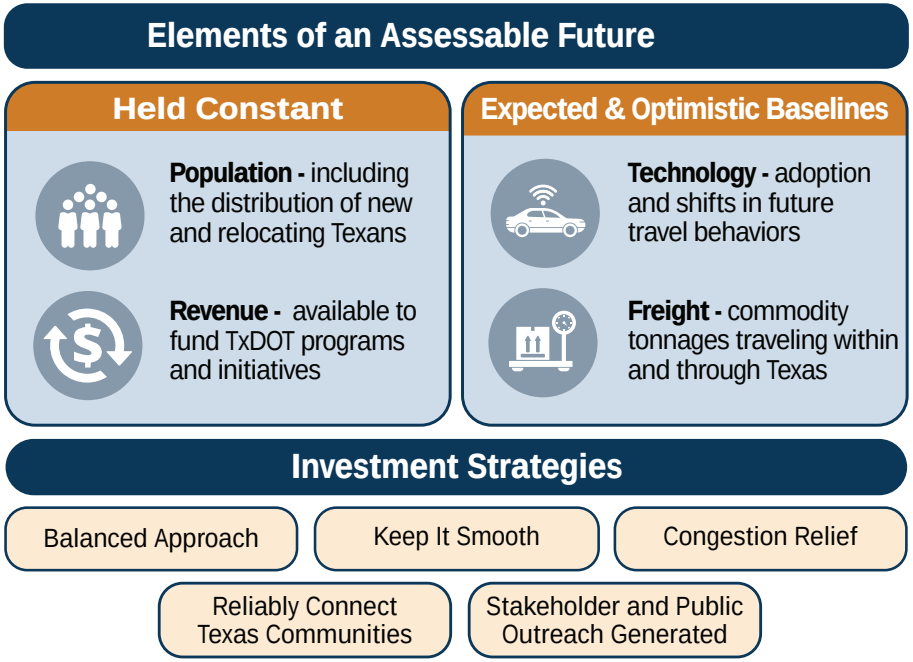
TTP 2050 scenarios were defined around anticipated population and revenue levels, as well as alternative assessable futures, identified in collaboration with subject matter experts on the TTP 2050 Technical Working Group. TxDOT identified emerging technology adoption and future freight demand as the two greatest areas of long-range uncertainty that could impact future transportation in Texas. *Expected* and *optimistic* baselines were established for each area to help understand the sensitivity of system performance relative to changes in technology adoption rates and goods movement levels. The *expected* baseline reflects TxDOT's view of the most likely future; the *optimistic* baseline reflects a feasible future with a slightly less conservative set of assumptions. To isolate the transportation performance impacts of the two baselines, both population and revenue levels were held constant.

Figure 4-1: Plausible Futures



For each combination of *expected* and *optimistic* technology and freight baselines, TxDOT evaluated a common set of five investment strategies. These strategies include four distinct resource allocation approaches with different performance priorities that were presented to stakeholders and the public during the TTP 2050 outreach, as well as a custom strategy based on outreach feedback (**Figure 4-2**).

Figure 4-2: Scenario Analysis Approach

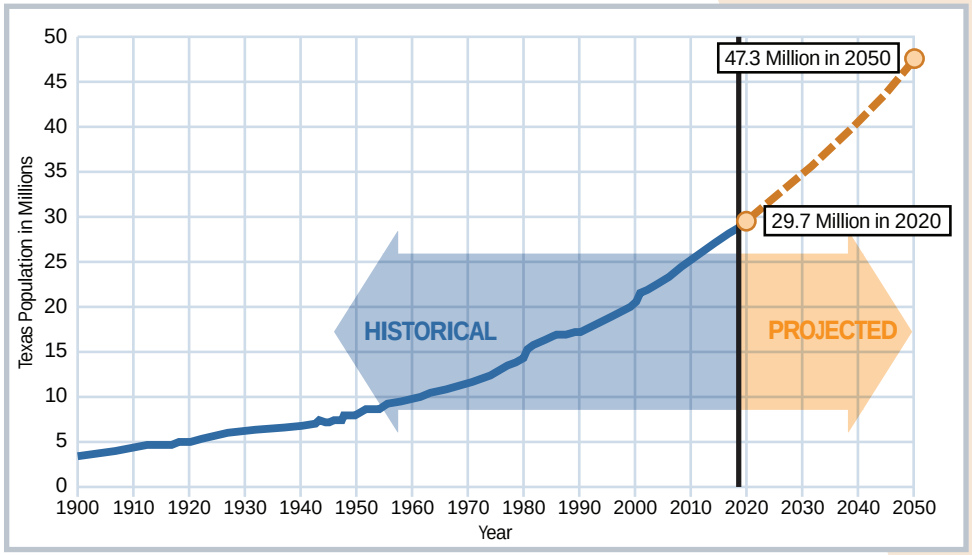


Population Trends

Over the last decade, the Texas population increased by 1,000 people a day, the fastest population growth rate in the country. Looking forward, Texas is expected to continue experiencing robust population growth for the foreseeable future, which will bring both increased economic opportunity and more traffic. By 2050, the Texas State Data Center projects the state population will exceed 47 million, representing a 60% increase from 2020 levels (**Figure 4-3**). As illustrated in **Figure 4-4** the highest rate of growth over the next 30 years is expected to occur in large urban areas (including Austin, Dallas, Fort Worth and Houston), as well as the cities of Midland, Odessa, and northern portions of the Texas Panhandle. Coinciding with this growth, Texas is projected to see significant aging of its population. The share of population aged 65 and older is projected to nearly double from 10% (in 2020) to 18% (in 2050).

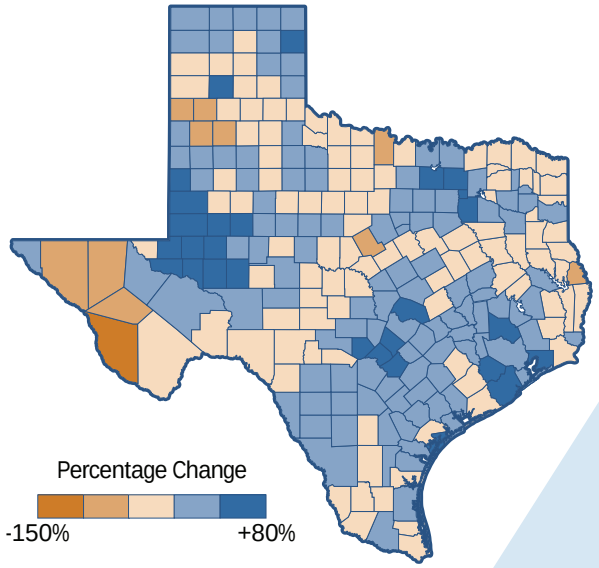
By 2050, the Texas State Data Center projects the state population will exceed 47 million, representing a 60% increase from 2020 levels.

Figure 4-3: Historical and Projected Texas Population from 1900 to 2050



Source: *Historical data source: U.S. Census Bureau; Projected data source: Texas Demographic Center (2018), 2018 Population Projections*

Figure 4-4: Percent Change in Population 2020-2050 by County



Source: *Texas Demographic Center (2018)*

Anticipated Revenues

In recent years, TxDOT has allocated around $7.7 billion annually for highway construction and non-highway expenditures. This total reflects the continuation of TxDOT's planned Fiscal Year (FY) 2019-2022 UTP funding levels, a continuation of current expenditure levels to support non-highway modes of transportation, and extension of FY 2019-2020 biennium funding the Road to Zero initiative to reach zero fatalities.

With an anticipated decline in state gas tax revenues over time – due to more efficient vehicles and alternative fuel usage – as well as the persistent challenge of keeping up with inflation, TxDOT may require innovative funding sources to sustain current funding purchasing power. For scenario planning purposes, it is assumed that TxDOT, its governing commission, and the Texas Legislature will continue to find a way to fund critical programs at current levels. Revenue levels were held constant for each analyzed scenario.

Technology Adoption

Thirty years ago, the smartphone did not exist, nor did the public have access to the internet. Thirty years from now, even more exciting innovations can be expected. While we may not be able to fully imagine what the world will look like, emerging transportation technologies and their corresponding behavioral changes are starting to come into focus.

Key Definitions

- **Connected Vehicles:** vehicles, infrastructure, and devices that "talk" to one another using features like short-range radio signals.
- **Automated Vehicles:** vehicles or technology that functions without being operated by a person.

Major manufacturers have begun testing Connected and Automated Vehicles (CAVs) and unmanned aerial vehicles ("drones") and are gearing up for production in the next decade. The National Highway Traffic Safety Administration (NHTSA) estimates that fully automated vehicles will begin rolling out to the market around 2025. By 2045, the Center for Transportation Research at the University of Texas at Austin estimates that nearly 25% of the privately held light-duty vehicle fleet will be highly or fully automated, with the potential to reach more than 87% of the market depending on vehicle pricing. Congress legalized commercial use of drones for deliveries and other purposes in August 2016. Adoption rates of both CAV and delivery drones will likely vary from community to community, with early use to occur in large urban settings. Other conceptual technologies with statewide impacts such as hyperloop and electric vertical air transport may eventually come to fruition, but sufficient details are not available at this nascent stage. Therefore, these technologies were not evaluated as part of the TTP 2050 scenario analysis.

Technology is being adopted at a faster pace than ever before. While it took 46 years for electricity to be adopted by a quarter of the American population after 1873, it took just five years for smartphone adoption at the same level. In 2015, when the TTP 2040 was adopted, ride-hailing services were only beginning to penetrate the traditional taxi service market. Just three years later, the number of ride-hailing users doubled.

The implications are that as Texans embrace new technologies, behavioral patterns for transportation use will likely change. Driverless technology is expected to expand access to non-traditional drivers and induce new demand on Texas roadways. The greater comfort and ability to engage in work, entertainment, and socialization during trips is expected to increase the transportation users' tolerance for longer and more frequent trips. Ride-hailing services and desire to avoid parking fees may further generate zero occupancy vehicle (ZOV) travel as trips are made to pick-up, park after a drop-off, or circulate while waiting for transportation users.

While the additional traffic enabled by technology applications may yield more congestion, CAVs show significant promise in enhancing roadway safety and operational efficiency. Approximately 94% of crashes are human error related. Conditionally automated vehicles have been estimated to reduce crashes by 40%, and fully automated vehicles are anticipated to reduce human error related crashes by upwards of 90%. CAVs also are expected to enable vehicles to travel safely at closer distances to one another, meaning that more traffic volume can be accommodated at higher speeds.

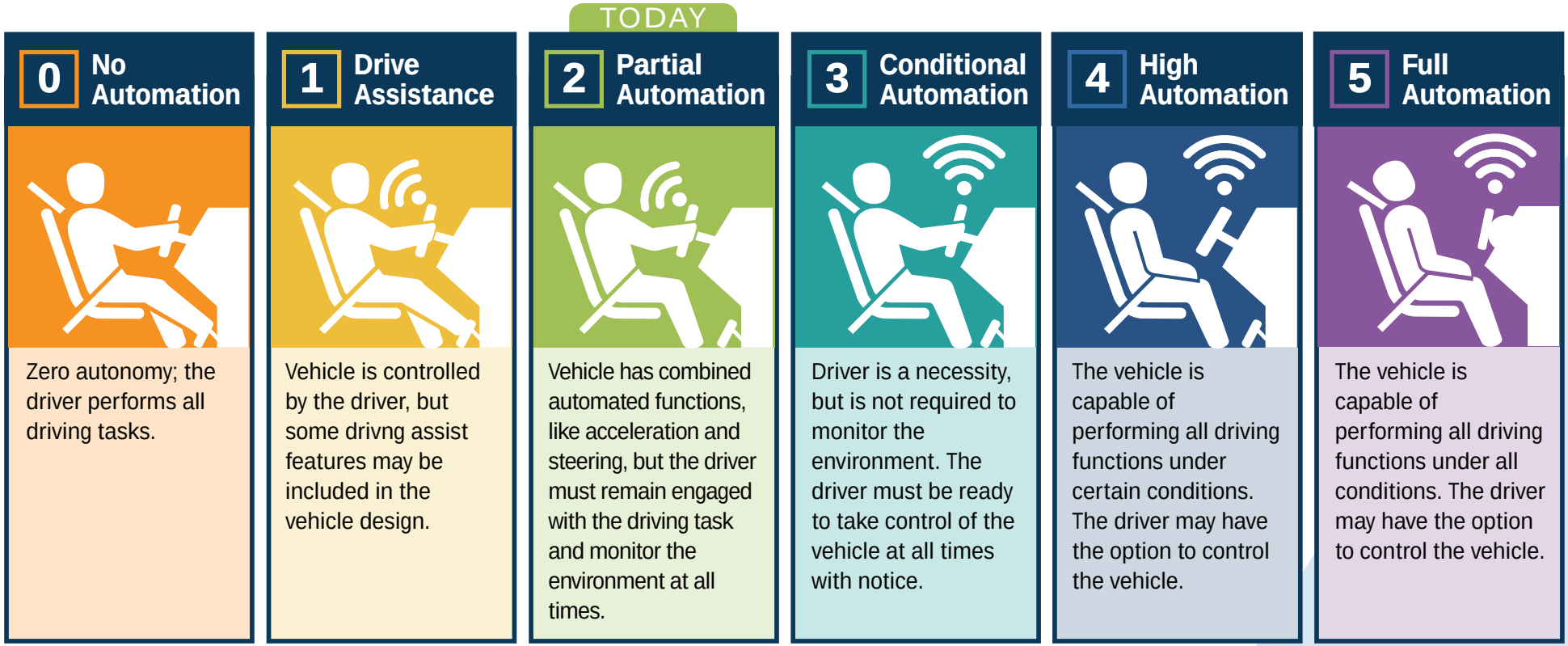
Ready access to safe, low-price, driverless vehicles that alleviate congestion-induced stress may further disrupt the transportation user's choice of mode, shifting public transportation users into single-occupancy vehicles. It should also be recognized, however, that travel may not always occur during peak hours as the share of telecommuters continues to increase. As of 2018, 5.2% of Texans worked at home full-time, with many more working at least part-time from home.

Combining consideration of these technologies and behaviors, TxDOT developed two baselines representing possible technology futures for Texas (See **Figure 4-5**). Key differences between the technology baselines include the degree of market penetration of fully automated vehicles, extent of roadways able to support connected vehicles, number of induced trips from ZOVs, impact on public transit use, delivery radius of unmanned aerial vehicles (i.e., drones), and telecommuting levels. Regardless of the baseline, it was assumed that CAVs would induce 14% to 26% more trips and increase roadway capacity by 15% to 33%, delivery drones would replace local truck trips within 5 to 15 miles and telecommuting would reduce work-related trips by 1% to 15%. **Table 4-1** summarizes the assumptions for each future scenario.

Freight Demand

According to the 2018 *Texas Freight Mobility Plan* (TFMP), 20 tons of freight per household and 12,700 tons of freight per business was delivered via the Texas transportation system in 2016. This freight volume is associated with a $215 billion economic impact and $49 billion in tax revenue. In addition, the freight transportation industry in Texas is a large employer, supporting an estimated 2.2 million full-time jobs and generating $145 billion in wage income in 2015. As the Texas population and economy grows, so will the demand for goods. With the trucking industry preparing for a connected and automated fleet, there is the potential that even more goods will be transported on the Texas highway system, which could worsen congestion, place more wear and tear on infrastructure, and create speed differentials on passing-limited roadways with passenger vehicles that can result in higher severity crashes.

Figure 4-5: Society of Automotive Engineers Levels of Automated Vehicles



Source: *National Highway Traffic Safety Administration (n.d.), Automated Vehicles for Safety.*

Table 4-1: Future Scenario Assumptions

Technology / Behavioral Impact	Expected	Optimistic
Automated Vehicles	■ 100% conditional automated fleet ■ 25% fully automated in large urban areas ■ Induces 7% more trips	■ 100% fully automated fleet statewide ■ Induces 14% more trips
Connected Vehicles	■ 33% increase in rural freeway capacity ■ 15% increase in large urban major arterial capacity	■ Same as expected scenario
Zero Occupancy Vehicles	■ Leads to 7% more trips in large urban areas	■ Leads to 12% more trips in medium and large urban areas
Passenger Mode Shift	■ 25% shift from public transportation to single-occupancy vehicles	■ No change in current share of public transportation travel
Freight Mode Shift	■ 100% increase in e-commerce ■ 25% reduction in local truck trips within 5 miles of medium and large urban areas	■ 100% increase in e-commerce ■ 50% reduction in local truck trips within 15 miles of medium and large urban areas
Telecommuting	■ 1% fewer work-related trips ■ 1% more non-work trips	■ 15% fewer work-related trips ■ 5% more non-work trips

TxDOT forecasted possible freight tonnages for the year 2050 by leveraging data sources used to update the TFMP (TRANSEARCH county-level truck data and forecast from FHWA's Freight Analysis Framework Version 4 (FAF[4]) and using the Statewide Analysis Model Version 4 (SAM-V4)) to translate commodity tonnages to trucks and assess the impacts to Texas roadways (**Figure 4-6**).

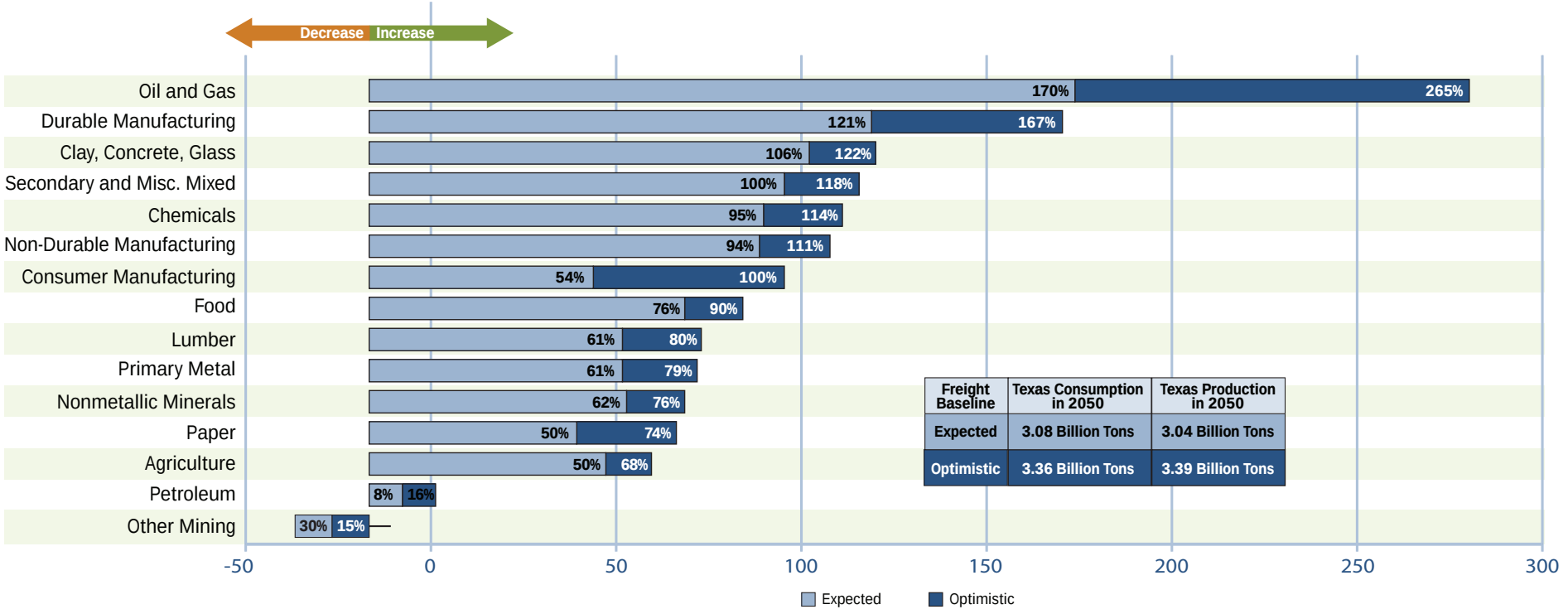
Investment Strategies

TxDOT's ongoing success relies on its ability to nimbly react to external shocks caused by events such as rapid technology development and fluctuations in demand for goods movement. Understanding resource allocation options remains one of the primary strategies TxDOT can use to prepare for eventualities associated with different foreseeable futures. For the TTP 2050 scenario analysis, TxDOT evaluated both technology and freight baselines against a common set of five investment strategies:

- The **Balanced Approach** strategy continues TxDOT's current approach of maintaining acceptable performance across all TxDOT *2019-2023 Strategic Plan* goals.
- The **Keep It Smooth** strategy significantly increases highway preservation funding by reallocating congestion relief funds to reconstruct and maintain on-system roads and bridges. This strategy achieves system performance targets – 90% "good" or "better" pavement lane-miles and an average statewide bridge condition score of 90 – in 2050 for the *expected* technology and freight baselines. Additional funding to further enhance highway safety as part of roadway reconstruction projects are included in this strategy to accelerate progress towards achieving zero fatalities on TxDOT roadways.
- The **Congestion Relief** strategy prioritizes deploying ITS to inform travelers of roadway conditions and connect vehicles while increasing urban freeway and arterial capacity to alleviate Level of Service (LOS) E or F (i.e., unstable flow or stop-and-go traffic at near capacity levels) conditions during peak periods. The strategy is expected to achieve TxDOT's urban congestion index target of 1.2 (meaning the annual average travel time experienced is within 20% of the travel time under free-flow conditions) and keep more than 75% of daily vehicle miles traveled (DVMT) within MPO jurisdictional boundaries free of congestion in 2050.
- The **Reliably Connect Texas Communities** strategy prioritizes alleviating LOS D (i.e., high-density traffic flow and restricted ability to maneuver) or lower operations on rural roadways, establishes a network of long-distance bicycle routes connecting to local bicycle facilities, and financially supports regional transit operators in meeting small urban and rural area transit needs – identified and updated through 2050 by TTI – as well as general aviation and reliever airport operators in meeting needs identified during the development of the *2019 Texas Airport Systems Plan*. This strategy cuts by approximately half the daily LOS D or lower vehicle miles travelled on roadways outside of MPO jurisdictional boundaries.

Figure 4-6: Forecasted Percent Change in Freight Tonnage Traveling Within and Through Texas

Relative to 2020 levels, the **Expected** baseline forecasts a **73% increase** in tonnage of freight comodities traveling within of through Texas by 2050. The **Optimistic** Baseline forecasts a **91% increase**.



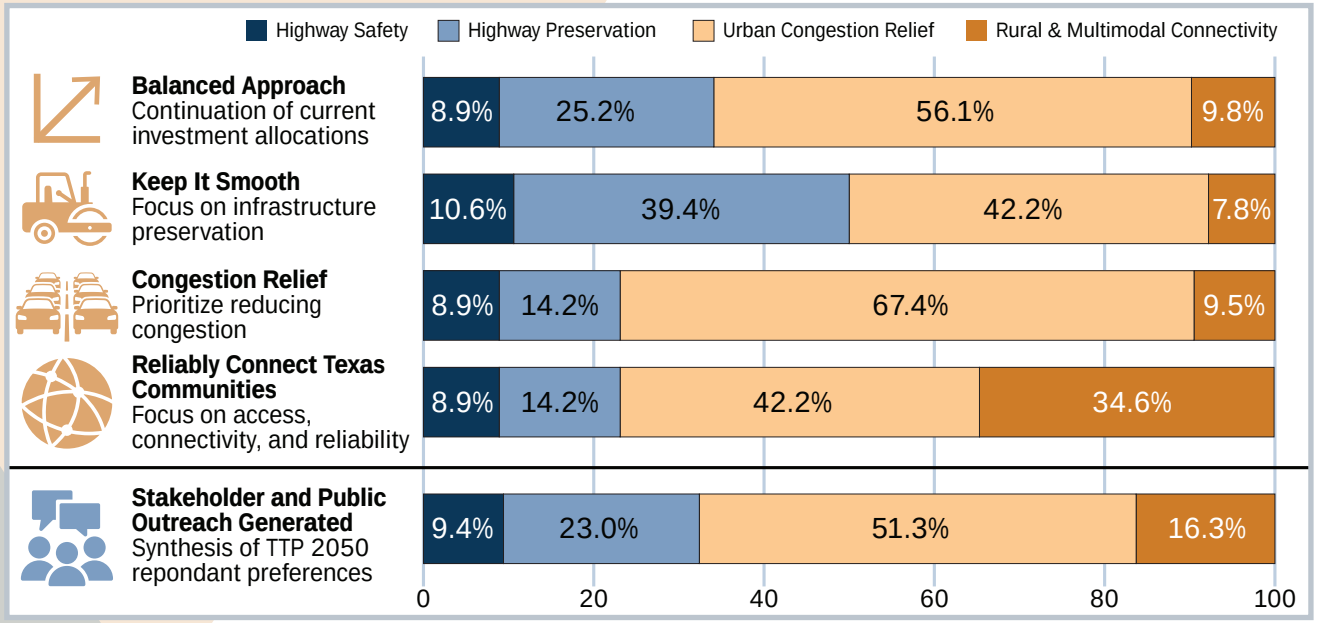
Freight Baseline	Texas Consumption in 2050	Texas Production in 2050
Expected	3.08 Billion Tons	3.04 Billion Tons
Optimistic	3.36 Billion Tons	3.39 Billion Tons

Source: *Federal Highway Administration, Freight Analysis Framework Version 4*

- The **Stakeholder and Public Outreach** Generated strategy reflects a representative allocation based on stakeholder and public preferences for each of the previously listed strategies.

All investment strategies ensure continued progress on TxDOT's performance vision in its Road To Zero fatalities by 2050. Available revenues, however, may require TxDOT to make judgments on acceptable performance tradeoffs. Implementing an investment strategy aligned with TxDOT, stakeholder, and public priorities over the short-term will ensure that programmed projects remain consistent with long-term planning goals regardless of the impact of future technologies and freight on the Texas transportation system. While funding mandates limit TxDOT's discretion on how to allocate funds, future adjustments can be evaluated to align the **Balanced Approach** closer with the **Stakeholder and Public Outreach Generated** strategy.

Figure 4-7: TTP 2050 Investment Strategy Allocations



Performance Implications of Possible Futures

Forecasting long-range transportation performance is both an art and a science. Although sophisticated tools and analytical approaches were applied during the development of the TTP 2050 scenarios, the analysis outcomes are more meaningful as a means of comparing the magnitude of scenario differences than as a way of estimating the specific performance that will occur under each scenario (**Figure 4-8**).

The long-range outcomes for each scenario are presented relative to current performance for each TTP goal area on a scale from reduced performance to improved performance. TxDOT determined these outcomes by applying evaluation measures to each of the five investment strategies under different combinations of *expected* and *optimistic* impacts from technology deployment and freight growth.

Total vehicle miles traveled (VMT) is forecasted to grow between 52% and 64% from 2020 to 2050 based on which set of technology and freight assumptions are used. Although the *optimistic* freight scenario is predicted to increase total VMT by only 1% relative to the *expected* freight scenario, this translates to a 12% increase in truck VMT, placing a greater strain on the Texas Highway Freight Network (THFN). Technology was found to have a larger impact on future travel with an approximate 11% increase in total VMT between the *expected* and *optimistic* scenarios. This growth is predicted primarily in non-truck vehicles.

Table 4-2: Scenario Evaluation Measures by Performance Area

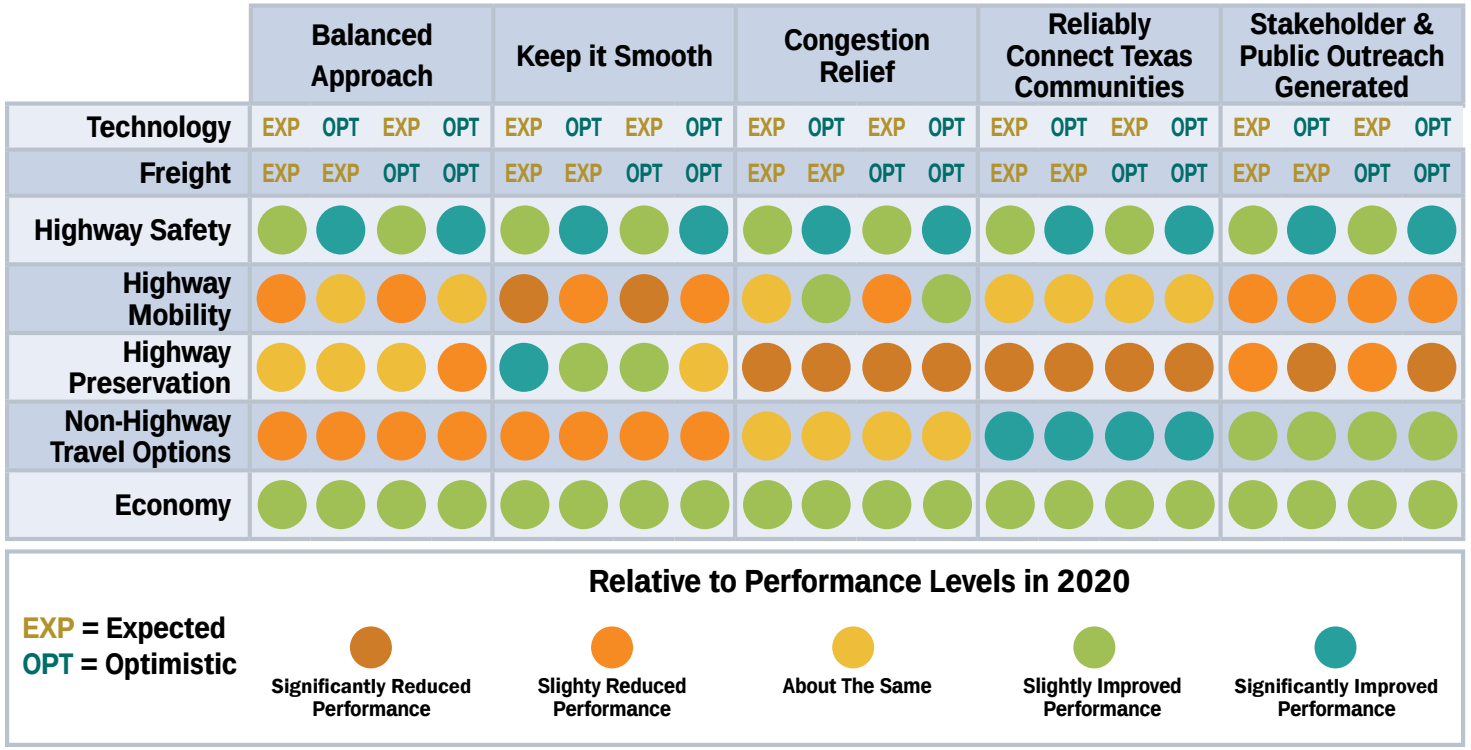
Topic Area	TTP 2050 Scenario Evaluation Measures
Highway Safety	**For all publicly owned roadways ...** ■ Fatalities Count and Rate ■ Serious Injuries Count and Rate
Highway Mobility	**For on-system roadways ...** ■ Urban Congestion Index ■ Urban, Rural, and Truck Reliability Indices ■ % Congested Urban and Rural DVMT
Highway Preservation	**For on-system roadways ...** ■ % Pavement Lane-miles in "Good" or "Better" Condition ■ Bridge Condition Score ■ % Poor Bridge Deck Area
Non-Highway Travel Options	■ % Completion of Long-Distance Bicycle Routes ■ % ITS, Transit, Non-Highway Freight, Ferry Operations, and Aviation Spending Requests Met
Economy	■ Business Output ■ Value Added ■ Jobs Added ■ Labor Income Generated

Other Key Takeaways From the TTP 2050 Scenario Analysis Include:

- Stakeholder and public responses during TTP 2050 outreach indicated a preference for significantly higher rural and multimodal transportation spending (nearly double current levels) and slightly increased safety spending.
- Emerging vehicle technology and behaviors may increase urban congested DVMT by 6% and rural congested DVMT by 2%, but driverless travel will make this time spent in traffic more convenient.
- Emerging vehicle technology will have significant safety benefits and enable TxDOT to achieve its vision of zero on-system roadway deaths coinciding with 51% (*expected*) to 85% (*optimistic*) fewer fatalities in 2050 on all public roads.
- Pavement preservation will become costlier to achieve the same performance levels seen today as TxDOT roadways age.
- Additional truck traffic in 2050 under the *optimistic* freight scenario could result in increased highway preservation costs of 2% to 4%.
- An *optimistic* technology scenario may lead to further economic benefits with an additional 2.2% increase in Gross State Product and 13,500 jobs relative to the *expected* baseline.
- Some job sectors may be more significantly impacted by the adoption of new transportation technologies.

Please see **Appendix B** for further details.

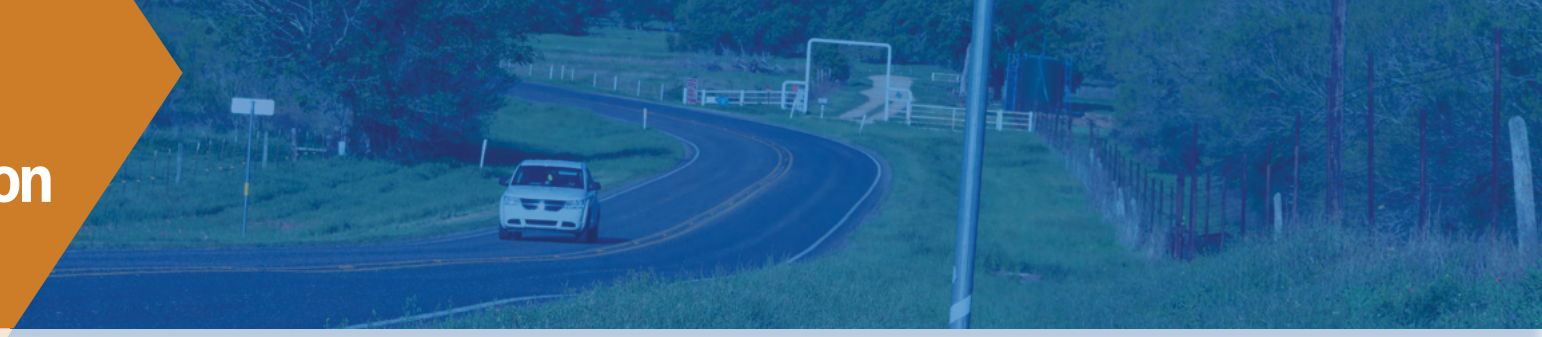
Figure 4-8: Forecasted Performance Level in 2050 by Topic Area Given Investment Strategy and Technology and Freight Scenarios



- **Expected** baseline - reflects TxDOT's view of the most likely future
- **Optimistic** baseline - reflects a feasible future with a slightly less conservative set of assumptions
- Population and revenue levels were held constant to isolate performance impacts of the two baselines

CHAPTER 5

Rural Transportation in Texas



An important part of the TTP development process is consideration of the unique challenges and opportunities of serving the multimodal transportation needs of people and businesses residing in or traveling the geographically large and socio-economically diverse rural share of the state. This requires exploring the extent, performance, and distinctive character of multimodal transportation network elements outside the state's urban areas. This chapter presents the findings from these efforts and discusses TxDOT's collaborative role with local and regional partners in supporting rural areas with transportation solutions that help sustain prosperity and quality of life. It also discusses planned transportation improvements in rural areas and identifies the key themes associated with addressing the unique transportation needs of the state's rural regions.

In short, recognizing, understanding, and addressing rural transportation's unique challenges is an important element of this plan, and consideration of rural transportation concerns is mandated under the *Texas Administrative Code*.

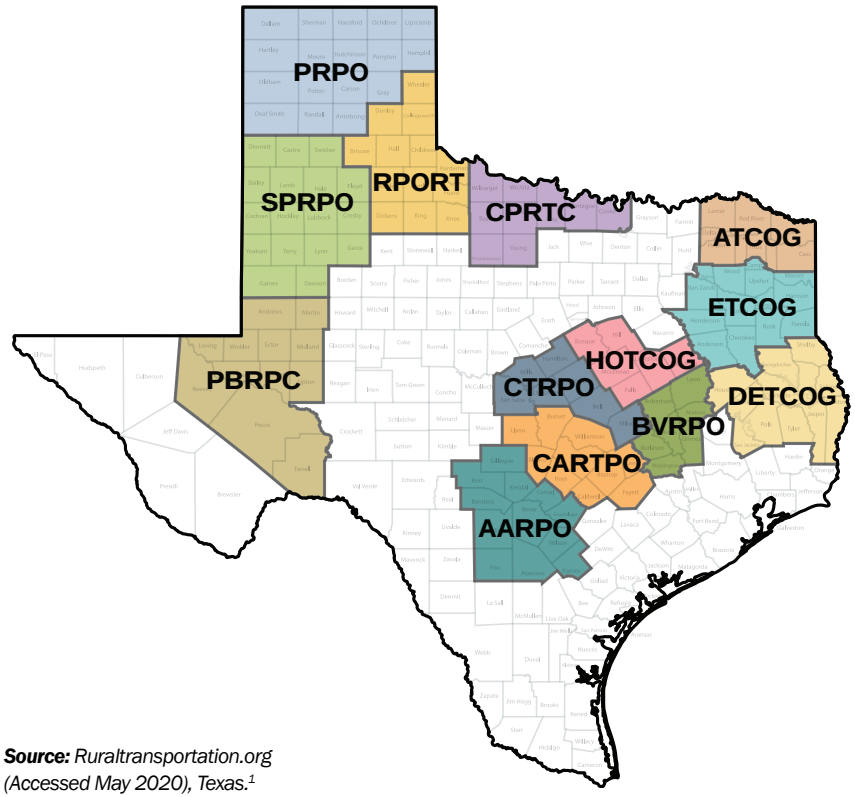
Rural Transportation Planning

TxDOT determines transportation improvements in rural areas of the state in consultation with local leaders, rural transit providers, and other transportation stakeholders, including rural planning organizations (RPOs), which are voluntary organizations created and governed by local elected officials. RPOs provide recommendations and priorities regarding transportation planning and project development to TxDOT in areas not included within MPO planning area boundaries. Capacity-building projects are added to TxDOT's 10-year Unified Transportation Program (UTP) based on input from local leaders, transportation stakeholders, and the public along with the evaluation of project and system needs. Tools used to examine a project include traffic data collection, travel demand modeling, mapping, and various other corridor and route analyses. The state's rural transportation improvements within and beyond the 10-year horizon are identified as part of TTP development and are discussed in subsequent sections of this chapter. Rural considerations are an aspect of all statewide plans, including the *Strategic Highway Safety Plan, Texas Freight Mobility Plan*, and various corridor-specific plans.

Defining the Rural Transportation System

The distinction between "urban" and "rural" geographies can vary depending on the context. For the purposes of the TTP, "rural" refers to the transportation network outside of metropolitan planning organization (MPO) regions. That is, roadways not contained by population centers with at least 50,000 residents.

Figure 5-1: Texas Rural Planning Organizations



Source: *Ruraltransportation.org (Accessed May 2020), Texas.*[1]

Texas Rural Planning Organizations

AARPO	Alamo Regional Rural Planning Organization
ATCOG	Ark-Tex Council of Governments
BVRPO	Brazos Valley Regional Planning Organization
CARTPO	Capital Area Regional Transportation Planning Organization
CTPRO	Central Texas Rural Planning Organization
CPRTC	Cross Plains Rural Transportation Council
DETCOG	Deep East Texas Council of Governments
ETCOG	East Texas Council of Governments
HOTCOG	Heart of Texas Council of Governments Rural Planning Org.
PRPO	Panhandle Rural Planning Organization
PBRPC	Permian Basin Regional Planning Commission
RPORT	Rolling Plains Organization for Rural Transportation
SPRPO	South Plains Rural Planning Organization

Rural Transportation Programs

Rural project funding varies by mode. Highway and bicycle and pedestrian projects are funded through a combination of 12 funding categories (**Table 5-1**). The bulk of the funding going to rural areas is determined by needs-driven formulas. Preventive maintenance and rehabilitation funding is distributed to TxDOT's 25 districts based on a combination of pavement distress scores, on-system lane-miles, truck traffic volumes, and on-system bridge deck area. Bridge funding is allocated based on a statewide prioritization of projects determined by structure condition ratings. Safety funding is determined by a safety improvement index with obligated funds for high-risk rural roads – that is, roads with fatality rates that exceed the statewide average for similar roadways. In addition, district discretionary funds are provided to TxDOT districts to supplement other available funding (Category 11).

Table 5-1: Primary TxDOT Funding Categories for Rural Areas

Category	Common Project Type
Category 1 – Preventive Maintenance	Roadway resurfacing, rehabilitation, and restoration
Category 3 – Non-Traditional Funds	New-location roadways and roadway widening
Category 4 – Statewide Connectivity	Road widening and interchange improvements
Category 6 – Bridge	Bridge replacement and repair
Category 8 – Safety	Median and shoulder widening, signals, lighting, guard rails, etc.
Category 9 – Transportation Alternatives	Bicycle and pedestrian infrastructure
Category 10 – Supplemental Transportation	Border highway infrastructure improvements
Category 11 – District Discretionary	Roadway resurfacing and passing lanes
Category 12 – Strategic Priority	Road widening (freeway or non-freeway)

Bicycle and pedestrian projects are predominantly funded through Category 9 (Transportation Alternatives). TxDOT administers Federal Highway Administration grants to sponsoring rural communities in support of bicycle infrastructure improvements, shared-use paths, sidewalk improvements, safe routes to school, compliance with the Americans with Disabilities Act, and infrastructure-related projects to improve safety for non-motorized transportation.

In addition to TxDOT's rural investment efforts through conventional UTP funding categories, TxDOT has allocated $2.1 billion to the Energy Sector Program (Category 11) for fiscal years 2020 to 2029.[2] This program is distributed to TxDOT districts to address specifically identified roadways affected by traffic in the Permian Basin, Anadarko Basin, Eagle Ford, Barnett Shale, and Haynesville-Bossier energy development areas. The Texas Transportation Commission also has authorized $365 million of a dedicated $600 million from Category 12 (Strategic Priority) to fund highway improvement projects in the Permian Basin region of West Texas.[2]

Rural airports are funded in part through Federal Aviation Administration grants administered by TxDOT. Additionally, TxDOT uses its Routine Airport Maintenance Program to match local government grants up to $50,000 for maintenance to airfield pavements, fencing, and other airside and landside needs.[3]

TxDOT supports rural public transportation through the administration of Federal Transit Administration and other U.S. Department of Transportation grant programs, the most significant being rural planning and transit assistance, intercity bus grants, fleet replacement, and those aimed at enhancing mobility for seniors and individuals with disabilities.

Key Definitions

- **Trunk System:** network of highways that includes and complements the interstate network, with the goal of improving rural mobility by providing a network of four-lane, divided roadways connecting cities, water ports, major Mexican ports of entry, and principal highways from other states.
- **Farm/Ranch to Market Roads:** economic engines, allowing everyone from farmers to manufacturers to move their goods to market.

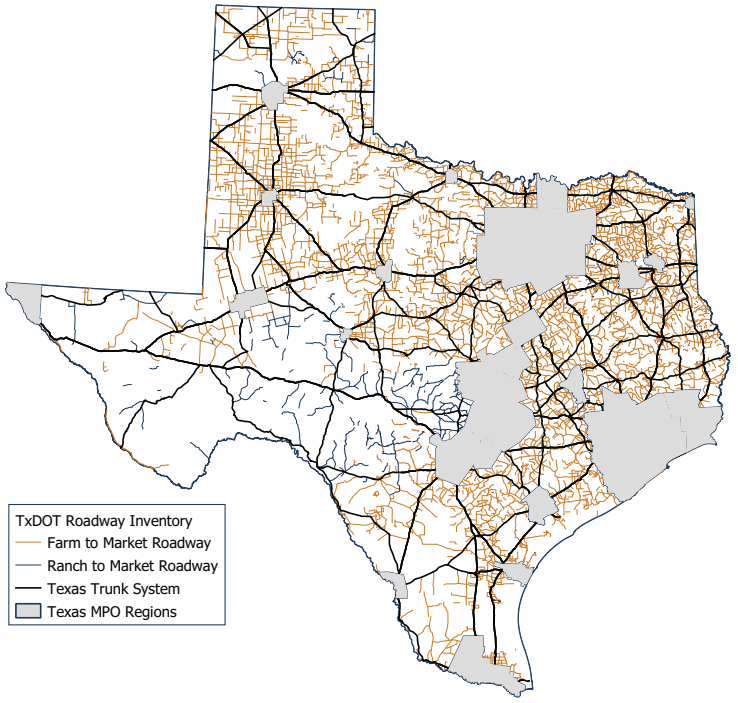
Source: Texas Department of Transportation, Rural Transportation: 2017 Educational Series

Rural Transportation System Overview

The multimodal rural transportation system connects diverse communities and markets across the vast geographic scale that is Texas. With nearly 57,000 miles of on-system roadways and 24,600 bridges[4] outside MPO boundaries, rural roadways make up nearly half of TxDOT-maintained roads and bridges (**Figure 5-2**). Rural roadways include nearly 10,500 miles of the TxDOT Trunk System[5] and 50,000 miles of farm/ranch-to-market roads[6] that provide critical economic connections. The rural highway network contains 53% of the Texas Highway Freight Network, which supports most truck traffic in the state.[7] This includes 745 miles of Critical Rural Freight Corridors.[8]

Twenty-five percent of the average annual daily traffic comes from trucks, and these corridors provide access to intermodal connections, international ports of entry, energy, agriculture, mining, and forestry sites.[8]

Figure 5-2: On-System Rural Highway Network



Source: *Texas Department of Transportation (2020), TxDOT Roadways, and Texas Department of Transportation (2019), Texas Metropolitan Planning Organizations*

Beyond highways, the rural transportation system includes:

- 197 general aviation and reliever airports representing about two-thirds of Texas Airport System supported by TxDOT[11]
- 72% of possible long-distance bicycle routes identified by TxDOT[12]
- 36 rural public transportation systems[13]
- 6,819 miles of rail[14]

Rural Transportation System Performance Levels

TxDOT regularly tracks and assesses the performance of rural roadways to inform resource allocation decisions and ensure equitable transportation benefits for all Texans (**Table 5-2**). Although TxDOT is predominantly responsible for the planning, construction, and operations of highways, TxDOT does coordinate and administer grants to local and regional partners in support of non-highway modes.

Highway Performance

On an average day in 2018, rural highways supported more than a quarter-billion vehicle miles traveled (VMT). This represents nearly 33% of all daily traffic and more than 55% of all truck traffic in Texas.[18] Although high truck traffic is indicative of a strong economy, additional truck traffic can create speed differentials on passing-limited roadways with passenger vehicles that can result in higher severity crashes, place more wear and tear on infrastructure, and worsen congested roadway conditions.

Highway Safety

Rural roads tend to have higher fatality rates than those in urban areas, making rural highway safety a top priority for TxDOT. A few of the risk factors for rural roads include narrower lanes, closer proximity to trees and ditches, faster speeds, and increased potential for animals to dart into traffic. Injured drivers in remote areas also can have longer wait times to receive medical care.

TxDOT has emphasized the identification of countermeasures to mitigate run-off-the-road and distracted-driving fatal crashes, which occur at a higher rate in rural areas. Just a few of the traffic safety solutions TxDOT implements with special dedication to rural areas include installing edge line rumble strips on all four-lane divided highways, widening narrow highways and bridges,[19] installing wildlife crossings, and increasing the availability of EMS training for first responders.[20]

Table 5-2: Current Rural and Urban Highway Performance Levels

Focus Area	Performance Measure	Rural	Urban
Highway Safety (All public roads 2018 data)[15]	Fatalities	1,277	2,423
	Fatalities Rate	1.39	1.27
	Serious Injuries	4,748	10,536
	Serious Injury Rate	5.17	5.54
Highway Preservation (on-system roads 2019 data)	% "Good" or "Better" Pavement[16] Lane Miles (higher is better)	90.6%	85.1%
	Bridge Condition Score[4] (higher is better)	87.8	88.1
	% Poor Bridge Deck Area (lower is better)	0.7%	1.2%
Highway Mobility[17] (on-system roads 2020 forecast)	Travel Time Reliability Index (lower is better)	1.14	1.59
	% Congested Daily VMT (lower is better)	2.3%	22.9%
	% Congested Morning Peak Hour Lane Miles (lower is better)	0.4%	17.1%

Source: *Crash Records Information System C.R.I.S. Query Tool, 2017 Safety Data, Texas Department of Transportation Maintenance Division, and SAM-V4 2020 Roadway Network.*

Highway Preservation

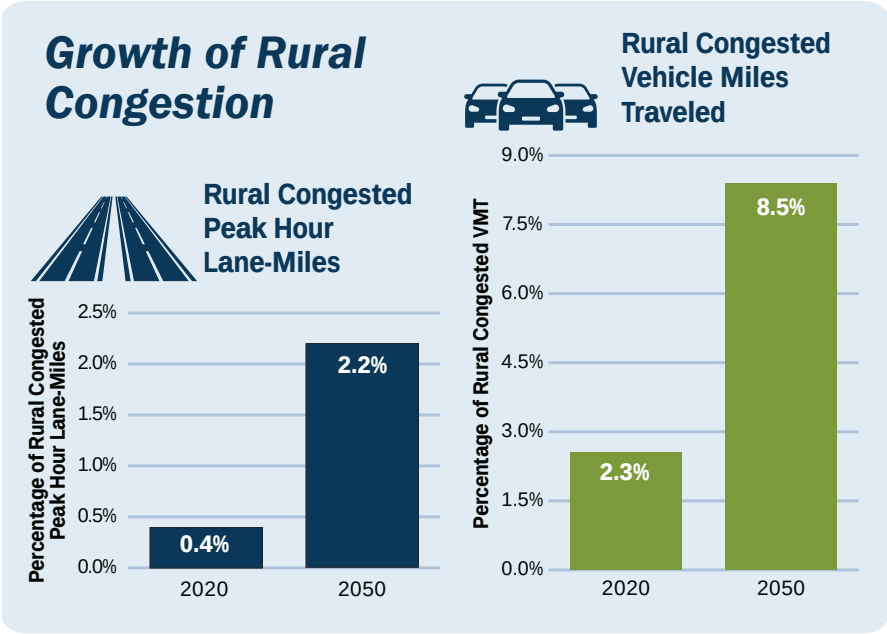
Rural roadways deteriorate due to a combination of environmental factors and traffic loadings. Droughts, for instance, cause soils to shrink drastically, resulting in deep pavement cracking. Heavier truck traffic can also cause damage. This has been common for rural roadways that support the energy sector, leading TxDOT to target investments for strengthening/reinforcing pavement structures on these roadways and to continue coordinating with local and industry partners. Investing in preventive maintenance while pavements are in "good" condition helps prolong the life of pavements in the state at a lower whole life cost. This strategy and allocation of funds to lower volume farm-to-market roads have resulted in rural pavement conditions (90.6% "good" or "better") outperforming urban areas (85.1% "good" or "better"), as of 2019.

Rural bridges perform at similar levels to urban structures. Although there are 0.5% fewer "poor" bridge deck areas in rural areas compared to urban areas, rural bridges are, on average about eight years older and, as such, have a slightly lower overall bridge condition score (0.3% lower in rural areas).

Highway Mobility

Different communities can have varying perspectives on what congestion looks like. In rural areas, TxDOT often defines "congestion" as roadways operating at Level of Service (LOS) D or lower. In urban areas, travelers tend to be more tolerant of (or at least more accustomed to) higher traffic densities. As such, TxDOT defines urban "congestion" as roadways operating at LOS E or lower. By these definitions, rural roadways tend to have 10% of the daily congestion of urban areas, and the congestion is reliably limited to fewer roadway miles.

Yet rural communities also will experience continued population and economic growth. TxDOT's Statewide Analysis Model Version 4 (SAM-V4) forecasts that rural areas will see congested daily VMT nearly quadruple between 2020 and 2050 (from 2.3% to 8.5%). Rural congested peak hour lane-miles are forecasted to increase from 0.4% in 2020 to 2.2% in 2050 with a corresponding reduction in rural travel time reliability. Most of this congestion is predicted to be due to 72% more daily truck VMT in rural areas as compared to 62% more daily automobile VMT. TxDOT's continued efforts to widen roadways and add passing lanes (often in the form of super-two roadways with periodic passing opportunities) will help offset the impact of more traffic.



Rural Non-Highway Performance

Accessibility to increased travel options is particularly important to rural areas. This includes the development of bicyclist-friendly roadways, expansion and maintenance of regional airports, more coverage and frequency of public transportation, and the ability to reach Amtrak rail stations within the state.

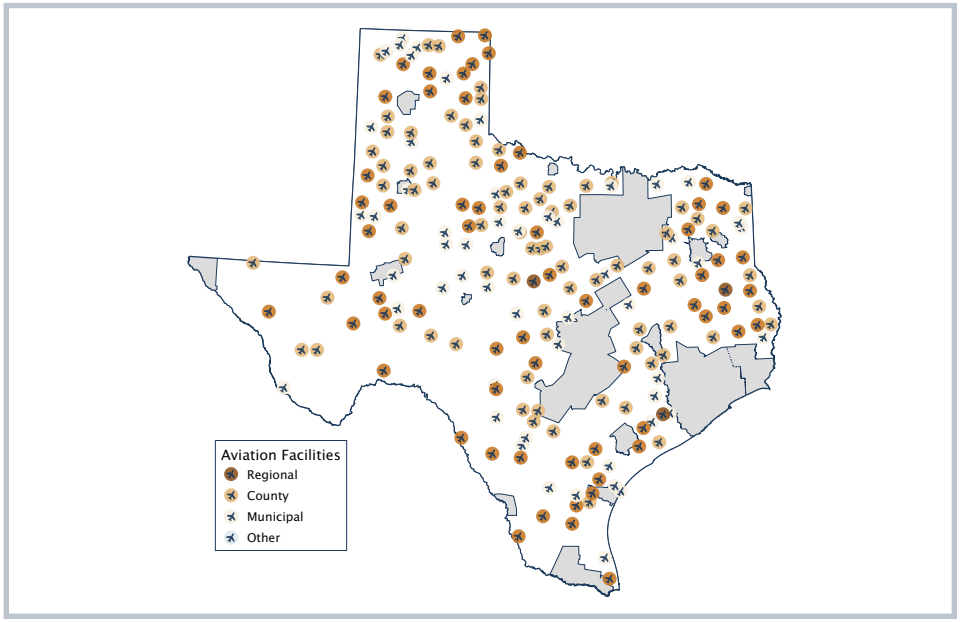
Bicycle and Pedestrian

In 2018, TxDOT conducted outreach to identify possible long-distance bicycle routes throughout the state to incentivize tourism and healthy lifestyles. This network, still conceptual in many areas, highlights the natural, historical, and exceptional landscapes across the many unique regions of the state. Bicycle amenities, businesses, and cultural events promoted along the statewide network are expected to channel bicycle tourism dollars into rural and small-town economic development. A significant majority (72%) of the network is located in rural Texas.

Aviation

There can be large distances between communities in Texas, and connections made through the airport system provide invaluable access to the state's more rural communities. TxDOT supports general aviation and reliever airports in the state (**Figure 5-3**), which make important services possible like flights for emergency response, moving people and freight, agricultural spraying, aerial surveying, energy exploration, and life-saving flights for patients in need of critical medical care. TxDOT Aviation Division staff and airport sponsors identify what capital improvements would best serve the state's aviation needs, and how to maximize the economic benefit and return on investment to the state, local communities, counties, and cities from development of the airport system. Five-year improvement lists are included in the *Texas Airport System Plan*. A preliminary list of more than 7,081 candidate projects has been identified for airports in rural areas at an estimated cost of over $1.6 billion to improve safety, preserve the functional or structural integrity of the facility, upgrade to current design standards and accommodate larger aircraft to enable longer flight distances, support increased airport operations while relieving congestion at other area airports and provide new access to a previously unserved area.[21]

Figure 5-3: Aviation Facilities



Source: *Texas Department of Transportation (2018), Rural Public Transportation System*[13]

Public Transportation

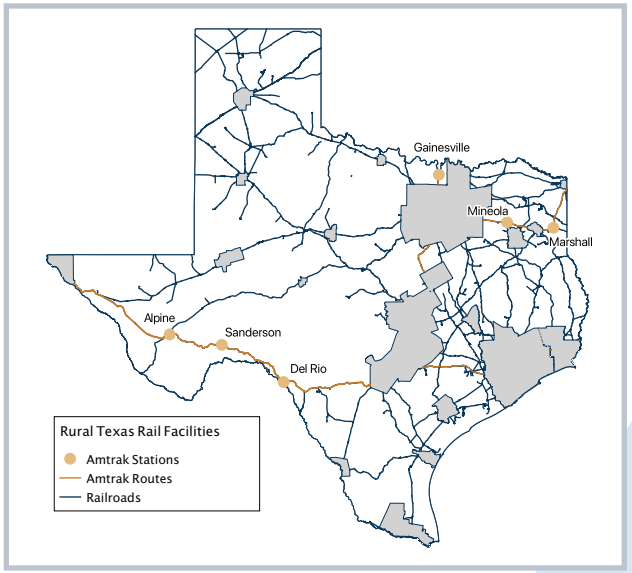
Public transit and intercity bus in rural Texas include scheduled transit and demand-response services throughout the state. These services help ensure residents have access to jobs, schools, medical services, businesses, and social and recreational opportunities. As of 2018, Texas has 36 transit systems across the state that serve rural regions. For FY 2018 and 2019, TxDOT allocated $21 million annually in state funds to supplement rural transit provider needs. The Texas A&M Transportation Institute (TTI) identified a gap reaching approximately $32 million in 2050 for rural transit districts to replace aging transit fleets, expand coverage, and increase operations to a 14-hour weekday, eight-hour Saturday schedule.[22]

Passenger Rail

There are six Amtrak stations in rural Texas, not counting through-stations (**Figure 5-4**).[23] Passenger rail service in Texas is provided by Amtrak, which operates three routes in Texas:

- **The Heartland Flyer** – Travels daily between Fort Worth and Oklahoma City with one rural area stop in Texas (Gainesville).
- **The Sunset Limited** – Travels triweekly between Los Angeles and New Orleans with three stops in rural areas of Texas (Del Rio, Sanderson, and Alpine).
- **The Texas Eagle** – Travels daily between Chicago and San Antonio and triweekly connecting to Los Angeles with five stops in rural areas of Texas (Marshall, Minola, Del Rio, Sanderson, and Alpine)

Figure 5-4: Rural Passenger Rail

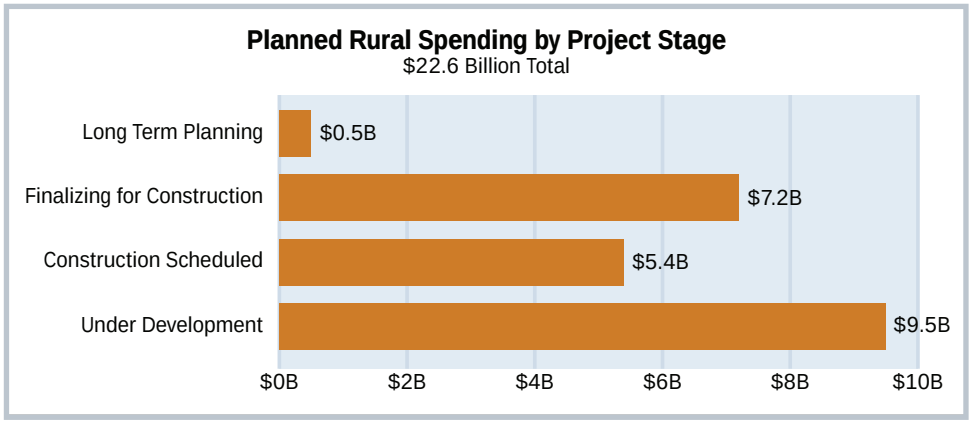


Planned Rural Transportation System Improvements

TxDOT uses Project Tracker, its publicly accessible online project reporting system, to provide information about all projects included in its Design and Construction Information System (DCIS). This includes both projects currently funded in the UTP, as well as longer-term projects. In total, Project Tracker includes more than 6,300 projects which are predominantly (at least 60% of project lane-miles) located in rural areas of the state with an initial total cost of $22.6 billion (see **Appendix C** for prioritized listing). This includes $9.5 billion of projects currently under development (next 1-5 years), $5.4 billion with construction scheduled (next 6-10 years), $7.2 billion being finalized for construction (next 10-15 years), and $0.5 billion in the pipeline for long-term planning (15+ years) (**Figure 5-6**).[24,10]

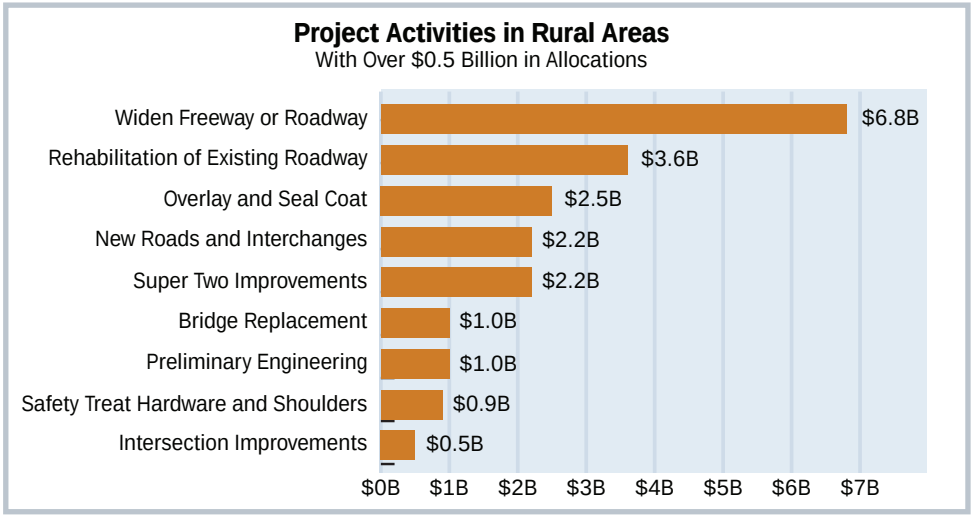
Figure 5-5: Most Common Rural Project Descriptions

Figure 5-6: Planned Spending in Rural Areas



Source: *Geospatial at the Bureau of Transportation Statistics, Amtrak Stations [Data set]; Texas Department of Transportation (2016), Texas Railroads [Data set][14] and Texas Metropolitan Planning Organizations[10]*

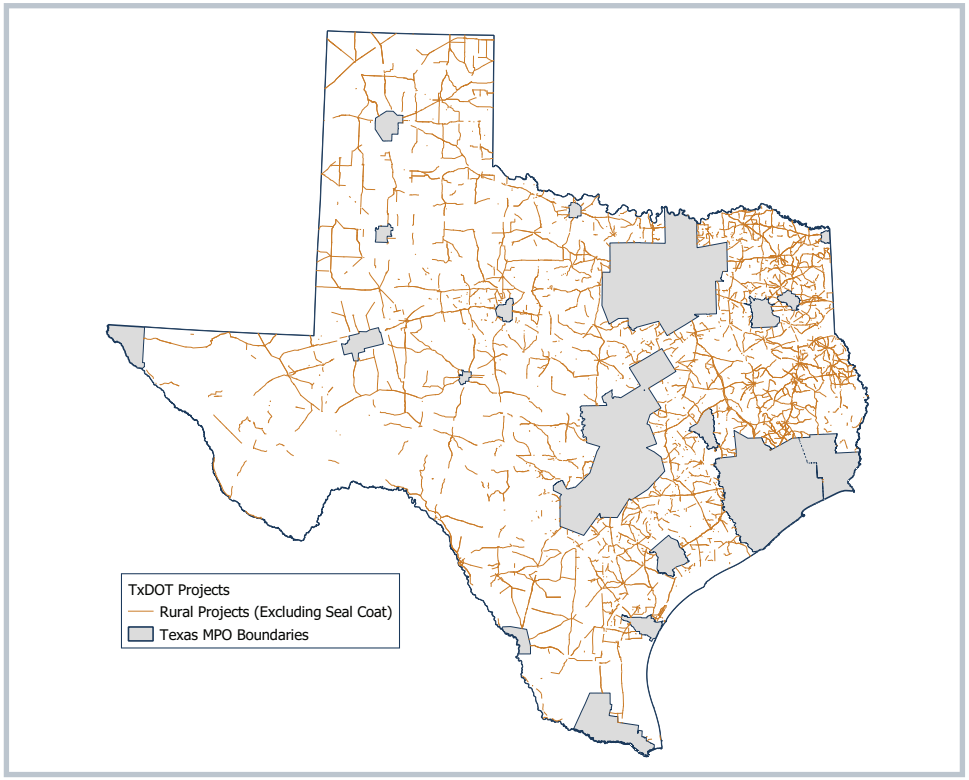
Figure 5-7: Planned Investments Outside of Urban Boundaries



Source: *Geospatial at the Bureau of Transportation Statistics, Amtrak Stations [Data set]; Texas Department of Transportation (2016), Texas Railroads [Data set][14] and Texas Metropolitan Planning Organizations[10]*

With about 15% of the state population in rural areas, this corresponds to about $4,700 of planned investments per person. This is approximately 33% higher than the statewide average.[25,26]

Figure 5-8: Map of Planned Projects in Rural Areas (Excluding Seal Coats)



Most of these projects are aimed at providing low-cost, preventive maintenance to rural roadways, including seal coating asphalt pavements. From a cost perspective, most planned investments outside of urban boundaries are for:

- **Adding rural capacity** – including $6.8 billion for widening existing roadways, $0.5 billion for improving intersections, and $2.2 billion for new roads and interchanges;
- **Preserving rural roadway infrastructure** – including $3.6 billion for pavement rehabilitation, $2.5 billion for resurfacing and preventive maintenance, and $1.0 billion for bridge replacements; and
- **Enhancing rural safety** – including $2.2 billion in super two improvements and $0.9 billion for maintenance of guard rails, crash barriers, and other safety hardware.

TxDOT districts and MPOs coordinate to identify the most important transportation projects in their respective regions. These candidate projects are then evaluated against criteria to align with statewide strategic goals, performance measures and approved targets for the transportation system. TxDOT provides its districts and MPOs with a software application to compare candidate projects based on their projected benefits to the Texas transportation system. The application evaluates each project's impact on highway safety, preservation, congestion, and connectivity, as well as its economic and environmental effects. TxDOT uses this data-driven approach to inform the selection of the right projects based on performance scores.

Key Rural Transportation System Considerations and Strategies

As part of the TTP update, members of TxDOT's planning team used open house events across the state to meet with rural- and urban-focused stakeholders, including elected officials, local and regional government staff, advocacy organization representatives, members of the public, and social, economic and business leaders. The purpose of these efforts was to share information, build connections, and understand perspectives. Engagement, in combination with thorough analysis of wide-ranging planning documents, led to identification of key rural transportation themes uniquely important for the future of transportation investment choices for projects and services in rural portions of Texas. These themes will help inform plans for the development of multimodal transportation projects and services in rural areas of the state.

Road Design Standard Upgrades

Any highway design strategies should provide safe, cost-effective remedies for safety, mobility, access, and capacity challenges. Design of rural portions of the Texas multimodal transportation network can benefit from engineering solutions that differ from those deployed in urban or suburban areas. Special engineering and design considerations that deserve attention include those geared toward typically rural safety concerns like animal and vehicle conflicts or slow-moving commercial vehicles, integration of active transportation infrastructure in rural communities, and practical rural highway capacity addition options like passing lanes in congestion-prone areas or on steep uphill grades.

System Ownership

Rural highways in Texas range from busy multi-lane rural expressways with considerable traffic to lightly traveled two-lane roads. Some connect communities across the state and others serve local travel needs within small towns and cities. Careful consideration of how ownership of rural highway elements is distributed between the state and local government units can help ensure the best use of state and local resources to meet transportation needs in a timely and cost-effective manner. Turning back some facilities to local ownership may enable maintenance strategies suited to local needs while freeing up state resources for investment in heavily used elements of the rural transportation network.

Key Considerations

The long distances and low population densities that define rural areas of Texas impose physical transportation challenges which differ sharply from those of more urbanized regions in the state.

- **Geographic Scale:** Rural areas comprise 70% of Texas by land area[10] and 15% of its population (about 4.5 million people).[25,26]
- **Agriculture:** Rural regions of the state sustain 247,000 farms and ranches producing crops like cotton and hay and raising livestock.
- **Energy:** Much of the oil, gas, and wind energy production that is vital to the Texas economy occurs in rural areas.
- **Access:** Many rural areas of the state are challenged by population decline and rural areas of Texas generally lag behind their metro counterparts in performance metrics for healthcare, social services, education, and high paying jobs.[27]

Safety

Less travel occurs on rural Texas roads than on roads in the state's major population centers, but each year almost half of all vehicle occupant deaths in Texas occur on rural parts of the transportation network. This disparity in safety demands a special focus on contributing crash factors in rural areas, which include lower seatbelt use, longer emergency response times, and more frequent involvement of speeding and run-off-the-road.

Each year almost half of all vehicle occupant deaths in Texas occur on rural parts of the transportation network.

Rest Areas

Texas is a large state, with long stretches of isolated rural highway running between centers of commerce. Public rest areas along these routes are a vital safety feature since they offer basic amenities like shelter, restrooms, and parking that are designed in part to encourage drivers to make long trips to pull over and take a break from driving. Rest areas at frequent intervals outside populated areas help reduce the risk of crashes caused by drowsy driving, which is a particular concern for commercial drivers who make long journeys or who drive either late at night or early in the morning. Provision of sufficient rest area facilities along rural routes with significant amounts of long-distance traffic is a critical issue for the rural transportation network.

Resilient Connections

In rural areas of Texas, population, economic activity, and supporting transportation infrastructure and services like transit or mobility-as-a-service are dispersed. As a result, rural communities typically experience lower levels of resiliency in terms of convenient transportation alternatives, whether around temporary bottlenecks like a flooded road, major crash, passing freight train, or in terms of alternatives to travel alone, like ride-hailing services or transit. Lack of resilient transportation connections imposes economic costs and threatens public safety in rural areas.

Digital Connectivity

Over the last decade, access to internet service has become an important catalyst for technological advances, community quality of life improvements, and growth in economic prosperity. Rural regions, which are physically distant from cities and sparsely populated, often lag metro areas in provision of physical broadband infrastructure. Within transportation, digital connectivity is particularly important for the future of self-driving vehicles, which use hundreds of sensors to make faster and smarter decisions than human operators. But these sensors generate unprecedented amounts of data that can only be handled with ultra-fast data networks. Policymakers describe a growing "digital divide" between rural and urban regions that could put geographic limits on technological, social, and economic opportunities in the future without the right investments in rural digital connectivity.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CHAPTER 6

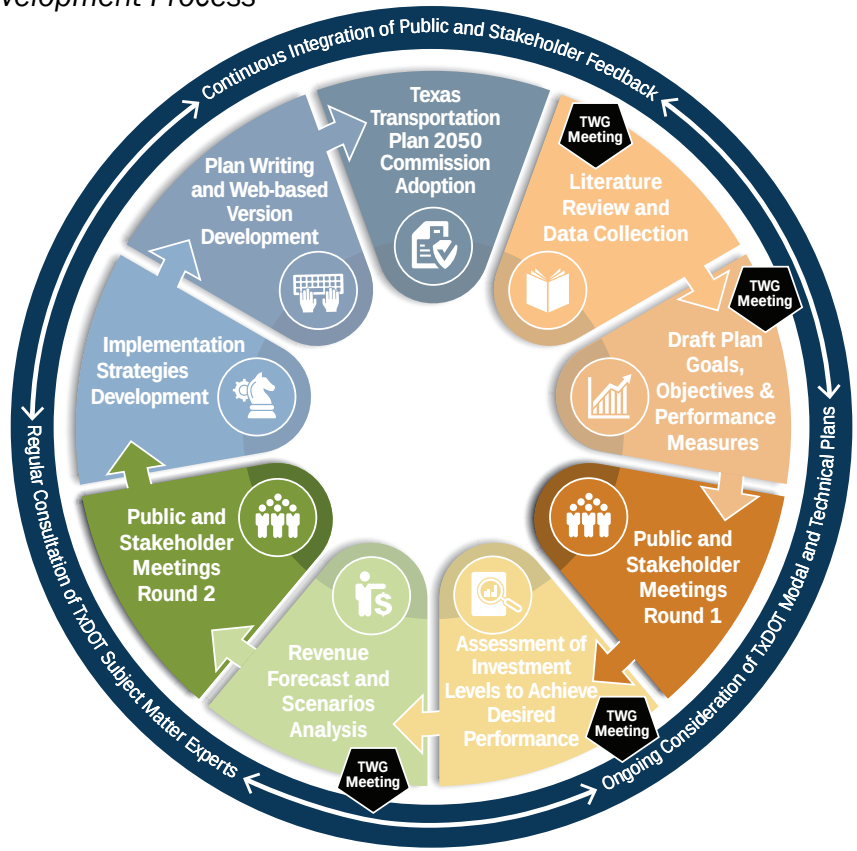
Public Involvement

Well-informed stakeholders can provide valuable input and insights to help inform the transportation planning process (**Figure 6-1**). Stakeholder and public participation during development of the Texas Transportation Plan (TTP) expand TxDOT's understanding of system usage, provides input on transportation issues and investment priorities, and helps the department better plan for the state's transportation future. Public engagement allows TxDOT to educate the public about the TTP development process, agency roles and responsibilities, system performance, and emerging transportation technology considerations. It also gives every Texan the opportunity to weigh in on transportation issues, comment on draft plan components, and better understand the tradeoffs between different investment strategies. The result is a TTP that is not only performance- and data-driven, but that also is responsive to the needs and interests of TxDOT's customers.

In addition to providing important input to plan development, the public involvement effort satisfies several state and federal planning requirements. Led by TxDOT's Transportation Planning and Programming Division (TPP), the effort ensured TxDOT complied with federal laws, regulations, and guidance that require states to include public involvement in the development of long-range transportation plans. Further, public involvement activities complied with the Americans with Disabilities Act of 1990 and Title VI of the Civil Rights Act of 1964. These laws ensure people with disabilities, and traditionally underserved populations are enabled and encouraged to participate. The public involvement effort also met requirements established by the Texas Legislature in House Bill 20 and Senate Bills 312 and 1420.

TxDOT values the contributions provided through the public engagement process. Engagement of stakeholders and the public offered valuable feedback to TTP 2050 goals and objectives, provided insights on how Texans use the current transportation system and their level of comfort with emerging transportation technologies, fostered better understanding about how TxDOT plans and funds system improvements, and facilitated education about the implications of different future allocation strategies.

Figure 6-1: Public Involvement Components of the TTP 2050 Plan Development Process



***TWG** = Technical Working Group*

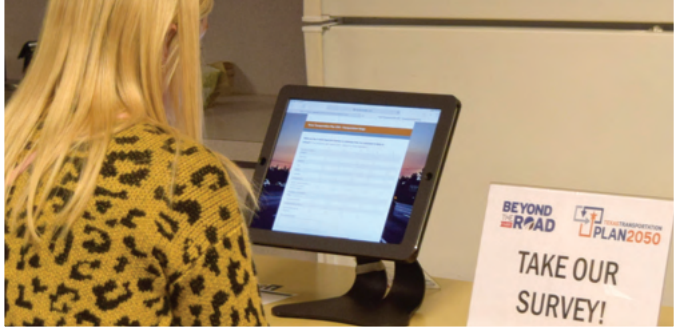
The TTP 2050 public engagement effort succeeded in reaching a large and diverse set of stakeholders and citizens from various regions of Texas. Throughout the workshops, open houses, and surveys, several key themes emerged that had significant impact on development of the TTP 2050.

Key Takeaways

- There is ongoing need for sufficient and sustainable funding.
- TxDOT should continue to balance investment between urban and rural areas.
- Stakeholders would like to see increased investment to accelerate technology deployment, upgrade ports of entry access, and address major freight bottlenecks and other congestion issues.
- There is confusion over the roles and responsibilities of TxDOT versus regional organizations.
- The public identified the need for more and better transportation options associated with public transportation, active transportation, and high-speed rail, but recognizes that new funding sources may be needed to pay for them.
- Texans have very mixed opinions about the use of connected and autonomous vehicles on Texas roadways – many cannot wait for the convenience, whereas others are skeptical that current technology is sufficiently safe, secure, and reliable.

Potent Quotables

What will the future of Texas transportation look like?	"Busy and Bright"
	"Flexible and adaptive. We must anticipate the dynamic evolution of transportation modes and preferences."
	"I look forward to what the future growth brings for my children and grandchildren. Thank you!"
What should TxDOT's investment priorities be?	"Find solutions that focus on moving people and goods, not cars and trucks."
	"Prioritize safety and flow. Modernize existing intersections with new technology to improve flow and reduce congestion."
	"Food, fuel, and fiber are the lifeblood of the Texas economy. We need infrastructure to support the associated industries."

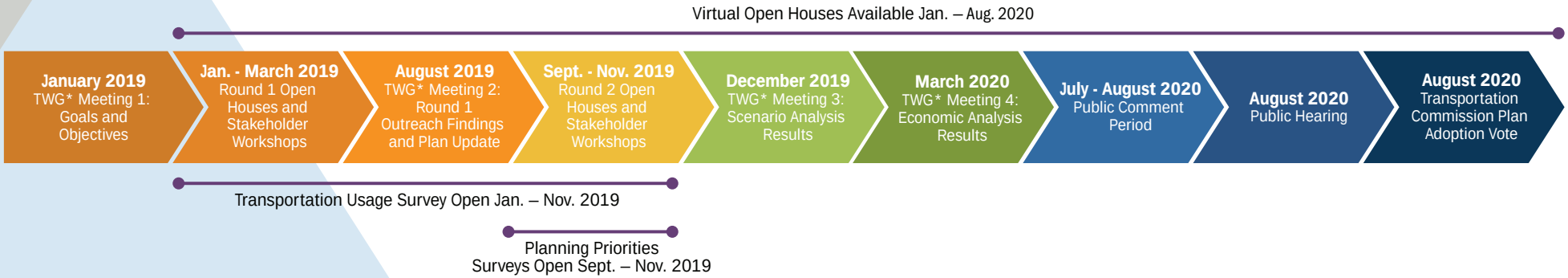


The Public Engagement Process

TxDOT established a Public Outreach Plan, which served as its roadmap for communicating with the Texas public and stakeholders throughout the TTP 2050 development effort. The outreach plan defined a multipronged approach that incorporated in-person and online outreach components. These components included the use of social media and email campaigns, several different surveys, and the collection of comments and live polling to gain meaningful input from the transportation system users. The target audience included transportation stakeholders such as representatives from metropolitan and rural planning organizations (MPOs and RPOs), public transportation agencies (metropolitan and rural), freight interests, private providers of transportation services, affected state and federal resource agencies and tribal governments, state and local elected officials, and all other interested parties. The effort also focused on reaching traditionally underserved groups including disabled, low-income, minority, and non-English speaking populations.

As illustrated in **Figure 6-2**, the outreach plan included a 19-month timeline that facilitated stakeholder and public input at key decision points throughout the development of the TTP 2050. In particular, the two rounds of stakeholder workshops and public open houses were scheduled to afford Texans the opportunity to weigh in on key plan elements such as goals and objectives, funding needs, emerging transportation issues, and investment strategies.

Figure 6-2: The TTP 2050 Public Engagement Timeline



* ***TWG*** **=** *Technical Working Group*

Engagement Audiences

General Public

TxDOT coordinated with district staff and its planning partners to develop and implement strategies to reach the general public and incorporate their input into TTP 2050 development. These efforts included newspaper advertisements (English and Spanish), use of social media, and email campaigns.

The engagement process was centered around two series of stakeholder meetings with public open houses in 15 TxDOT districts (**Figure 6-3**). Public open houses were consistent in terms of information presented and feedback solicited, while stakeholder workshops were geared toward subject matter experts, addressed specific regional topics, and were structured to facilitate more in-depth discussions. All TTP 2050 in-person outreach events were accessible via internet and audio conferencing. Two virtual open houses also complimented the engagement efforts and presented information identical to the Round 1 and Round 2 public open houses. All outreach events encouraged the public to participate in the various surveys intended to provide additional input to the TTP 2050 development. TxDOT also presented on the TTP 2050 to three groups with large and diverse stakeholders: the Bicycle Advisory Committee, the Semiannual Transit Operators Meeting, and the Capitol Area Regional Transportation Planning Organization which is a member group of several area MPOs and RPOs. As is illustrated in **Figure 6-4**, the TTP 2050 outreach effort succeeded in reaching a large number of citizens and stakeholders across the state through in-person events, online surveys, and a variety of conventional and social media mechanisms.

In addition to providing all Texans with an opportunity to be part of the TTP 2050, TxDOT worked with two diverse groups of experts and professionals to provide technical guidance to the plan development effort (**Figure 6-5**).

Figure 6-3: TxDOT Districts Visited During Round 1 and 2

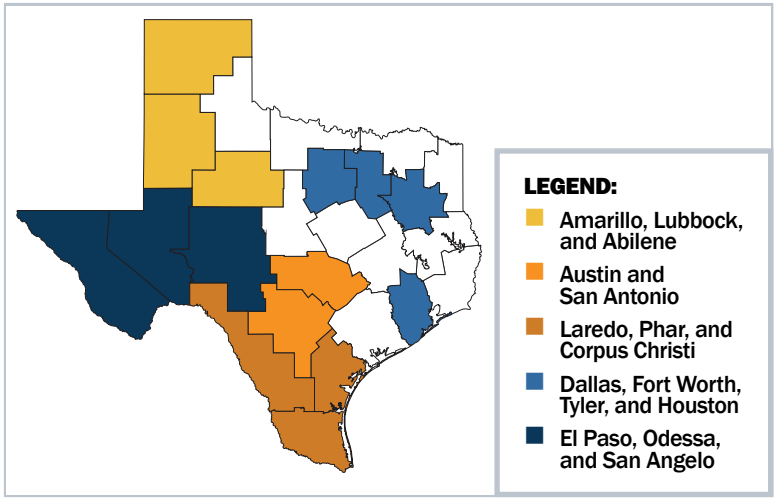


Figure 6-4: TTP 2050 Survey Response by County

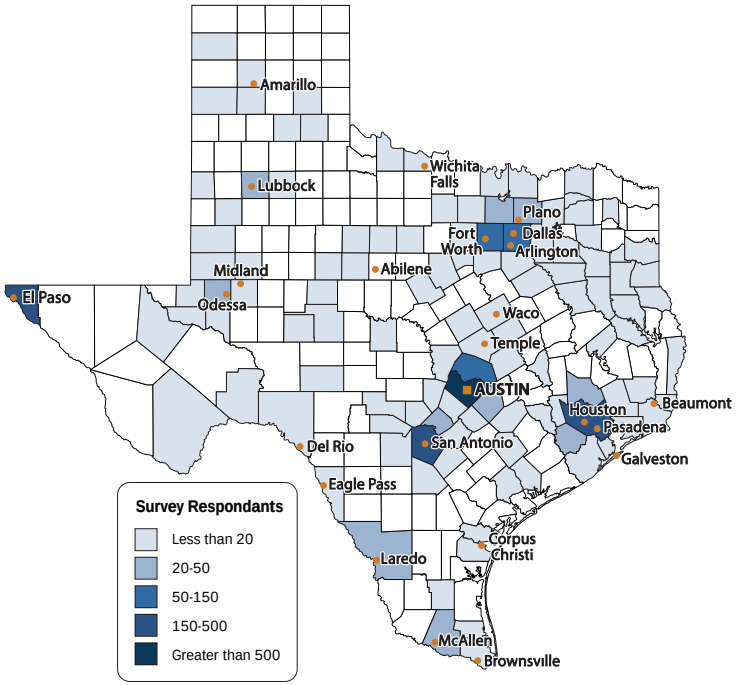


Figure 6-5: TTP 2050 Engagement Audiences

- Bureau of Indian Affairs
- Councils of Governments
- Counties
- Cities
- Elected Officials
- Historical Commissions
- Metropolitan Planning Organizations
- Regional Mobility Authorities
- Rural Planning Organizations
- Transit Providers
- Rail Providers
- U.S. Department of Transportation Agencies
- Advocacy Groups
- Non-governmental Organizations
- Tribes
- General Public

Engagement by the Numbers

#FactFriday Videos	7
Newspaper Ads	14
Facebook Posts	57
Tweets	72
Eblasts	113
Meeting Attendees	764
Virtual Open House Participants	1,043
Comments	2,243
Survey Respondants	4,116
Outreach Contacts	16,083

Technical Working Group

Before, between, and after each round of public engagement outreach, TxDOT met with a Technical Working Group (TWG) of TxDOT, Federal Highway Administration (FHWA), and Federal Transit Administration (FTA) subject matter experts. Charged with providing technical support and oversight of the TTP 2050 development, the TWG ensured that any information shared during outreach events was technically sound and met both Texas legislative and federal requirements.

Stakeholders

Stakeholders are planning partners that bring external subject matter expertise to the plan development effort across a diverse range of topics including planning, program delivery, the natural and built environment, freight services, tribal concerns, and local transportation issues. Stakeholder groups were encouraged to inform and invite their organizations to participate in the public outreach activities as well as provide comments on the development process.

Table 6-1: Public and Stakeholder Engagement Activity Summary

In-Person Outreach	Online Outreach	Other Outreach
2 Rounds of 14 Public Open Houses ■ Round 1 (Winter 2019) – Reviewed draft goals and objectives and got input on local transportation usage and issues ■ Round 2 (Fall 2019) – Gathered feedback on alternative performance scenarios and investment strategies	**2 Virtual Open Houses** ■ TxDOT.gov; keyword search “TTP 2050” ■ Provided an opportunity for those not able to attend the in-person meetings to view all the meeting material ■ Featured surveys, outreach materials, and data dashboard for every county in Texas ■ Available January-November 2019	**Email Campaigns** ■ Semi-weekly email blasts containing open house and stakeholder workshop notices, survey links, and planning process updates distributed statewide ■ Follow-up emails containing meeting materials provided to stakeholder workshop participants

Table 6-1: Public and Stakeholder Engagement Activity Summary (Continued)

In-Person Outreach	Online Outreach	Other Outreach
2 Rounds of 14 Stakeholder Workshops ■ Teleconference opportunities for all 28 stakeholder workshops ■ Round 1 (Winter 2019) – Reviewed draft goals and objectives and got input on local transportation usage and issues ■ Round 2 (Fall 2019) – Gathered feedback on alternative performance scenarios and investment strategies	**5 Surveys** ■ Transportation System Usage ■ TTP 2050 Planning Priorities ■ Unified Transportation Program (UTP) Programming Priorities ■ Emerging Transportation Technology ■ Environmental Statewide Public Engagement Plan Survey – "Beyond The Road" ■ Responses from all 25 TxDOT districts	**Press Releases and Newspaper Ads** ■ Press releases and newspaper ads with public open house details were utilized to increase awareness in rural and underserved areas
4 Technical Working Group Meetings ■ Subject matter experts from TxDOT administration, districts, and divisions as well as FHWA provided comprehensive support and oversight throughout the planning process **3 Stakeholder Organization Presentations** ■ Bicycle Advisory Committee ■ Semiannual Transit Operators Meeting ■ Capital Area Regional Transportation Planning Organization (CARTPO)	**TxDOT.gov** ■ Open house details ■ Outreach materials ■ Draft goals and objectives ■ Links to topic-specific and past long-range plans ■ Virtual open house and online survey access ■ Comment submission	**Comment Collection** ■ Phone, USPS mail, and email ■ Paper and web-based forms ■ Open-ended survey questions ■ Stakeholder discussions
3 Visioning Meetings ■ TPP administration conducted three "thinking-outside the box" visioning meetings involving TxDOT staff, MPOs, and other stakeholders	**Social Media** ■ Semi-weekly Facebook posts ■ Semi-weekly Twitter posts using TxDOT district accounts ■ #FactFriday Videos	**Live Polling** ■ Interactive polling software gathered real-time information from stakeholders on topics like automated vehicles and roadway traffic conditions

Sample Outreach Materials

What did we hear?

FEEDBACK ON GOALS AND OBJECTIVES

The two rounds of outreach provided the public and stakeholders opportunities to weigh in on the initial and final draft TTP 2050 goals and objectives. Based on the input received, several refinements were made to the plan goals and objectives. Most comments focused on emphasizing innovation, technology deployment, resiliency, expanding travel options, and the environment.

Public Recommendations for Goal and Objective Refinements

- Incorporate the need for sustainable funding
- Elevate the importance of a future-focused, resilient system that accommodates emerging technologies
- Recognize the importance of maintaining technology devices along with bridges and pavement
- Emphasize the need for more travel options
- Reiterate the need for alternative strategies, including technology deployment, to relieve congestion and better operate the system

How do Texans Use the Transportation System?

The TTP 2050 outreach effort included paper and online versions of the Transportation Usage Survey. More than 1,900 respondents identified their top transportation issues and provided information on their travel practices.

Public's Top Three Transportation Concerns

1. Potholes, crumbling roads and bridges
2. Traffic congestion and delays
3. Pedestrian and bicyclist safety

Most Important Factors in Commuting Choice

1. Travel Time
2. Convenience
3. Reliability
4. Only Option
5. Flexibility

What Ways Do You Travel?

73% Drive alone in a vehicle daily

10% Use public transit daily

7% Carpool or rideshare daily

8% The percentage of respondants who drive alone in a vehicle daily was down compared to the previous study done for TTP 2040

10.6 miles Average one-way commute distance

- Urban respondents use non-motorized modes more frequently and favor multimodal transportation options
- Rural respondents rely more heavily on motorized travel, have longer commutes, and favor preservation and non-capacity expansion alternatives to congestion and travel time reliability improvements

How far is your one-way commute to work or school (in approximate miles)?

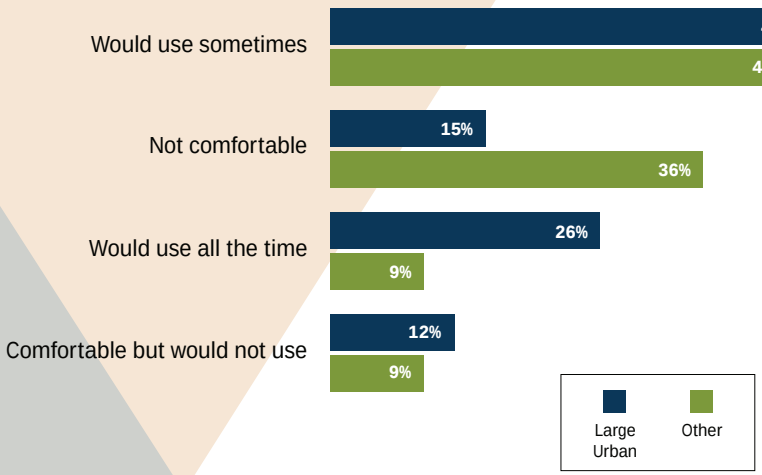
10 URBAN

18 RURAL

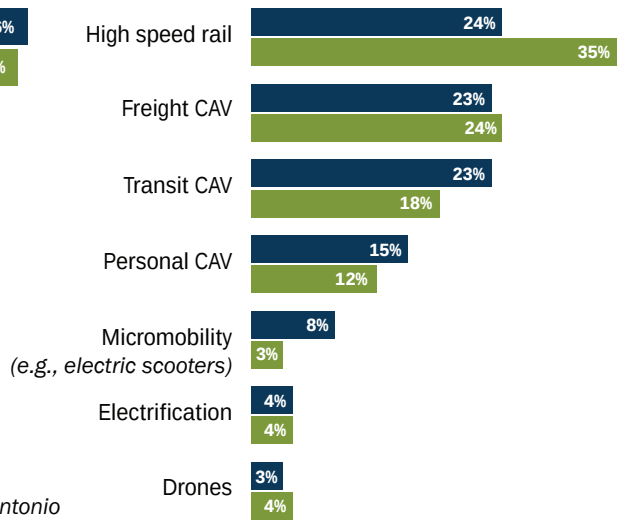
What do Texans Think about Emerging Transportation Technology?

During Round 2 of the public outreach efforts and as part of the emerging technology survey, participants were asked about their comfort with the presence of connected or autonomous vehicles (CAVs) on Texas roads and about their views on other new transportation technologies.

What is your comfort level with driverless vehicles?

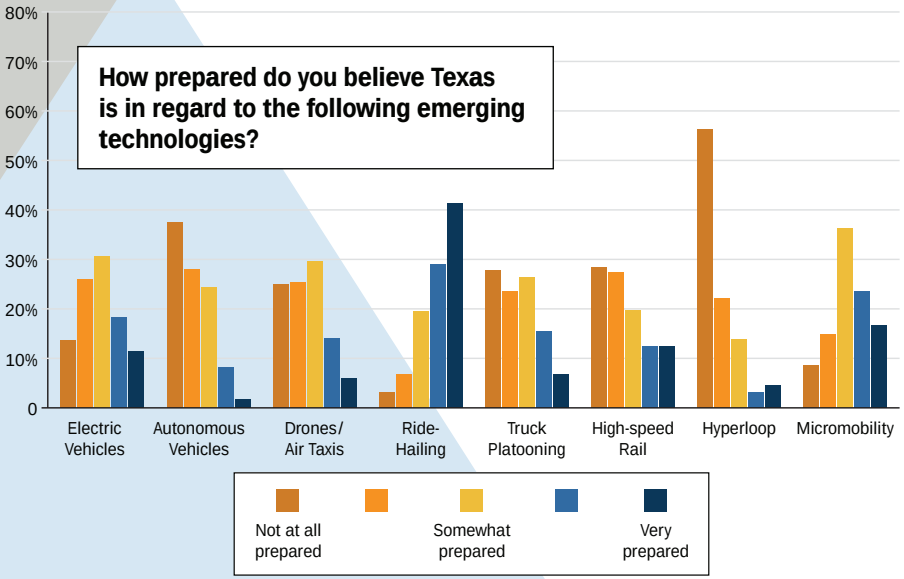


How important is planning for these modal technologies?



Large Urban: Austin, Houston, El Paso, Dallas, Fort Worth, San Antonio

How prepared do you believe Texas is in regard to the following emerging technologies?



Key Takeaways

- Most respondents are comfortable using autonomous vehicles sometimes.
- High-speed rail, freight CAVs, and transit CAVs are viewed as the three most important technologies TxDOT should plan for in the future, followed by personal CAVs.
- A majority of respondents are comfortable with Unmanned Aerial Systems (i.e., drones) delivering packages.
- Roughly a third of respondents believe electric vehicles and driverless cars will be readily available in the next 11 to 20 years.

Investment Strategy Preferences

To help inform the policy direction in the TTP 2050, the TTP 2050 Planning Priorities Survey asked respondents to rate four investment strategies that reflected different ways of allocating TxDOT's available transportation resources. The survey also asked participants to identify how they would allocate TxDOT resources and to rank each investment strategy on a scale of 1 to 5 stars (5 is the highest). The results of the surveys conducted during the public outreach are shared below:

Average Ratings of Investment Strategies

Reliably Connect Texas Communities
Focus on access, connectivity, and reliability

Keep it Smooth
Focus on infrastructure preservation

Congestion Relief
Prioritize reducing congestion

Balance Approach
Continuation of current investment allocations

Overall results imply respondents want to see change from current practices but are divided about what the new emphasis should be.

Integrating Findings

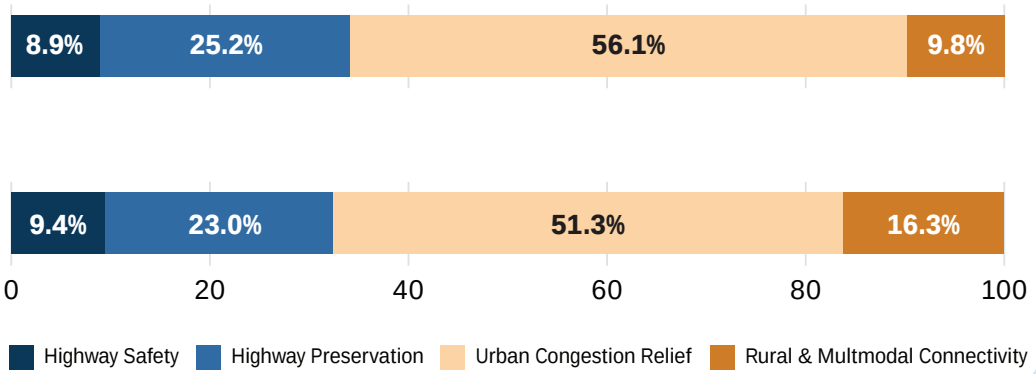
The input received helped shape the plan in a few key ways. The visioning meetings helped create and articulate a long-term direction for transportation in Texas. The plan goals and objectives were adjusted to better reflect the public's transportation interests and concerns. The scenario analysis process was influenced by the investment priorities Texans expressed in workshops and surveys. Lastly, the input from citizens, businesses, and stakeholders helped identify the implementation strategies TxDOT will need to continue or undertake to make the plans goals and objectives a reality.

Refer to **Appendix A** for complete documentation from the TTP 2050 outreach effort.

Stakeholder and Public Outreach Generated Strategy v. Maintaining Current Strategies

Balanced Approach
Continuation of current investment allocations

Stakeholder and Public Outreach Generated
Focus on infrastructure preservation



Responses show an increased emphasis on safety and rural and multimodal connectivity.

CHAPTER 7

Implementation Strategies

To put Texas on the path to achieving the TTP 2050 goals and objectives, TxDOT will need to continue implementing current strategies and undertake several initiatives that are already planned. In some cases, TxDOT also will need to develop new strategies to implement the plan. The following section provides an overview of the TTP 2050 plan implementation strategies, with an emphasis on specific initiatives that are associated with achieving the plan vision. A comprehensive list of current, planned, and proposed strategies is documented in the *TTP 2050 Implementation Strategies Technical Report* in **Appendix B**.

How were the implementation strategies developed?

TxDOT regularly coordinates with its planning partners, state research agencies, and transportation system users to help identify strategies to continue moving the state forward. The strategies described in this chapter were developed through a combination of agency coordination, a review of existing TxDOT plans and policies, and extensive stakeholder engagement. This includes the visioning sessions discussed in **Chapter 1**, where participants defined a three-stage vision for transportation in Texas, identified barriers to vision attainment, and suggested steps to address these hurdles.

Who is responsible for implementation?

Given the comprehensive, statewide focus of TTP 2050, many entities will need to participate in its implementation. This includes TxDOT, the federal government, Texas Legislature, metropolitan planning organizations (MPOs), transit authorities, regional mobility authorities (RMAs), localities, and the private sector. As illustrated in **Figure 7-1**, the roles and responsibilities of the different entities vary by mode and activity.

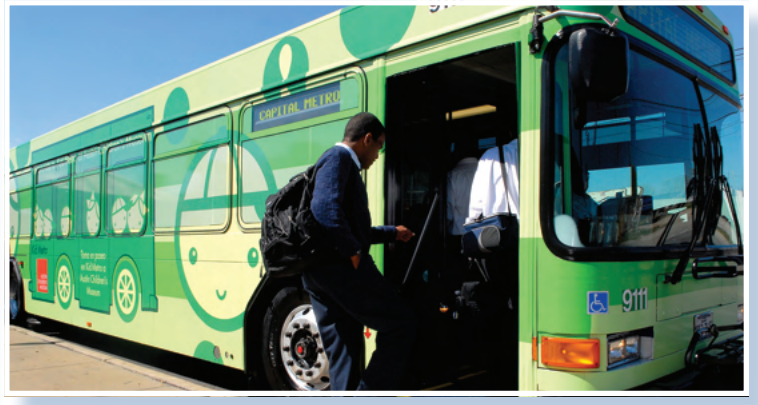


Figure 7-1: Roles

How TxDOT and Others Contribute to Each Mode on the State System

The Texas Transportation Plan (TTP) 2050 covers all transportation modes across the state, but TxDOT's involvement in each varies. See how different entities – including TxDOT – fit into the planning, funding, design, and construction of each mode in Texas.

Infrastructure & Operations
Responsible for the construction, maintenance, and functioning of facilities.

Planning & Coordination
Takes part in discussions on overall plans and investment priorities.

Design Guidance
Provides input on final project from and outcomes.

Administer Funding
Funds projects or serves as "pass through" for Federal or other funds.

	Highway & Bridge	Truck Freight	Bicycle & Pedestrian	Aviation	Intelligent Transportation Systems (ITS)	Ports & Waterways	Passenger Rail	Public Transportation	Freight Rail	Pipelines
Texas Department of Transportation (TxDOT) **State**	●	●	●	●	●	●	●	●	●	●
US Department Transportation **Federal**	●	●	●	●	●	●	●	●	●	
Metropolitan Planning Organizations (MPOs) **Regional**	●	●	●	●	●	●	●	●	●	
Metropolitan Transit Authorities (MTAs) **Large Urban**	●	●	●		●			●		
Regional Mobility Authorities (RMAs) **Local**	●	●	●	●		●	●	●	●	●
Cities, Counties & Tribes **Local**	●	●	●	●	●	●	●			
Private Industry **Non-governmental**			●	●		●	●		●	●

What Are the Different Types of Implementation Strategies?

Implementation of TTP 2050 is not simply about designing and building transportation projects. That is part of it, but successful implementation also will require strategies that cover a broad range of policy, planning, research, intergovernmental coordination, and business process initiatives. These strategies are discussed in the following sections that address strategies associated with emerging technology, risk and resiliency, highway mobility, highway preservation, safety, freight accommodation, modal areas, and program delivery.

Emerging Transportation Technology Strategies

An important theme that emerged from the visioning sessions and the public and stakeholder meetings was the potential for emerging technologies to greatly improve the accessibility, affordability, and adaptability of the Texas transportation system. Among the feedback was a shared interest in thinking in terms of the future rather than the present. In the near term, technology implementation strategies will primarily focus on efforts that improve safety, enhance the efficiency of existing infrastructure, and support decision-making. In the longer term, technology strategies will likely emphasize transitioning the highway system to accommodate connected and automated vehicles (CAVs), and efforts to make the overall transportation system to be more integrated. TxDOT has also been working on two new plans focused specifically on emerging transportation technology. The Emerging Technology Transportation Plan (ETTP) builds on existing efforts to incorporate innovative transportation technologies into Texas transportation planning while the Cooperative Automated Transportation (CAT) Strategic Plan offers strategies that will help TxDOT prepare to integrate technologies like CAVs. The following are examples of current and potential future technology strategies that will help TxDOT and its partners achieve the TTP 2050 vision.

Topic Areas	Strategies
Transportation Systems and Management Operations (TSMO): Proactive approaches for improving mobility by integrating technology into transportation plans, designs, operations, and maintenance	Maintain and update the TSMO Strategic Plan Incorporate TSMO into TxDOT business processes to enable the implementation of mobility strategies Improve TxDOT district systems and technology activities that support TSMO Develop organizational structures and workforce strategies to better support TSMO activities Improve internal and external collaboration on TSMO initiatives, including working with institutions and the private sector
Intelligent Transportation Systems (ITS): The devices, facilities, communications media, and systems that support traffic management systems and network operations	Consolidate traffic management centers to provide cost savings and improve regional ITS delivery Update the 2013 ITS inventory and track ITS expansion to determine ITS coverage and needs Update the Statewide ITS Strategic Plan Develop guidance on including and funding ITS projects in the Unified Transportation Program (UTP)
Data Collection and Management: Approaches to improve the use of data and analytics	Develop a plan for leveraging emerging transportation data sources Create policies ensuring that TxDOT can access private mobility provider data Update communications networks and systems to anticipate future needs

Methodology-based Systems

Risk and Resiliency Strategies

The increasing number of natural and man-made disasters throughout Texas has highlighted the need for TxDOT to plan and prepare for hazardous disruptions. The transportation system, as well as supporting infrastructure and operations, must be designed to be more resilient in the face of these potentially adverse impacts. The following are examples of strategies TxDOT is currently implementing, or considering, to reduce risk and improve the overall resiliency of the state's transportation system.

Topic Areas	Strategies
Risk Assessment: Actions to help TxDOT and its planning partners better understand risks to the system	Develop a vulnerability assessment tool
	Conduct pilot studies to identify vulnerable assets
	Issue design guidance to help projects meet resiliency objectives
	Create a data clearinghouse to store and provide access to resiliency information
Resiliency Improvement: Efforts by TxDOT to mitigate risks and better respond to the impacts caused by natural disasters	Improve infrastructure to make it more resilient to the effects of natural disasters
	Incorporate resiliency factors into performance-based planning and programming frameworks
	Identify resiliency measures
	Create a cross-disciplinary organizational structure to coordinate resiliency efforts
	Leverage data to understand the consequences of extreme events

Common Texas Emergencies

- **Flooding** – Makes roadways unusable, creating short and long-term closures on roads and shipping channels
- **Hurricanes** – Infrastructure at risk of flooding and creates extreme traffic demands
- **Tornadoes** – Halts transportation activities and triggers emergency responses on roadways
- **Hazardous Material Spills** – Damages the environment and can take infrastructure out of service
- **High Heat** – Contributes to infrastructure damage and unsafe worker conditions
- **Drought** – Increases likelihood of wildfires and decreases water levels, limiting inland shipping
- **Wildfires** – Reduces visibility and threatens roads and infrastructure

Highway Mobility Strategies

TxDOT efforts to enhance highway mobility strive to reduce congestion and improve system reliability. Strategies associated with mobility include activities that both increase the efficiency of existing infrastructure and add additional capacity through better planning, intergovernmental coordination, project selection, and technology deployment. The following are examples of highway mobility strategies TxDOT is currently implementing or considering. Many of these strategies have technology aspects to them, so there is some overlap between these strategies and those listed under emerging transportation technology.

Topic Areas	Strategies
Coordination and Collaboration: Strategies to foster implementation of highway mobility practices across all jurisdictions and modes	Coordinate planning and programming efforts with local and regional agencies
	Coordinate with MPOs to ensure that TxDOT plans align with Metropolitan Transportation Plans
	Work with the Texas A&M Transportation Institute (TTI) to update the annual list of the top 100 most congested roadway segments per the 2009 Texas Legislature mandate
Analytical Planning: Strategies that support effective planning approaches involving data sets, analysis tools, travel demand modeling, and future-year scenario planning	Develop improved methods to determine, monitor, and track transportation system reliability
	Expand the use of performance-based, data-driven project prioritization
	Provide comprehensive and timely crash data and analysis to help TxDOT and MPOs plan projects
	Establish predictive travel time reliability models
Project Programming: Data-driven strategies to objectively assess, rank, and select projects that provide the greatest benefit	Refine selection processes for applicable programs to emphasize rural connectivity priorities
	Prioritize traffic management practices
	Explore development of selection criteria that consider non-motorized travel benefits
TSMO: Specific highway mobility strategies associated with system operations and management that can increase capacity and improve safety	Expand the use of active traffic management applications that reduce congestion
	Increase highway capacity by adding new lanes and roadways or by enhancing design
	Make system modifications (e.g., constructing acceleration lanes) to improve safety and efficiency
	Make operational improvements to improve system performance



Utility-based Systems

Highway Preservation Strategies

One of TxDOT's highest priorities is preservation of the state's extensive system of pavement and bridges. The state highway system includes about 314,000 centerline miles of pavement that Texas spends nearly $1.5 billion annually to maintain. Similarly, Texas has roughly 55,000 bridges—more than any other state—and preserving them is one of TxDOT's highest priorities. The following strategies largely identified in the TxDOT Transportation Asset Management Plan (TAMP) provide examples of steps TxDOT is taking to ensure this system is efficiently and effectively maintained it in a state of good repair.

Topic Areas	Strategies
Innovation: Strategies that leverage national best practices, new research findings, and emerging technologies to improve TxDOT's pavement and bridge preservation efforts	Use innovative data collection and analysis methods to maintain pavements and bridges
	Upgrade pavements to withstand the demands of transporting Texas energy sector products
	Implement innovative tools and techniques to accelerate construction and prolong pavement life
	Include life-cycle costs in bridge project development
Maintenance and Rehabilitation: Strategies that ensure the effectiveness and efficiency of TxDOT's pavement and bridge preservation investment activities	Leverage new and innovative materials and practices
	Further invest in preventive maintenance
	Emphasize importance of asset management during periods of declining performance
	Coordinate preservation efforts with MPOs and other entities
	Focus on reducing vertical clearance deficiencies when replacing bridges
	Implement maintenance strategies that minimize life-cycle costs for pavement and bridges

Highway Safety Strategies

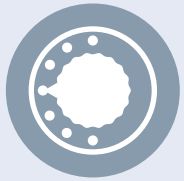
TxDOT is working toward a future with zero traffic fatalities and serious injuries, and safety is the department's top priority in terms of both planning and investment. The Texas Strategic Highway Safety Plan (SHSP) outlines strategies TxDOT is implementing to improve safety in Texas for seven emphasis areas described below.

Topic Areas	Strategies
Roadway and Lane Departures	Improve data systems and methods for targeting locations with a high probability of crashes
	Implement barriers and median treatments to minimize the consequences of roadway departures
Distracted Driving	Inform the public about the dangers of distracted driving
	Work with automakers to develop apps that encourage distraction-free driving
Intersection Safety	Install improvements to increase pedestrian, bicycle and micromobility safety
	Improve traffic signal timing and interconnect signals to improve traffic flow and encourage safe travel speeds
Pedestrian Safety	Implement pedestrian-oriented design elements such as walkways and paved shoulders
	Assist cities and other agencies in addressing common pedestrian crash types
Speed Limit Enforcement	Assist law enforcement agencies with data-driven deployment strategies
	Develop a best practice guide for speed enforcement techniques
Impaired Driving	Use data to optimize areas and times for enforcement
	Identify methodologies for improving the identification of drugged driving as a contributing factor in crashes
Aging Road Users	Identify current and recommended strategies for improving older person mobility in urban and rural areas
	Implement design strategies targeted at aging population safety considerations

Freight Strategies

As the Texas population and economy continue to grow, demand for the efficient movement of freight increases. It is a TxDOT strategic goal to develop and operate an integrated transportation system that fosters economic growth. While freight movement is multimodal and includes trucks, rail, ports and waterways, aviation, and pipelines, TxDOT's primary role is accommodating highway freight movement. Accordingly, many of the examples of TxDOT freight implementation strategies listed below, most of which were identified in the Texas Freight Mobility Plan 2018, are associated with highway mobility improvements.

Topic Areas	Strategies
Highway Construction: Programs associated with investments that support freight mobility	Continue to implement the Freight Network Bridge Reconstruction and Replacement Program
	Develop a Highway Freight Network Design, Construction, and Safety Guidelines Program
Multimodal: Activities associated with supporting and advocating for freight improvements via non-highway modes	Prioritize improving intermodal connectivity between modes and the international border
	Partner with airports and local, regional, and other statewide agencies to identify critical airport landside access improvements
Administrative: Strategies associated with education, funding, and project prioritization processes	Develop a Freight Movement Public Education and Awareness Program
	Work with state legislators to identify funding for existing freight programs
	Pursue the full return of Harbor Maintenance Tax funds to Texas
Operations: Strategies to improve freight movement through operational enhancements	Develop a comprehensive and coordinated Texas-Mexico border master plan
	Support integrated cargo security strategies to reduce congestion at border crossings
Safety: Programs and initiatives that enhance freight-related safety	Conduct a Statewide Truck Parking and Rest Stop Study
	Develop a Statewide Commercial Vehicle Traffic Incident Management Program
Technology: Deployment of technology that improves the efficiency and safety of highway-related freight activities	Develop and implement a Statewide Freight Technology-based Solutions Program
	Develop a Statewide Traffic Management Center Concept of Operations and Implementation Plan



Non-Highway Strategies

To improve the state's multimodal system, TxDOT is implementing or will explore a range of mode-specific strategies that can alleviate roadway congestion and improve overall mobility. Some strengthen multimodal travel choices while others focus on truck traffic reduction and freight mobility. Strategies were developed with guidance from TxDOT's mode-specific plans, internal subject matter experts, divisions, and best practices research. These strategies will help TxDOT's various modal divisions align their plans and activities with the strategic direction in TTP 2050.

Topic Areas	Strategies
Aviation	Maximize the state's ability to leverage federal aviation funding
	Identify and implement sustaining revenue sources for aviation
Public Transportation	Leverage new technology that streamlines transit operations
	Address transit service gaps identified in the 2019 Transit Needs Assessment
	Develop a plan for vehicle and facility replacement
	Address priorities identified by regional planning organizations
Bicycle and Pedestrian	Address bicycle and pedestrian safety hotspots
	Develop a statewide bicycle network
	Continue investing in bicycle and pedestrian data collection
	Continue collaborating with local partners on bicycle and pedestrian planning
Freight Rail **Ports / Waterways** **Pipelines**	Study freight infrastructure design considerations
	Develop regional freight plans
	Develop a freight technology and operations vision and masterplan
	Document the role of freight in the Texas economy
	Develop a freight investment optimization tool
Passenger Rail	Coordinate with Amtrak on service changes
	Work with freight rail companies to improve passenger rail on-time performance

Program Prioritization Strategies

Successfully implementing a statewide long-range plan requires not only strategies to address emerging issues and improve the performance of individual modes, it also necessities refinements to select program delivery processes to ensure decision-making and resources are well aligned with plan goals. Accordingly, this section highlights TxDOT strategies and activities related to three important elements associated with TxDOT program delivery: corridor prioritization, major projects, and programming enhancements.

Recent and Ongoing Corridor Studies

Corridor studies help identify the needs and benefits of potential improvements to the transportation system and are followed up by more detailed project development studies. The following identifies example corridor studies that have recently been performed and those currently under way.

- Continued study and development of the I-69 System
- Capital-Alamo Connections Study
- US 190 Feasibility Study in Bell County
- US 67 Corridor Master Plan
- Ports-to-Plains Corridor Feasibility Study (House Bill 1079)

Corridor Study Prioritization

The Department invests heavily in corridor studies. TxDOT conducts these studies to link multijurisdictional development along corridors. To help inform decisions on the order in which to perform studies, the Department has developed a Corridor Prioritization Tool (CPT.) At this stage, the approach is not to prioritize projects for funding but to apply a needs-based process to help determine which studies to perform.

The CPT is a data-driven, performance-based tool that enables TxDOT to establish and consider the relative importance of TxDOT's different goal areas (safety, infrastructure condition, freight movement and economic vitality, and congestion reduction and system reliability) to corridor analysis. In applying the tool, TxDOT works closely with municipalities, counties, and MPOs to understand and incorporate their needs and considerations into the statewide prioritization of corridors.

As part of the TTP 2050 development effort, TXDOT asked stakeholders how the corridor prioritization process could be improved and will work to incorporate many of these ideas into process refinements. Examples of possible inclusions are: considering flooding and other resiliency issues, and looking more at future population growth.

TxDOT currently recognizes 340 individual corridors across the state, which include facilities connecting economic activity centers, elements of the Statewide Connectivity Corridor Network, key corridors on the Texas Highway Trunk System, and critical rural fright corridors. The top 25 corridors in Texas based on application of the CPT are illustrated in **Figure 7-2** and **Table 7-1**.

Figure 7-2: Top 100 Corridors for Study Prioritization

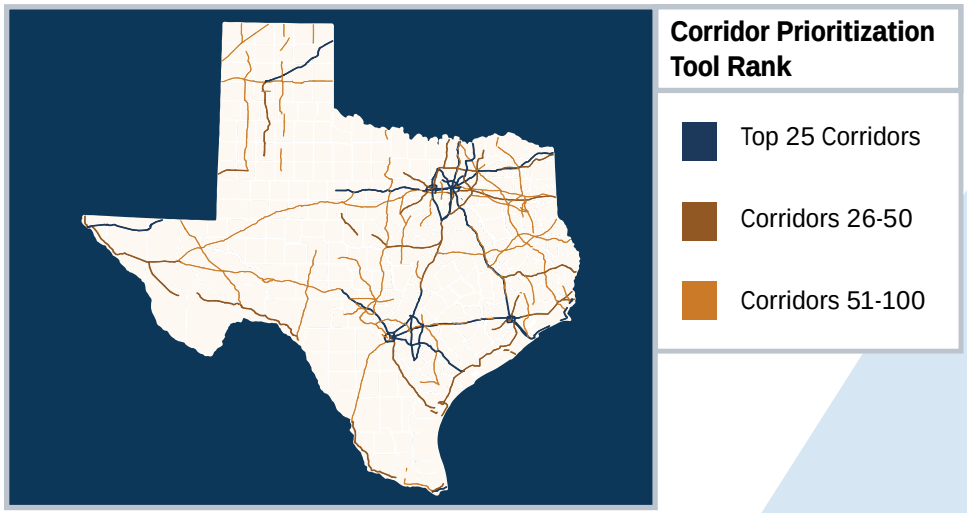


Table 7-1: Top 25 Corridors for Study Prioritization

Rank	Name	Description	Rank	Name	Description	Rank	Name	Description	Rank	Name	Description
1	I-635	I-20 to SR 121	8	SH 123	State Highway 123	15	U.S. 62	Stateline to Stateline	22	I-10	San Antonio to Houston
2	I-35 E	Hillsboro to Denton	9	SH 78	State Highway 78	16	U.S. 77	Red Oak to Hillsboro	23	I-10	US 83 to San Antonio
3	I-610	I-10 to I-10	10	SH 87	Pinehurst to Galveston	17	SH 3	State Highway 3	24	SH 180	State Highway 180
4	I-410	I-35 to I-35	11	U.S. 87	San Antonio to Port Lavaca	18	SH 4	State Highway 4	25	I-45	Galveston to Dallas
5	I-820	I-20 to I-20	12	U.S. 60	Amarillo to Stateline	19	U.S. 180	Anson to Weatherford			
6	I-35	San Antonio to Austin	13	I-35 W	Hillsboro to Denton	20	I-30	I-20 to Stateline			
7	SH 352	State Highway 352	14	U.S. 75	Stateline to Dallas	21	SH 80	State Highway 80			

Major and Large-scale Projects

TTP 2050 considers the impact that planned major and large-scale projects will have on future system performance and associated investment needs. These projects include both TxDOT and regionally delivered projects that are expected to make significant contributions to achieving TTP 2050 mobility goals.

- **Major Projects** – Projects on the state highway system that address congestion reduction, enhanced connectivity, preservation, safety, environmental effects, and/or economic development and meet at least one of the following criteria: 1) total estimated cost of $500 million or more; 2) high-level of public or legislative interest; 3) significant local or private entity funding; 4) unusually complex, or (5) satisfy a time-sensitive critical need.
  - **U.S. 281 Improvements in San Antonio**
    U.S. 281 from Loop 1604 to the Bexar/Comal County line is one of the most congested roads in San Antonio and one of the 50 most congested corridors in Texas. TxDOT is planning to construct a six-lane, non-tolled expressway to relieve congestion and improve mobility. The project also will include northern interchange connectors at Loop 1604.
  - **SH 99 (Grand Parkway) in Houston**
    Grand Parkway is a proposed 180-mile loop around the greater Houston area to improve connectivity with other roadways, relieve congestion, encourage economic growth, and enhance safety. The new facility is being developed and constructed in 11 segments, the first two segments will add a new two-lane controlled-access facility from U.S. 59 N to Interstate 10. As of TTP 2050 publication, five of the segments are already open to the public.
- **Large-scale Projects** – Other TxDOT or planning partner-led initiatives that are estimated to cost near or over $500 million to complete.

Together, these projects represent an important element of plan implementation, reflect the important role of TxDOT's planning partners in meeting plan goals, and exemplify TxDOT's ongoing stewardship of the state's transportation resources. The following are a few examples of major and large-scale projects planned or under construction in Texas.

Other Planned Large Projects	
TxDOT Projects	**Planning Partner Projects (Sponsor)**
Austin area improvements to I-35 in Travis, Hays, and Williamson counties	The Green Line (Capital Metro)
Harbor Bridge Project in Corpus Christi and improvements to I-35 in San Antonio	Loop 20 Interchange (Laredo MPO)
Several initiatives in the Dallas-Fort Worth region including improvements to I-35, Midtown Express/SH 183, I-30, I-635, the Southeast Connector, U.S. 80, State Loop 9, and the Dallas North Tollway	Several new regional rail facilities and extension initiatives, Southwest TEX Rail, Dallas North Tollway improvements, and other highway improvements (NCTCOG)
Major improvements in the Houston-Galveston region including projects on I-45, I-69, and I-610	Several initiatives in the Houston-Galveston region such as the Gessner Corridor, multiple transit centers, improvements to I-10, and the Regional Greenways Network

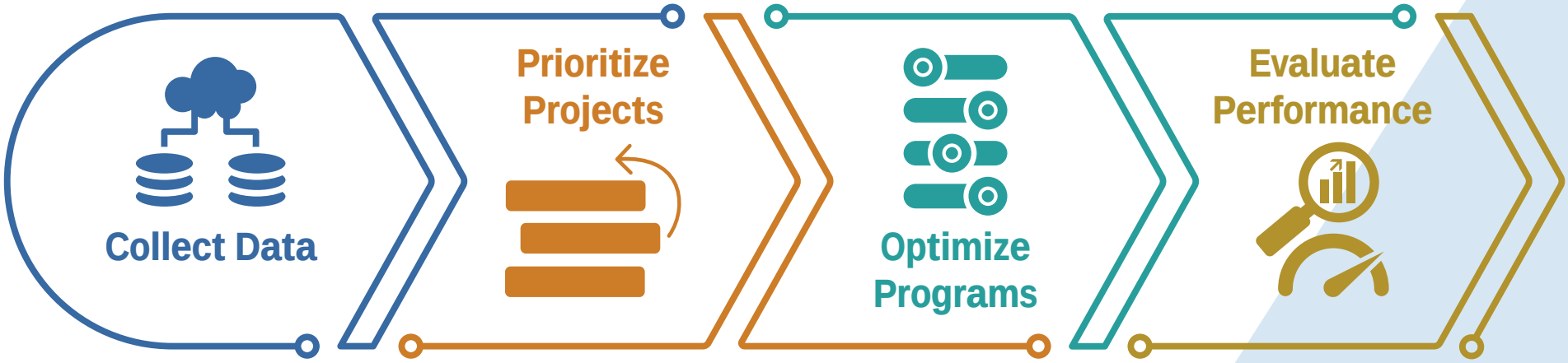
Performance-based Project Selection

In addition to assessing project readiness, coordinating with districts, and applying expert judgement, TxDOT has incorporated a project selection approach that uses Multiple Objective Decision Analysis (MODA) to ensure it makes investment decisions based on a performance-based prioritization and selection framework. To do this, TxDOT first develops data-driven criteria that align with the TxDOT performance goals. The relative importance of each criterion is established based upon public and stakeholder interests, along with input from TxDOT subject matter experts. From there, candidate projects are evaluated based on their impact to system performance and the best "bang for the buck." TxDOT can track its progress toward the goal areas by evaluating how the programmed projects drive key performance measures, such as the reduction in poor pavement lane miles and improvements to roadway congestion. These measures are shared publicly on the TxDOT Performance Dashboard, along with several others. As illustrated in **Figure 7-3**, this process entails analyzing significant amounts of performance data to understand candidate project impacts followed by an evaluation of different investment strategies to optimize how TxDOT funds are spent.

As part of TTP 2050 implementation, TxDOT will initiate strategies to enhance the current project selection methodology to improve its stewardship over the on-system transportation network.

Topic Areas	Strategies
Customer Input: Suggested refinements from stakeholder workshops and public survey results	Update priority weighting for criteria to reflect stakeholder preferences
	Evaluate performance implications of investment strategies favored by stakeholders and the public in TTP 2050 workshops and surveys
Process Upgrades: Updates to align process with TTP 2050 and other technical refinements	Strengthen prioritization criteria and ensure consistency with TTP 2050 goals, objectives, measures, and performance targets
	Enhance predictive methodologies associated with project impacts
Process Integration: Activities to expand the use performance-based project selection	Establish prioritization processes for independent funding categories
	Link resource allocation to TTP 2050 performance forecasts

Figure 7-3: TxDOT Performance-based Project Selection Process



TEXAS TRANSPORTATION PLAN 2050

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