# APPENDIX B

# TECHNICAL MEMORANDUM

# Texas Transportation Plan

## Tech Memo 1: Plan Assessment and Framework

October 10, 2013

## Acknowledgements

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# 1.0 Introduction

In fulfillment of the Texas statutory requirements to develop a statewide, multimodal, and intermodal plan with a forecast period of 24 years, the Texas Transportation Plan (TTP) is currently being developed as an update to the 2035 Statewide Long-Range Transportation Plan (SLRTP). The TTP framework will advance performance-based decision-making to link transportation investments with the Department's 2013-2017 Strategic Plan. By providing a transparent and outcome-oriented decision process that increases accountability and maximizes the use of taxpayer dollars, the TTP will uphold the Texas Department of Transportation's (TxDOT's) commitment to customer service and will enhance the Department's reputation as a "best in class" state agency.

This Technical Memorandum (Tech Memo #1) is organized into two sections: Plan Assessment and Plan Framework. The Plan Assessment provides context for the development of the TTP based on existing TxDOT plans and initiatives, specific challenges and considerations for the multimodal system, and State/ Federal legislative requirements. Based upon findings from the Plan Assessment, the Plan Framework outlines the development of a performance-based plan.

# 2.0 Plan Assessment

The following sections provide a review of TxDOT initiatives and implications for the TTP, a summary of TxDOT plans for coordination with the TTP, a discussion of potential challenges for the Texas transportation system, and a summary of legislative requirements regarding TTP development and outreach.

## *2.1 Ongoing TxDOT Initiatives and Implications for the TTP*

TxDOT has long been recognized as a national leader in transportation excellence, providing for and maintaining a diverse and multimodal transportation system that serves the equally diverse needs of Texas and its growing economy. In recent years, recognizing that continuous improvement is needed to remain a best in class agency, TxDOT started to transform the transportation delivery process and the culture in which it operates. Many of these changes have occurred through *Modernization*, the first of three "Phases of Change" as outlined in the Strategic Plan. These phases define TxDOT's path towards becoming a "performance-driven organization, a great place to work, and an organization committed to quality customer service."

With the majority of *Modernization* activities complete, TxDOT is now working towards the second phase, *Operational Excellence*, by focusing on the achievement of continuous, disciplined improvement and performance with respect to agency processes and the management of resources. The focus of the third phase, *Innovation*, is on becoming a national leader in the development and deployment of transportation solutions.

In accordance with TxDOT's commitment to operational excellence and innovation, the TTP will be performance-based and will apply state-of-the-art methodologies that link investment decisions with the achievement of the long-term goals defined in the Strategic Plan (**Exhibit 1**). In addition to the clear articulation of goals, the TTP will include a method for predicting and tracking progress towards Plan goals over time as well as the effects of investments on system performance.

**Exhibit 1: TxDOT Mission, Values, and Goals as defined in the 2013-2017 Strategic Plan**

| | |
|---|---|
| Mission | Work with others to provide safe and reliable transportation solutions for Texas |
| Values | **Trust**: We understand the importance of being trustworthy and credible, both as an agency and as individuals. |
| | **Integrity**: We honor our commitments and keep our word. |
| | **Responsibility**: We are reliable and dependable in carrying out our mission and roles. |
| | **Excellence**: We do our work at a high level of quality. |
| | **Service**: We do what we do for others with a spirit of humility and honor. |
| Goals | Maintain a Safe System |
| | Address Congestion |
| | Connect Texas Communities |
| | Become a Best in Class State Agency |

## *2.2 TxDOT Plans for TTP Coordination*

TTP development will include any analysis of existing and ongoing TxDOT, metropolitan planning organization (MPO), rural, and modal plans to ensure consistency with other ongoing efforts and initiatives. **Exhibit 2** provides a summary of the plans that will be reviewed and considered throughout TTP development. The Texas Freight Mobility Plan will also be integrated into the TTP. With an expected completion date of September 2014, this effort represents the State's first comprehensive and multimodal freight plan to:

- Enhance freight mobility and improve economic competitiveness through efficient, reliable, and safe transport of goods throughout the state
- Define policies and investments that will enhance Texas' freight transportation system into the future
- Establish a framework for Texas' comprehensive freight planning program and decision-making.

The Texas multimodal transportation system is comprised of many owners and operators. While TxDOT is responsible for assessing needs and funding gaps for all modes as part of the TTP, its role as owner-operator, partner, and advocate varies widely across modes.

**Exhibit 2: TxDOT Plans for Coordination with TTP (Source: 2035 SLRTP)**

| Plan/Program | Who Develops? | Who Approves? | Time Period | Content | Update Cycle |
|---|---|---|---|---|---|
| Statewide Long-Range Transportation Plan (SLRTP) | TxDOT | Texas Transportation Commission | 24 years | Future goals, strategies, and performance measures | Every 4 years |
| TxDOT Strategic Plan | TxDOT | Texas Transportation Commission | 5 years | TxDOT's operational goals and strategies | Every 2 years |
| Statewide TIP | TxDOT | USDOT | 4 years | Transportation investments | Every 2 years |
| Unified Transportation Program (UTP) | TxDOT | Texas Transportation Commission | Current year + 10 years | Projects to be funded/built in a 10-year period | Annual |
| Metropolitan Transportation Plan (MTP) | Metropolitan Planning Organization | MPO | 20+ years | Future goals, strategies, and projects | Every 5 years (Every 4 years in Air Quality Non-Attainment Area) |
| Transportation Improvement Programs (TIPS) | MPO-TxDOT Districts | Governor*/MPOs | 4 years | Transportation investments (projects) | Every 2 years) |
| Corridor Studies (e.g., MY-35) | TxDOT | Texas Transportation Commission | N/A | Benefit cost analysis and feasibility | As needed |
| Texas Rail Plan | TxDOT | Texas Transportation Commission | 5 and 20 years | Future goals and strategies | Every 5 years |
| Texas Airport System Plan | TxDOT | Texas Transportation Commission | 5, 10, and 20 years | Focus on general aviation needs | Annual |
| Texas Port 2010–2011 Capital Plan | Port Authority Advisory Committee | Texas Transportation Commission | 2 years | Goals, objectives, and projects | Annual |
| Texas Transit Statistics | TxDOT | TxDOT | 1 year | Public Transportation Operation Statistics | Annual |

Note:
* While the legislature gives the approval authority to the Governor, the Governor delegates the authority back to TxDOT.

## 2.3 Potential Challenges for the Texas Transportation System

According to the Strategic Plan, the Texas population is expected to grow from 25 million to 40 million by 2035, with the majority of growth occurring in urban areas. This will present specific challenges with respect to congestion mitigation and the condition of bridges and pavements under more frequent loadings. Additionally, the general aging of the population as described in the Strategic Plan will require a renewed focus on ensuring multimodal access for the elderly, especially in rural areas. Other future challenges for the Texas transportation system include but are not limited to:

> ***"Transportation is an engine of economic development. If we fail to respond to the need to maintain and develop our transportation infrastructure, we will choke the growth of Texas."***
> – Drew Crutcher, 2030 Committee, from *It's About Time: Investing in Transportation to Keep Texas Economically Competitive*

- **Diminishing revenues and higher transportation costs:**
  TxDOT, like most other departments of transportation (DOTs) throughout the country, is experiencing declining revenues and increasing demands on the transportation system. As noted in the Strategic Plan, funding from traditional sources such as the gas tax cannot keep pace with the growing demands on the system that include preserving aging infrastructure, expanding multimodal capacity to accommodate population growth, and enhancing the design of the system to improve traffic operations, safety, and viability for freight traffic. To address these demands amid constrained resources, it is critical to maximize the impact of every dollar spent. This is the value of performance-based planning, which seeks to determine how to invest wisely to achieve goals and improve system performance over time.

- **Addressing multimodal transportation system needs in urban and rural areas:**
  Texas is "more than a triangle;" the rural areas located outside of Dallas, Houston, Austin, and other metropolitan boundaries are critical to the state economy and home to millions of Texans. As noted in the Texas Rural Transportation Plan (TRTP), the rural transportation system facilitates state, national, and global commerce and supports the activities of many Texas industries including farming, ranching, timber and logging, mineral extraction, and energy. While the TRTP was provided as a standalone supplement to the 2035 SLRTP to specifically address the condition and multimodal needs of the rural transportation system (i.e., occurring outside of MPO boundaries), the TTP will consolidate both to provide a comprehensive assessment of condition, needs, and investment scenarios across all areas of the state. The TTP will consider the distinctive qualities and priorities of the rural and urban transportation systems, including:
  - Multimodal access in rural areas with a focus on aging and disadvantaged populations
  - Capacity enhancements in urban areas to accommodate population growth
  - The different safety needs of rural and urban interstates (e.g., safe passing on rural interstates)
  - High freight volume on rural roads.

## 2.4 *Long-Range Transportation Plan (LRTP) Legislative Requirements*

### 2.4.1 Texas

The SLRTP provides the framework for advancing TxDOT's values, mission, and goals identified in the Strategic Plan. Through coordination with existing TxDOT plans and those in development, the TTP will link the Strategic Plan goals with project prioritization and programming.

The specific Texas requirements for the development of a SLRTP (as found in Title 43, Part 1, Chapter 16, Subchapter B of the Texas Administrative Code [Rule 16.54]) are as follows:

- A 24-year planning horizon with an update cycle every 4 years
- The inclusion of all modes of the transportation system
- The integration with the Statewide Transportation Improvement Program (STIP) and Unified Transportation Program (UTP)
- The inclusion of specific, long-term goals for the state that advance Strategic Plan goals
- The inclusion of specific, measurable targets for each goal
- The consideration of MPO and regional planning organization (RPO) transportation plans and strategies
- The identification of priority corridors, projects, or areas of concern with respect to meeting plan goals
- The inclusion of a participation plan for obtaining input on goals, targets, and project selection and prioritization.

### 2.4.2 National

Federal requirements for the development of a statewide transportation plan based on Title 23 U.S.C. 135 and 23 C.F.R. Part 450 include that it be based on a minimum forecast period of 20 years at the time of adoption, that it provides for the development and implementation of a multimodal transportation system, and that it considers the following eight federal planning factors:

- Support economic vitality
- Increase transportation system safety for motorized and nonmotorized users
- Increase transportation system security for motorized and nonmotorized users
- Protect and enhance the environment, promote energy conservation, improve quality of life, and promote consistency between land use and transportation improvements
- Enhance, integrate, and connect the multimodal transportation system for people and freight
- Promote efficient system management and operation
- Emphasize transportation system preservation.

### 2.4.3 MAP-21

Moving Ahead for Progress in the 21st Century (MAP-21) was signed into law in 2012 as a reauthorization of SAFETEA-LU. Changes from the previous legislation with respect to LRTP development include:

- **The endorsement of a performance-based approach to transportation decision making**: In recognition of the growing revenue gaps facing state DOTs, MAP-21 calls for a performance-based approach to transportation decision-making and provides a clear sense of purpose for transportation investments through the establishment of seven national goal areas: ***safety, infrastructure condition, congestion reduction, system reliability, freight movement and economic vitality, environmental sustainability, and reduced project delivery delays***. States and MPOs are required to measure and report on performance in these areas; however, the legislation does not stipulate the use of performance measures to guide investment decisions.
- **Continued focus on environmental streamlining to reduce project delivery delays:** MAP-21 recognizes that the majority of project delivery delays result from the environmental review process required under the National Environmental Policy Act (NEPA), and that these delays have significant financial and practical consequences. To achieve the goal of reduced project delivery delays, MAP-21 establishes a method for streamlining the state and federal environmental review processes to avoid duplication. It is important to note that although environmental streamlining will not directly impact the development of the TTP (as transportation plans are not subject for review under NEPA), these improvements will accelerate the project transition from the TTP to the UTP and, for select projects, the subsequent advancement to the STIP for implementation.
- **The advancement of performance-based provisions for the national freight system:** MAP-21 establishes a policy to improve the condition and performance of the national freight network in order to achieve goals related to ***economic competitiveness and efficiency; congestion; productivity; safety, security, and resilience of freight movement; infrastructure condition; use of advanced technology; performance, innovation, competition, and accountability in the operation and maintenance of the network; and environmental impacts***. MAP-21 requires the U.S. Department of Transportation (USDOT) to develop a set of national freight measures within 18 months of bill enactment. States are encouraged to designate a freight advisory committee composed of public- and private-sector freight stakeholders and to develop comprehensive freight movement plans for immediate and long-range freight planning and investment.

# 3.0 Plan Framework

The following sections provide a review of best practices and legislative guidance with respect to the components of a performance-based plan:

- Plan goals and objectives
- Plan performance measures
- Project prioritization/resource allocation
- Performance-based data for Plan analysis and for monitoring and reporting on Plan progress over time.

## *3.1 Goals and Objectives*

Goals and objectives serve a critical purpose in the development of a long-range transportation plan. By identifying Plan components that can be measured and tracked given the high-level priorities of stakeholders in Plan development, they can indirectly articulate a long-range vision for the multimodal transportation system. Because the distinction between goals and objectives varies widely in practice (and is sometimes used synonymously with "guiding principles" and/or "strategies"), the following definitions will be applied for the TTP:

- **Goal**: Broad statement of priority that is largely directional in nature
- **Objective**: Specific desired outcome.

### 3.1.1 Best Practices and Legislative Guidance

Goals and objectives vary among state DOTs in accordance with agency, planning partner, and stakeholder priorities and reflect the specific challenges and future shared vision for the state transportation system. A synthesis study of SLRTPs conducted by the John A. Volpe National Transportation Systems Center found that the majority of state DOTs adopt and implement goals that align with national goals (*Trends in Statewide Long-Range Transportation Plans: Core and Emerging Topics*, 2012). In particular, the study found that the five most commonly cited goals—safety/security, mobility/accessibility, environmental stewardship, economic development, and preservation—correspond directly with the SAFETEA-LU planning factors, the prevailing legislation at the time of study development.

MAP-21 replaced SAFETEA-LU as the nation's surface transportation bill in 2012, establishing seven national goals for the federal-aid highway program:

- **Safety**: To achieve a significant reduction in traffic fatalities and serious injuries on all public roads
- **Infrastructure condition**: To maintain the highway infrastructure asset system in a state of good repair
- **Congestion reduction**: To achieve a significant reduction in congestion on the National Highway System (NHS)

- **System reliability**: To improve the efficiency of the surface transportation system
- **Freight movement and economic vitality**: To improve the national freight network, strengthen the ability of rural communities to access national and international trade markets, and support regional economic development
- **Environmental sustainability**: To enhance the performance of the transportation system while protecting and enhancing the natural environment
- **Reduced project delivery delays**: To reduce project costs, promote jobs and the economy, and expedite the movement of people and goods by accelerating project completion through eliminating delays in the project development and delivery process, including reducing regulatory burdens and improving agencies' work practices.

State DOTs must incorporate these national goals into their long-range plans. Under-performance in these areas may affect their ability to receive federal funding under the MAP-21 core programs: the National Highway Performance Program (NHPP), Highway Safety Improvement Program (HSIP), and Congestion Mitigation and Air Quality Program (CMAQ).

### 3.1.2 Texas Transportation Plan Goals and Objectives

The Strategic Plan goals will direct agency decisions and investments through 2017; TTP goals will continue to implement Strategic Plan goals over 24 years and will meet MAP-21 requirements, such as by addressing environmental stewardship and system reliability.

**Exhibit 3** shows how the **DRAFT** TTP goal areas may fit within the context of the Strategic Plan and MAP-21 and how they compare to the 2035 SLRTP goals. These goals are based on a review of current TxDOT plans and are presented here as the starting point for the goal and objective development process shown in **Exhibit 4**. As described in Technical Memo #2: Goal and Objective "Building Blocks," the development of TTP goals and objectives will follow an iterative and inclusive process that considers the opinions of multimodal owners, operators, stakeholders, and users of the Texas transportation system.

**Exhibit 3: DRAFT TTP Goal and Objective "Building Blocks"**

| Strategic Plan Goals | Maintain a Safe System | Address Congestion | Connect Texas Communities | Become a Best-in-Class State Agency |
|---|---|---|---|---|
| DRAFT TTP Goals | Reduce fatal and serious injury crashes | Address corridor bottlenecks | Increase passenger travel time reliability | Improve customer service |
| | Reduce pedestrian- and bicycle-related crashes | Increase roadway capacity where appropriate | Increase freight travel time reliability | Improve project delivery |
| | Improve work zone safety | Reduce travel times in select corridors | Ensure multimodal access | Maximize multimodal transportation benefits while managing agency costs |
| | Encourage responsible driving behaviors | Encourage design enhancements and system management and operations to improve traffic flow and manage demand | Support economic development | Responsibly manage current resources for future generations |
| | Improve safety at highway-railway crossings | Improve incident response times | | |
| | Achieve State-of-Good-Repair for transportation assets | | | |
| Corresponding MAP-21 Goal Areas | Safety | Congestion Reduction | System Reliability | Environmental Sustainability |
| | Infrastructure Condition | | Freight Movement and Economic Vitality | Reduced Project Delivery Delays |

**Exhibit 4: TTP Goal and Objective Development Process**

## 3.2 Performance Measures

Transportation system performance measurement is not new; state DOTs and MPOs use performance information to manage state and regional systems, to evaluate project-level investment alternatives, to assess transportation-land use issues, and for many other purposes. However, the use of performance measures for evaluating, selecting, and programming projects to achieve agency goals is much less common. States and MPOs are only beginning to develop performance-based plans that incorporate performance management concepts for all modes, for operations, and for the achievement of broad economic efficiency, economic development, and social equity goals.

### 3.2.1 Best Practices and Legislative Guidance

Performance measures form the foundation of a performance-based plan. While applying measures is conceptually straightforward, implementing them in a meaningful way can present some challenges. In order to maximize the value of the measures for informing agency processes and investments while minimizing the burdens of implementation, it is critical to select the "right" measures, collect quality data to support the measures, and apply them appropriately (e.g., for decision-making, performance tracking and reporting, etc.).

MAP-21 will provide state DOTs and MPOs with national performance measures to collect and report on through a series of rulemaking refinements shown in Exhibit 5. States and MPOs will be responsible for setting their own targets with respect to these measures.

**Exhibit 5: U.S. DOT Guidance on MAP-21 Performance Rulemaking**

| Program | Measure Category |
|---|---|
| Status I<br>January 2015 | Serious injuries per VMT[1]<br>Fatalities per VMT[1]<br>Number of serious injuries[1]<br>Number of fatalities[1] |
| Status II<br>April 2015 | Pavement condition on the Interstates[2]<br>Pavement condition on the Non-Interstate NHS[2]<br>Bridge condition on NHS[2] |
| Status III<br>July 2015 | Traffic congestion[3]<br>On-road mobile source emissions[3]<br>Freight movement on the Interstate[4]<br>Performance of Interstate system[2]<br>Performance of Non-Interstate NHS[2] |

Notes:
[1]Highway Safety Improvement Program
[2]National Highway Performance Program
[3]Congestion Mitigation and Air Quality (CMAQ)
[4]Freight policy

Source: Osbourne, 2013
NHS = National Highway System
VMT = vehicle miles traveled

### 3.2.2 Texas Transportation Plan Performance Measures

The TTP performance measures will link directly to the final set of TTP goals and objectives and will evolve over time based on data availability among other considerations. In general, performance measures selected for use in the TTP will:

- Be supported by existing resources
- Be important to decision-makers and stakeholders
- Reflect agency priorities and influence
- Be suitable for a statewide context
- Support predictive capacity
- Integrate national priorities.

There are several ongoing efforts at TxDOT and at MPOs/RPOs to establish performance measures for implementation within the department and to inform the development of national measures. One such effort was the Association of Texas Metropolitan Planning Organizations (TEMPO) meeting held on August 20, 2013 with the purpose of discussing current TxDOT measures and recommendations for national measures in the areas of safety, bridge and pavement condition, freight, system performance, congestion mitigation and air quality, and transit. The full set of measures discussed at the meeting is presented in **Exhibit 6** along with the AASHTO Standing Committee on Performance Measures (SCOPM) recommendations for national measures. Important insights from the discussion include that:

- TxDOT is transitioning towards an asset-management approach for system preservation; this will not impact what is currently in the pipeline but will affect future project selection.
- Transit ridership should be considered as a potential TxDOT and national measure.
- Vehicle miles traveled (VMT) and vehicle hours traveled (VHT) should be used to provide context for congestion but should not be applied as measures themselves.

It is difficult to determine the impacts of congestion mitigation measures on air quality.

**Exhibit 6: TxDOT Performance Measures Recommended for National Use and AASHTO SCOPM Recommendations for National Performance Measures**

| TxDOT Strategic Plan Goals | TxDOT Strategic Plan Objectives | MAP-21 Goal Area | AASHTO SCOPM Perf Area | Performance Measure | Recommended by TEMPO? | Recommended by AASHTO SCOPM? |
|---|---|---|---|---|---|---|
| Maintain a Safe System | Reduce crashes and fatalities on the system through innovations, technology, and public awareness | Safety | Safety | Number of Fatalities (5-year moving average) | X | X |
| | | | | Fatality Rate (5-year moving average) | X | X |
| | | | | Number of Serious/ Non-Fatal Injuries (5-year moving average) | X | X |
| | | | | Serious/ Non-Fatal Injury Rate (5-year moving average) | X | X |
| | Maintain and preserve the transportation assets of the state of Texas | Infrastructure Condition | Bridge Condition | % (by total NHS deck area) of SD deck area on NHS bridges | X | X |
| | | | | % (by total non-NHS deck area) of SD deck area on non-NHS bridges[1] | X | |
| | | | | % (by deck area) of NHS bridges in good/fair/poor condition | X | X |
| | | | | Count and % (by deck area) of bridges with cyclic maintenance needs[1] | X | |
| | | | | Count and % (by deck area) of bridges with preventive maintenance needs[1] | X | |
| | | | | Count and % (by deck area) of bridges with rehabilitation/replacement needs[1] | X | |
| | | | | Functional obsolescence[2] | | |
| | | | | Substandard for load[2] | | |
| | | | Pavement Condition | Interstate (NHS) pavement by SGR (% of 0.1 mile segment) | X | X |
| | | | | Non-interstate (NHS) pavement by SGR (% of 0.1 mile segment) | X | X |
| | | | | Pavement Structural Health Index | | X |
| Address Congestion | Partner with local officials to develop and implement congestion mitigation plans in Texas | Congestion Reduction | Congestion Mitigation and Air Quality | Annual Hours of Delay (AHD) | X | X |
| | | | | Annual Hours of Truck Delay (AHTD) | X | X |

**Exhibit 6: TxDOT Performance Measures Recommended for National Use and AASHTO SCOPM Recommendations for National Performance Measures**

| TxDOT Strategic Plan Goals | TxDOT Strategic Plan Objectives | MAP-21 Goal Area | AASHTO SCOPM Perf Area | Performance Measure | Recommended by TEMPO? | Recommended by AASHTO SCOPM? |
|---|---|---|---|---|---|---|
| Become a Best in Class State Agency | Ensure the agency deploys its resources responsibly and has a customer service mindset | Environmental Sustainability | Congestion Mitigation and Air Quality | Daily kg of NOx reduced by the latest annual program of CMAQ projects[3] | X | X |
| | | | | Daily kg of CO reduced by the latest annual program of CMAQ projects[3] | X | X |
| | | | | Daily kg of VOC reduced by the latest annual program of CMAQ projects[3] | X | X |
| | | | | Daily kg of PM reduced by the latest annual program of CMAQ projects | | X |
| | | | | Annual hours of delay reduced by the latest annual CMAQ program[4] | X | |
| Connect Texas Communities | Prioritize new projects that will increase the state GDP and enhance access to goods and services throughout the state | System Reliability | System Performance | Annual Hours of Delay (AHD) | X | X |
| | | | | Reliability Index[5] | X | X |
| | | | | Rural connectivity (% of rural pop. with access to public transportation service administered by TxDOT) | X | |
| | | | | Average condition of TxDOT-funded fleet | X | |
| | | | | Average condition of Elderly and Individuals with Disabilities Program fleet | X | |
| | | | | Average condition of Rural Areas Program fleet | X | |
| | | | | Average condition of Small Urban Program fleet | X | |
| | | Freight Movement and Economic Vitality | Freight | Annual Hours of Truck Delay (AHTD) | X | X |
| | | | | Truck Reliability Index (RI)[5] | X | X |

**Notes:**

[1] Consistent with the AASHTO Subcommittee on Bridges and Structures (SCOBS) recommendations

[2] TxDOT desired measure but not currently collected; will likely be required at national level

[3] Five-year moving average of on-road, mobile source criteria pollutant emissions in areas with 1 million population or more

[4] In areas with 1 million population or more

[5] NHS interstates based on 80th percentile travel time

AHD = Annual Hours of Delay
AHTD = Annual Hours of Truck Delay
CMAQ = Congestion Mitigation and Air Quality Program
CO = carbon monoxide
kg = kilograms
NHS = National Highway System
NOx = nitrogen oxide
PM = particulate matter
SCOPM = Standing Committee on Performance Measures
SD = structurally deficient
SGR = state-of-good-repair
VOC = volatile organic compound

## *3.3 Project Selection and Resource Allocation*

While the Strategic Plan directs all TxDOT business decisions and investments, and the TTP supports the Strategic Plan, progress towards goals is largely dictated by the projects selected for implementation. Thus, to support the achievement of Strategic Plan goals, the TTP will provide a method for aligning planning and programming decisions in order to maximize the value of investments in the Texas transportation system. This will be developed by analyzing alternative investment scenarios given Plan needs and reasonably expected revenues, with a focus on reporting outcomes using the performance measures identified in the Plan.

### 3.3.1 Best Practices and Legislative Guidance

The states maintain the sovereign power to prioritize and select specific projects; Congress by law authorizes federally-funded transportation programs as well as eligibility and programmatic requirements. In accordance with the nationwide shift towards performance management (John A. Volpe National Transportation Systems Center, 2012), some state DOTs are beginning to use performance measures to evaluate, select, and prioritize projects; however, the majority do not consider fiscal constraints, or what could actually be implemented based on currently available funds and anticipated future revenues. Additionally, long-range plans can be policy-based and are largely not developed to include specific projects in practice.

Best practices in the literature are increasingly calling for a consistent, repeatable, and defensible approach to project selection and ranking that considers:

- Performance constraints/ minimum performance thresholds
- Budgetary constraints
- Identification of multimodal Plan investment scenarios
- An evaluation of tradeoffs to determine impacts across scenarios
- The development of a recommend investment strategy to guide high-level resource allocation.

### 3.3.2 Texas Transportation Plan - Resource Allocation Analysis

The TTP will be developed to both incorporate the UTP and to guide future UTP projects. The TTP 43 TAC Rule 16.105 requires the UTP to link high-level planning activities from the SLRTP with more detailed programming activities in the STIP. The UTP is a listing of all projects that TxDOT intends to develop or initiate construction for during the program period. However, the UTP is not fiscally constrained; it does not obligate funding for projects nor guarantee that they will be constructed.

The UTP Toolkit provides specific programming instructions based on 12 funding categories. Pursuant to 43 TAC Rule 16.105, all projects excluding Category 1 projects (preventative maintenance and rehabilitation) that are included in the UTP must be ranked as Tier 1-3 based on a set of criteria. This ranking is used to inform the advancement of some projects to the STIP and then to project letting for implementation. To standardize the approach and criteria for ranking projects, the 2014 UTP Toolkit provides a Project Ranking Tool that encompasses three criteria areas:

- **Project need** based on the potential of the project to advance the goals of the Strategic Plan (34 points possible)
- **Funding availability** based on secured and local committed funding as a percent of construction cost (33 points possible)
- **Project readiness** based on current phase of project development: plan, develop, construct, and let (33 points possible).

Using Plan-specific goals and objectives that align with the Strategic Plan and incorporate UTP criteria, the TTP will include the development of resource allocation scenarios and a recommended investment strategy that can align with TxDOT's capital program and operating budget. In addition to informing UTP projects, the TTP will include the identification of priority corridors, projects, or areas of the state that are of particular concern in meeting goals and objectives.

## *3.4 Performance Data Collection, Monitoring, and Reporting*

Performance monitoring serves several important functions in the context of a performance-based plan. It is used to support agency decision-making on a daily or longer-term basis; to inform the development of performance targets based on what can realistically be achieved; to refine/calibrate predictive tools and methodologies based on a comparison of actual to predicted performance outcomes; and to track progress towards goals. Through clear communication of how well the system is performing against established benchmarks, reporting can be used to support internal coordination and collaboration; remain accountable to the public and stakeholders; justify the need for increased Federal funding; and comply with MAP-21 requirements.

### 3.4.1 Best Practices and Legislative Guidance

Information management systems are often used for performance monitoring and reporting. State DOTs commonly maintain roadway, structural, safety and facility, and mobility data systems (**Exhibit 7**); however, there is significant variation in the data collected and maintained by DOTs that further complicates the selection of national measures.

In the context of a performance-based plan, these databases are used not only for monitoring system condition and performance but also as the basis for transportation investments. Historic data can be used to calibrate predictive tools and methodologies that assess likely project impacts prior to implementation. In this way, the expected "value" of a given project with respect to long-term goals can be determined and compared to others in order to select the set of projects that achieves the greatest overall benefit. Such data-driven decision processes require quality data to ensure that investments are truly aligned with the best and most probable performance outcomes.

Developing and maintaining quality databases is very resource intensive. Fiscally-constrained DOTs and MPOs often lack the resources to continually update the databases with the most recent information. As such, key challenges that are currently being addressed by transportation agencies include the development of cost-effective data collection methodologies and the use of data sharing agreements with the private sector and other public agencies to avoid duplicating efforts.

**Exhibit 7: Common State DOT Data Systems**

| Data Category | Database System |
|---|---|
| Roadway Data | **Highway Performance Management System (HPMS).** Includes data in highway inventory, condition, performance, and operations. It also describes functional characteristics, performance, and operations.<br>**PMS Database.** Most state agencies collect pavement data to support PMS, but there is no standard format for how the information is collected and stored. Different state agencies collect different pavement data, and examples of pavement data include pavement type, land width, shoulder width, number of lanes, layer thickness, pavement layer material, drainage, subgrade type, cracking, IRI, and rutting data. |
| Structure Data | **National Bridge Inventory (NBI).** NBI is a federally mandated database of bridge inventory and conditions, and this data is submitted to FHWA. The NBI data set contains condition/rating data by bridge component: deck, superstructure, substructure, channel/channel protection, and culvert. It also contains data on a bridge's functionality, such as under clearances and load-posting information.<br>**Pontis BMS.** The Pontis database contains additional data on the distribution of conditions by condition state for each structural element of the superstructure, including elements such as girders, stringers, and floor beams. |
| Safety Feature and Facility Data | Most state DOTs collect and maintain asset inventory data of their safety features and facilities. The data is stored in a variety of ways, ranging from filed books to database applications. There are no standards for collecting asset data for safety features and facilities, and data availability varies from one agency to another. LOS is commonly used to support performance-based budgeting or resource allocation.<br>Commonly used safety data includes Fatality Analysis Reporting System (FARS), Highway Safety Information System (HSIS), State Crash Data Systems, and State Highway Safety Improvement Plans (HSIP). |
| Mobility Data | State DOTs typically use HPMS as a source of mobility data. The FHWA Highway Economic Requirements System (HERS-ST) uses HPMS data to generate mobility measures. Most state DOTs maintain databases for tracking highway inventory and traffic data in addition to what they report to FHWA through the HPMS Program. However, there are no standards for how and what additional data are collected and stored. |

Notes:
Sources: Wiegmann & Yelchuru, 2012) as adapted from (Cambridge Systematics, Inc., 2007); (Cambridge Systematics, Inc., Applied Research Associates, Inc., Arora and Associates, KLS Engineering, PB Consult, Inc., Lambert, Louis, 2009
BMS = Bridge Management System
DOT = Department of Transportation
FHWA = Federal Highway Administration
IRI = International Roughness Index
LOS = level of service

### 3.4.2 Texas Transportation Plan Performance Data

The TTP will include an extensive review of the multimodal data systems that are currently used and maintained by TxDOT and other transportation providers within the state. At a minimum and based on an initial review, TxDOT maintains the following for performance data:

- **Highway Performance Management System (HPMS):** Includes highway inventory, condition, and performance data for on-system roadways and others depending on functional classification
- **National Bridge Inventory (NBI):** Includes condition data by bridge deck, superstructure, and substructure, as well as functional data including underclearances and load-posting
- **TxDOT Road–Highway Inventory Network (RHiNo)** database
- **Project Tracker:** Publically available database via the TxDOT website that provides project-specific information including schedule and costs to date.

## 4.0 Plan Outreach

Plan outreach is critical for cultivating trust with the public and stakeholders, increasing public participation and "buy-in," and achieving internal acceptance and support. Successful plans are those that are (1) comprehensive with respect to statewide and multimodal transportation priorities; (2) relevant for all system users and stakeholders; (3) and useful for supporting agency processes and decision-making. Regardless of the specific approach taken, these characteristics can generally be achieved by continuously collecting and integrating feedback from a diverse set of transportation users and stakeholders throughout plan development and implementation.

### *4.1 Plan Outreach Requirements*

While specific approaches to plan outreach vary among DOTs, there are significant legislative requirements regarding who should be involved in the development process. In summary, these include:

- **Texas (43 TAC Rule 16.54):** Other state agencies, political subdivisions, metropolitan planning organizations, rural planning organizations, local transportation entities, other officials who have local responsibility for the various modes of transportation, and members of the general public.
- **National (23 USC 135):** Governments in metropolitan, non-metropolitan, and Indian tribal areas; all other interested parties including local elected officials, the general public, freight stakeholders, multimodal representatives, and private industry transportation providers, among others.

## *4.2 Texas Transportation Plan Outreach*

TTP outreach will be conducted in two rounds:

- Round #1 will occur in the fall/ winter of 2013/ 2014 and will include the presentation of Draft TTP Goals and Objective for public input.
- Round #2 will occur in the spring/ summer of 2014 and will provide the public with an opportunity to consider various long-term investment strategies, the costs of these strategies, and the impact of these investments on system performance.
- TxDOT is currently developing a Public Outreach Plan (POP) for the TTP. While the specific approach and milestones will be discussed in a separate technical memo, it will generally be based on a "comprehensive, cooperative, and continuing" (3-C) planning process that is transparent and inclusive of all transportation stakeholders. It will be fully compliant with the state and national statutory requirements listed in 43 TAC 16.54 and 16.55 and 23 USC 135, respectively.

# 5.0 Plan Communication/Data Presentation

In support of a more inclusive process, and to provide greater accountability and transparency to the public and stakeholders, state DOTs are working to create a format for communicating system performance that is understandable to a diverse set of audiences. While narrative formats including handouts and fact sheets are still preferred by some DOTs, infographics including report cards and dashboards are becoming increasingly utilized by DOTs to more clearly communicate progress towards benchmarks and to support internal decision-making processes.

## *5.1 Best Practices in Plan Communication/ Data Presentation*

Infographics can be used to translate technical information into a format that can be easily understood by the general public. Tools such as report cards/scorecards (**Exhibit 8**) and dashboards (**Exhibit 9**) can be used to establish greater trust and accountability with the public and stakeholders by allowing them access to the performance of the multimodal transportation system. Both of these formats are best served by a centralized database that supports the continuous updating of performance indicators for public viewing.

Legislative guidance for SLRTP communication and data presentation provided by 23 USC 135 (as amended by MAP-21) requires state DOTs to employ visualization techniques to the extent practicable when describing the Plan or its findings to the general public.

**Exhibit 8: ASCE 2013 Systemic Report Card**

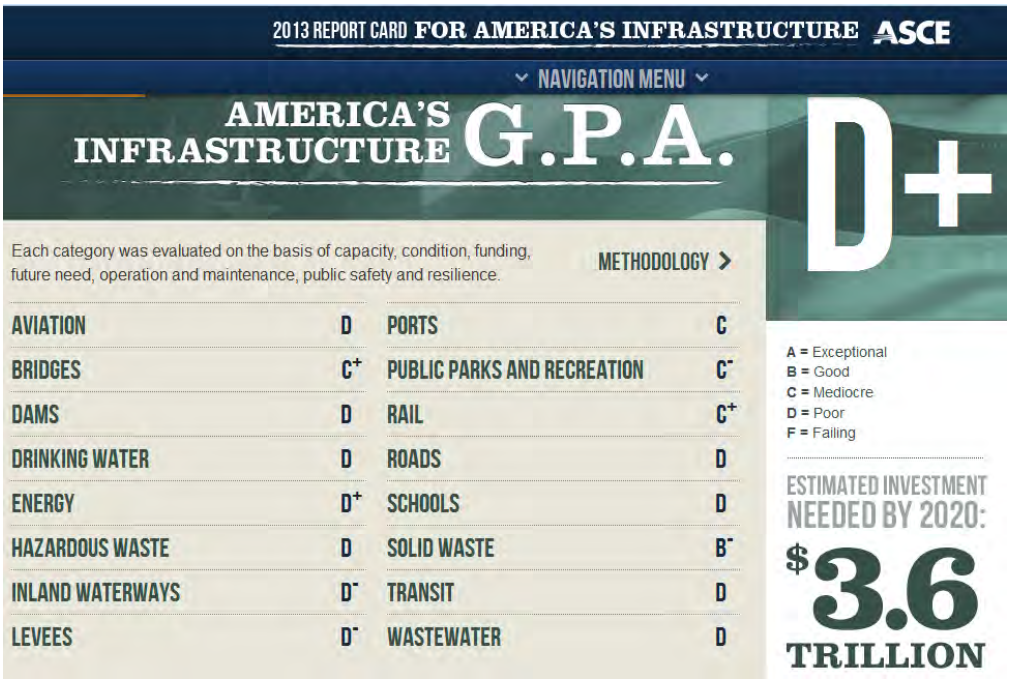
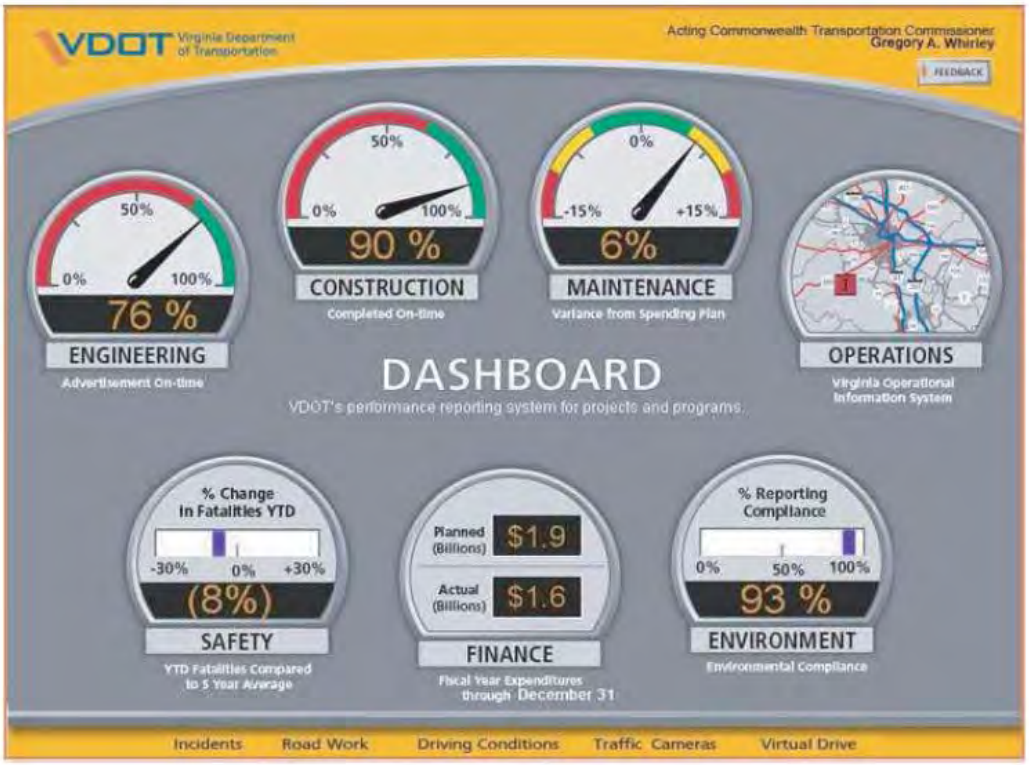



**Exhibit 9: Example Dashboard Developed by VDOT**



## 5.2 *Texas Transportation Plan Communication/ Data Presentation*

Effective plan communication is critical to successful TTP development and implementation. As such, the Plan framework calls for the use of innovative, interesting, and understandable methods for communicating findings and "decision points" to the public for consideration and feedback. The TTP communications and data presentation will focus on building trust with the Texas public through greater transparency and accountability in agency decision-making and with respect to the current and anticipated future performance of the multimodal system. In these ways, TTP communications will provide improvement from those of past plans, which the Strategic Plan notes were not consistently "viewed by various audiences as timely, reliable, or accurate."

The TTP will include updates to the TxDOT website to reflect ongoing development and outreach activities and to continuously collect feedback from the public and stakeholders. Additionally, it will employ visualization techniques to improve general understanding of the multimodal system needs and funding gaps and to comply with national requirements. Data presentation techniques that will be considered include GIS maps that display the statewide performance of the system across goal areas, and performance indicators that visually communicate current progress towards goals. Additionally, to support greater public understanding of TxDOT decision processes within the context of constrained resources, an interactive tool will be provided that allows users to visualize the systemic impacts and tradeoffs that result from shifting resources from one priority to another (e.g., from system preservation to expansion) and what a given level of investment can "buy" with respect to performance across all goal areas.

The 2030 Committee report *It's About Time: Investing in Transportation to Keep Texas Economically Competitive* warns that sustained underinvestment in the Texas transportation system will result in a degraded future system with worsening traffic congestion and insufficient connectivity to support the Texas economy. The alternative requires Texans to invest more in order to preserve the quality and reliability of the transportation system for years to come. While this conclusion is never politically popular, it will be an easier sell if the Texas public understands the severity of the funding gap, its pervasive consequences, and that their individual contributions (i.e., via taxes and fees) are critical for enhancing the performance of the multimodal transportation system.

# 6.0 Recommended Plan Framework

Based on findings from the Plan Assessment and a review of best practices, the TTP will focus on outcomes of proposed investments on the Texas multimodal transportation system and will showcase technical analyses using innovative, effective, and transparent communication and data presentation techniques that cultivate trust with the public and improve general understanding of the Plan.

The Plan Framework will include the following components:

- **Goals and objectives** that implement the Department's mission and long-term vision as identified in the Strategic Plan as well as the incorporation of MAP-21 goals/ requirements and additional agency/ stakeholder priorities. Goals and objectives will be developed using input from the TTP Technical Advisory Committee (TAC), the state's planning partners and TEMPO, and the public (Round #1 of Public Outreach).
- **Performance measures** and supporting data that track progress towards goals and facilitate data-driven decision processes.
- **Outcome-based investment analysis** to guide project development and selection. This analysis will be based on a multimodal needs assessment and existing/ project revenues and will include the identification of priority corridors, projects, or areas of the state that are of particular concern in meeting goals and objectives. Evaluation will include input from the public on how/ where investments should be made across the multimodal system (Round #2 of Public Outreach).
- A methodology for tracking and reporting on **Plan implementation progress** over time will be included in the final TTP.

The TTP will use **inclusive and engaging public outreach methods** that result in meaningful and diverse contributions to the TTP development process. The public will be presented with the opportunity to understand the outcomes of investment decisions on system performance using language that is easily understood.

# Texas Transportation Plan

## Tech Memo 2: TTP Goals & Objectives "Building Blocks"

September 26, 2013

## Acknowledgements

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# 1.0 Background

The Texas Transportation Plan (TTP) will serve as the statewide long-range transportation plan (SLRTP) in compliance with state and federal requirements under Title 43 of the Texas Administrative Code and Senate Bill (SB) 1420, 23 U.S. Code (USC) 135 (as amended by MAP-21), and 23 Code of Federal Regulations (CFR) 450.214. The TTP will implement the statewide vision and goals as identified in the 2013-2017 Strategic Plan and will incorporate—by reference—statewide, metropolitan, and rural plans, programs, and studies relevant to the evaluation and performance of the statewide and multimodal transportation system, including:

Passenger Modes

- Highway/Bridge
- Bus Transit and Inter-city Bus
- Passenger Rail
- Aviation
- Bicycle and Pedestrian
- Intelligent Transportation Systems.

Freight Modes

- Truck Freight
- Freight Rail and Intermodal
- Ports and Waterways
- Pipeline

In addition, the TTP will integrate pending changes to statewide planning regulations as they are issued by the U.S. Department of Transportation (DOT) under MAP-21, including the development of national measures and other relevant provisions.

This Technical Memorandum (Tech Memo #2) summarizes the "building blocks" of – and development process for – the goals and objectives (G&O) for the TTP.

## *1.1 Requirements for SLRTP Development*

Under Title 23, state departments of transportation (DOTs) are required to develop SLRTPs in coordination and cooperation with statewide transportation planning and delivery partners, stakeholders, and the public. The basic federal requirements for statewide planning include the development of a multimodal statewide transportation plan with a minimum 20-year time horizon.

Under Title 43 of the Texas Administrative Code (TAC) and SB 1420, the Texas Department of Transportation (TxDOT) is required to develop an SLRTP with a 24-year planning horizon that contains specific, long-term transportation goals and performance targets and identifies priority corridors, projects, or areas of concern with respect to achieving these goals.

## *1.2 TTP G&O – Development Process*

The development of goals and objectives for the TTP is a critical part of the statewide planning process. Building blocks for TTP G&O are defined by documents, provisions, and on-going TxDOT agency initiatives as well as state and federal legislation, national transportation planning trends, and existing statewide planning efforts as documented in:

- Title 23 USC § 135 Statewide Transportation Planning
- 23 the U.S. Code of Federal Regulations (CFR) Parts 450 and 500

- Moving Ahead for Progress in the Twenty-first Century (MAP-21)
- Title 43 of the TAC [Rule 16.54 and 16.55]
- TxDOT's Strategic Plan (2013 – 2017)
- The Texas Rural Transportation Plan 2013-2037 (TRTP)
- TxDOT's 2035 Statewide Long-range Transportation Plan.

While these regulations and plans form the basis of G&O development, the involvement of decision-makers, planning partners, stakeholders, and the public is essential to ensure that the goals are comprehensive and reflective of statewide multimodal priorities. To incorporate the ideas of these diverse groups, the TTP G&O development follows an iterative process that includes:

- A review of existing plans and regulations
- Presentation and discussion of the G&O building blocks to TxDOT's TPP Technical Advisory Committee (TAC) (Oct 10, 2013)
- Development of Draft TTP G&O for distribution to the TTP TAC and for review by TxDOT executives
- Presentation and discussion of Draft G&O during Public Outreach Round #1 (fall/ winter 2013)
- Updates to G&O and presentation/ adoption of final TTP G&O by TxDOT executives for the TTP (winter 2013).

# 2.0 Building Blocks

## *2.1 TxDOT Strategic Plan*

The TxDOT 2013-2017 Strategic Plan provides direction for TxDOT's business and operational decisions and investments. The TTP will implement the Strategic Plan using performance-based planning concepts with a focus on the State's multimodal transportation system.

### 2.1.1 Strategic Plan Priorities

As documented in the Strategic Plan, TxDOT's priorities are to:

- Be the safest state department of transportation in the United States
- Develop and implement authorized Comprehensive Development Agreements (CDAs) and discuss the need for additional CDAs
- Develop innovative maintenance approaches that reduce costs and improve/preserve transportation system conditions
- Develop effective information systems
- Act as resource for transportation funding
- Implement congestion mitigation projects
- Further strengthen and enhance relationships with MPOs, counties, and other key stakeholders.

### 2.1.2 Strategic Plan Goals

Developed by the Texas Transportation Commission and TxDOT executives, the Strategic Plan goals provide broad directional areas of focus for TxDOT's mission to "Work with others to provide safe and reliable transportation solutions for Texas." The Strategic Plan goals focus on improving business processes and the performance of the Texas transportation system. As an expression of TxDOT priorities, the following Strategic Plan goals and objectives provide the umbrella framework for the development of TTP G&O:

Goal: Maintain a Safe System

**Objective(s):**

- Reduce crashes and fatalities on the system through innovations, technology, and public awareness
- Maintain and preserve the transportation assets of the state of Texas

Goal: Address Congestion

**Objective(s):**

- Partner with local officials to develop and implement congestion mitigation plans in Texas

Goal: Connect Texas Communities

**Objective(s):**

- Prioritize new projects that will increase the state GDP and enhance access to goods and services throughout the state

Goal: Become a Best in Class State Agency

**Objective(s):**

- Ensure the agency deploys its resources responsibly and has a customer service mindset
- Focus on work environment, safety, succession planning, and training to develop a great workforce

## *2.2 SLRTP 2035*

Adopted on November 18, 2010, the 2035 Statewide Long Range Transportation Plan (SLRTP) identifies the following goals to support the implementation of the Strategic Plan:

- Develop an organizational structure and strategies designed to address the future multimodal transportation needs of all Texans
- Enhance safety for all Texas transportation system users
- Maintain the existing Texas transportation system
- Promote congestion relief strategies

- Enhance system connectivity
- Facilitate the development and exchange of comprehensive multimodal transportation funding strategies with transportation program and project partners.

## 2.3 Texas Rural Transportation Plan

Adopted on June 28, 2012 as a supplement to the SLRTP, the 2013-2037 Texas Rural Transportation Plan (TRTP) specifically addresses the multimodal transportation system condition and needs in rural areas (i.e., outside of MPO boundaries). The TRTP considered all six goals from the SLRTP with a specific focus on two over-arching goals:

- Promote Congestion Relief Strategies
- Enhance System Connectivity.

## 2.4 Texas Freight Mobility Plan

The Texas Freight Mobility Plan (TFMP) is currently under development and is scheduled to be completed in 2014. As the State's first comprehensive freight plan, the TFMP will develop short-, mid-, and long-term needs for freight-related transportation investments as part of an integrated multimodal system approach that includes:

- Freight Rail
- Air Cargo
- Pipelines
- Border Crossings
- Ports/Waterways
- Highways/Trucks.

An important part of this effort was the establishment of the Texas Freight Advisory Committee (TxFAC) to guide TFMP development and support implementation. The Freight Stakeholder Engagement Plan outlines the TFMP outreach activities and strategies to support increased participation by private and public sector freight stakeholders throughout the state.

## 2.5 Federal Legislation

Under SAFETEA-LU, as codified in 23 USC Section 135, states were afforded significant flexibility in the development of SLRTP goals, objectives, and content. The national legislation provided guidance for Plan development and required only that the following eight federal "planning factors" be considered:

- Support the economic vitality of the United States, the States, nonmetropolitan areas, and metropolitan areas, especially by enabling global competitiveness, productivity, and efficiency
- Increase the safety of the transportation system for motorized and non-motorized users
- Increase the security of the transportation system for motorized and non-motorized users
- Increase accessibility and mobility of people and freight

- Protect and enhance the environment, promote energy conservation, improve the quality of life, and promote consistency between transportation improvements and State and local planned growth and economic development patterns
- Enhance the integration and connectivity of the transportation system, across and between modes, for people and freight
- Promote efficient system management and operation
- Emphasize the preservation of the existing transportation system.

MAP-21 amends the planning factors by providing specific national goals for incorporation into the SLRTP and establishes an outcome-driven framework for investment, where states and metropolitan planning organizations (MPOs) shall work to measure, manage, and improve upon system conditions and performance and incorporate the following national goals into the statewide long-range transportation planning process:

- **Safety:** Reduce fatalities and injuries on all public roads
- **Condition:** Maintain the National Highway System (NHS) to a state of good repair
- **Congestion:** Significantly reduce congestion on the NHS
- **Reliability:** Improve efficiency for passengers and freight
- **Freight movement and economic vitality:** Improve connectivity, access, and rural economic development
- **Environmental sustainability:** Enhance performance while protecting and enhancing the natural environment
- **Project delivery:** Accelerate project completion and promote jobs and the economy.

MAP-21 regulations for national measures will be issued according to the schedule shown in **Exhibit 1**. TxDOT is continuing to inform the Federal Highway Administration (FHWA) rulemaking for national measures through coordination with the American Association of State Highway and Transportation Organization (AASHTO) Standing Committee on Performance Measurement (SCOPM). The TTP will incorporate these measures at a minimum.

**Exhibit 1: FHWA Guidance on MAP-21 Performance Rulemaking**

| | Measure Category |
|---|---|
| Status I<br>January 2015 | • Serious injuries per VMT[1]<br>• Fatalities per VMT[1]<br>• Number of serious injuries[1]<br>• Number of fatalities[1] |
| Status II<br>April 2015 | • Pavement condition on the Interstates[2]<br>• Pavement condition on the Non-Interstate NHS[2]<br>• Bridge condition on NHS[2] |
| Status III<br>July 2015 | • Traffic congestion[3]<br>• On-road mobile source emissions[3]<br>• Freight movement on the Interstate[4]<br>• Performance of Interstate system[2]<br>• Performance of Non-Interstate NHS[2] |

Notes:

[1]Highway Safety Improvement Program
[2]National Highway Performance Program
[3]Congestion Mitigation and Air Quality (CMAQ)
[4]Freight Policy

VMT = vehicle miles traveled
NHS = National Highway System

*Source: Osbourne, 2013*

Other key federal initiatives include the broad sweeping requirement for performance-based planning[1] that is the cornerstone of MAP-21, the development of a national freight policy, and environmental streamlining to accelerate project design and delivery.

### National Freight Policy Goals (as established in 23 U.S.C. 167)

MAP-21 includes a provision to improve the condition and performance of the national freight network in order to support the global economic competitiveness of the United States and achieve the following goals:

- Improve the contribution of the freight transportation system to economic efficiency, productivity, and competitiveness
- Reduce congestion on the freight transportation system
- Improve the safety, security, and resilience of the freight transportation system
- Improve the state of good repair of the freight transportation system
- Use advanced technology, performance management, innovation, competition, and accountability in operating and maintaining the freight transportation system
- Reduce adverse environmental and community impacts of the freight transportation system.

MAP-21 also requires the U.S. DOT to establish a national freight network to provide strategic direction for States on highway investments that enhance freight mobility.

[1] The components and importance of performance-based planning and its application to SLRTP development are further defined in TTP Tech Memo #1: Plan Assessment and Framework.

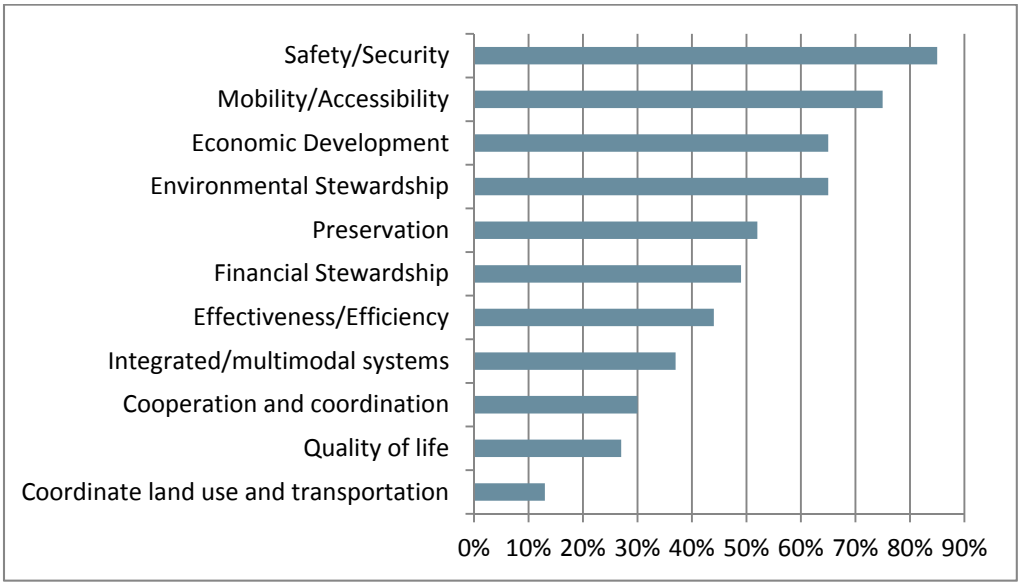
NEPA Streamlining

MAP-21 promotes accelerating project delivery and encourages innovation through the increased use of Categorical Exclusions, programmatic approaches, and planning and environmental linkages in 22 different sections. To speed project delivery, MAP-21 encourages timely decisions by environmental agencies. The Bill authorizes a process for U.S.DOT and the environmental agencies to establish deadlines for issuance of project approvals and a process for the elevation of disputes among agencies.

## *2.6 National Trends in LRTP Goals*

A 2012 review of state DOT SLRTPs completed by the Volpe National Transportation Systems Center provides a summary of trends in statewide planning goals (**Exhibit 2**). Prior to MAP-21, many of the overarching goals defined in SLRTPs were consistent with the federal planning factors outlined in SAFETEA-LU.

**Exhibit 2. Trends in Statewide Planning Goals**




*Source: Volpe, Trends in Statewide Long-Range Transportation Plans, March, 2012*

# 3.0 Next Steps

## *3.1 Developing TTP-specific Goals*

The TTP goal development process assumes the following definitions:

- **Goal area**: A broad identification of general direction that aligns with TxDOT Strategic Plan goals and priorities (safety); goal areas will be developed for the TTP with the Strategic Plan as the umbrella framework
- **Goal**: A more targeted statement of directional priority within the general goal area (e.g., improve pedestrian and bicycle safety); TTP goals will incorporate MAP-21 national goals as well as state priorities

- **Objective**: A specific and measurable statement of action (e.g., reduce the number of pedestrian- and bicycle-related crashes); TTP objectives will be developed with the TAC and TxDOT leadership.

## *3.2 Aligning MAP-21 to Strategic Plan*

**Exhibit 3** illustrates how the national goals identified under MAP-21 align with those of the Strategic Plan. In addition to providing specific guidance on the achievement of Strategic Plan goals, the TTP goals will be used to fill any existing gaps with MAP-21 requirements, such as by addressing environmental stewardship and system reliability requirements.

**Exhibit 3. Aligning MAP-21 Goals to the TxDOT Strategic Plan**

| Strategic Plan Goals | MAP-21 Goals |
|---|---|
| Maintain a Safe System | **Safety:** To achieve a significant reduction in traffic fatalities and serious injuries on all public roads<br>**Infrastructure Condition:** maintain assets to a state of good repair* |
| Address Congestion | **Congestion Reduction:** To achieve a significant reduction in congestion on the NHS |
| Connect Texas Communities | **System Reliability:** To improve the efficiency of the surface transportation system*<br>**Freight Movement and Economic Vitality:** To improve the national freight network, strengthen the ability of rural communities to access national and international trade markets, and support regional economic development |
| Become a Best in Class State Agency | **Reduced Project Delivery Delays:** To reduce project costs, promote jobs and the economy, and expedite the movement of people and goods by accelerating project completion through eliminating delays in the project development and delivery<br>**Environmental Sustainability:** To enhance the performance of the transportation system while protecting and enhancing the natural environment<br>**Infrastructure Condition:** maintain assets to a state of good repair* |

Note:
*Additional coordination with TxDOT and the TTP TAC is required to identify where these MAP-21 goal areas best fit under TxDOT's 2013-2017 Strategic Plan.

## *3.3 Defining Performance Measures*

Another integral part of this process is the identification and development of performance measures to address the requirements of MAP-21 and as part of the TxDOT modernization process. Criteria for "good" performance measures include the following development indicators:

- Supported by existing resources
- Important to decision-makers, partners and stakeholders
- Aligned with the Department mission, values, and goals
- Appropriate with respect to Department responsibilities and influence
- Suitable for context
- Supportive of predictive capabilities
- Reflective of state and national priorities

MAP-21 national measures will be integrated into the TTP per AASHTO/ FHWA recommendations.[2]

## *3.4 TAC Input*

After reviewing the building blocks for the TTP and identifying the strategic goals, the next step is to work with the internal partners and stakeholders through the TTP TAC to develop draft working goals, objectives, and performance measures.

Draft working goals will be taken out to external partners and stakeholders for review and refinement, then brought forward into the TTP scenario development process.

### 3.4.1 Schedule

The schedule for the remainder of 2013 will focus on the TTP G&O development process and will continue as follows:

| | |
|---|---|
| October 10, 2013 | TTP TAC |
| Fall/Winter 2013 | Partner and Stakeholder Meetings and Webinars Round #1 |
| Fall/Winter 2013 | Public Meetings and Webinars Round #1 |
| January 2014 | Draft final goals, objectives, and performance measures |
| February 2014 | Final goals, objectives, and performance measures |

[2] Final rulemaking for SLRTP/ national performance measures has not yet been issued by FHWA, but will be issued according to the schedule shown in Exhibit 1.

# Texas Transportation Plan

## Tech Memo 3.1: Pavement

January 15, 2014

## Acknowledgements

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# 1.0 Introduction

In supporting the long-range Texas Transportation Plan (TTP), this Technical Memorandum describes the methodology for conducting an assessment of highway pavement investment needs required to maintain state-owned highway pavements in good condition over the planning horizon while providing an acceptable level of service for road users. This methodology will be employed in Task 4 of the TTP.

The suggested performance-based approach incorporates the methodology used in the Texas Pavement Management Information System (PMIS) and uses a life-cycle analysis framework to conduct long-term pavement needs assessment. It provides cost-effective investment needs for pavement maintenance, preservation, rehabilitation, and reconstruction to maximize the use of resources and optimize pavement performance.

The following sections discuss the scope of the analysis, data collection, and determination of needs.

# 2.0 Scope of Analysis

## *2.1 Types of Investment*

Pavement investment can be broken out into two broad categorizations: preservation and service expansion.

- **Preservation:** Pavement preservation generally refers to all types of pavement treatments that maintain, strengthen, and enhance the serviceability of pavements assets. According to the TxDOT PMIS, the following four categories of pavement treatments are typically applied for Texas pavements: preventive preservation, light rehabilitation, medium rehabilitation, and heavy rehabilitation (including reconstruction). For each pavement section, a combination of the above four categories of treatments will be programmed over the planning horizon to generate the optimal pavement performance while minimizing the life-cycle cost.
- **Service Expansion:** Expansion or "capacity" projects listed in the existing Texas Statewide Long-Range Transportation Plan 2035 and Metropolitan/Regional Transportation long-range plans will be evaluated for inclusion in the statewide travel demand model (SAMv3). Based in part on the predicted traffic volume, roadway capacity expansion projects will be considered to further alleviate traffic congestion and support economic movement. Then the preservation investment needs during the planning horizon for new constructed pavements in roadway expansion projects will also be identified.

## *2.2 Modal Overview*

With approximately 197,000 lane-miles of roadway owned and operated by TxDOT, the PMIS is used to track conditions, costs, and maintenance histories. As part of this system, Texas staff are currently working to update performance models and decision trees to more accurately project

future needs. A description of TxDOT divisions, roles, responsibilities, and efforts to update the PMIS predictive framework are described as follows:

- Overview of Texas agencies/departments:
  - The TxDOT Maintenance Division oversees the preservation, upkeep, and restoration of Texas highways. Under the Maintenance Division, the Pavement Preservation Branch is responsible for the maintenance of pavements.
  - The Transportation Planning and Programming Division administers planning funds, prepares maps, collects data on the highway system, and programs projects, as well as acting as the central clearinghouse for project selection.
  - The Construction Division performs inspection and testing and provides administrative oversight for all department construction contracts. The division is responsible for contractor pre-qualification, bid proposal issuance, and awarding (letting) construction and maintenance contracts.
- Overview of pertinent transportation plans, programs, and studies reviewed:
  - The current TxDOT Strategic Plan, Texas Statewide Long-Range Transportation Plan 2035, TxDOT 2013 Unified Transportation Program (UTP), the most recent TxDOT Statewide Transportation Improvement Program, and 25 Metropolitan/ Regional Transportation Plans were reviewed. These plans will be evaluated to validate forecasted needs and priorities and to identify committed projects for inclusion in the development of the TTP.
  - TxDOT PMIS and the study *Project 0-6386: Evaluation and Development of Pavement Scores, Performance Models and Needs Estimates* (TxDOT Project 0-6386) were also reviewed. The Project 0-6386 publication has supported TxDOT staff in updating the PMIS with detailed information on pavement condition evaluation, performance modeling, and decision trees for pavement programming. As the PMIS processes are being updated, the current PMIS is limited to a 10-year planning horizon. The outcomes of this study and the methodologies used by TxDOT PMIS will serve as a base for the pavement methodology used in the development of the TTP.

# 3.0 Data Collection

## *3.1 Data Availability and Sources*

The following data was obtained from the Pavement Preservation Branch of the Maintenance Division at TxDOT:

1. Pavement Inventory Data:
   - TxDOT roadway inventory data - RHiNO File (http://www.txdot.gov/inside-txdot/division/transportation-planning.html)
   - TxDOT PMIS pavement section information

2. Pavement Condition Data:
   - Pavement condition data from Year 2001 to Year 2013
   - Pavement distress score (scale: 1 to 100), ride score (scale: 0 to 5), International Roughness Index (scale: 1 to 950), and condition score (scale: 1 to 100) for each pavement section
3. Pavement Treatment Categories and Detailed Pavement Treatment List
4. Pavement Treatment Cost Information: the average unit cost ($/lane-mile) for each TxDOT defined pavement treatment category, including preventive maintenance, light rehabilitation, medium rehabilitation, and heavy rehabilitation

The following information and data were obtained from *Project 0-6386: Evaluation and Development of Pavement Scores, Performance Models and Needs Estimates*:

1. Pavement performance models for each distress type and ride score for each pavement type
2. Decision trees used to identify pavement treatments for each type of pavement

## *3.2 Gaps in Data and Recommendations*

As seen in Section 3.1, several types of pavement data have been collected for the development of TTP. However, some important information is still limited or missing:

1. **Pavement construction and maintenance history**. Pavement maintenance and rehabilitation history provided by the Pavement Preservation Branch of the Maintenance Division is limited. Additionally, age information (i.e., build year or the reconstruction year) is unavailable, which may affect the accuracy regarding the identification of appropriate pavement rehabilitation treatments and timings.
2. **Unit cost of pavement treatment in each functional class.** The average unit cost ($/lane-mile) for each pavement treatment category has been collected; but the disaggregated unit cost of pavement treatment at each functional class is not available. Higher functional class roadways typically have incrementally larger costs. Consequently, an average aggregated cost is to be used unless sufficient unit cost information by functional class can be obtained.

The Consultant Team will make efforts to attain supplemental information by:

1. Reaching out to the Construction and Design Divisions as potential data sources for pavement construction and maintenance histories
2. Contacting the programming officials at TxDOT to identify typical treatment unit costs for each functional class. The Federal Highway Administration's (FHWA) Highway Economic Requirements System (HERS), which provides cost ratios between different functional classes at the national level, may be accessed to help disaggregate unit costs should Texas data be unavailable.

# 4.0 Needs Determination

## *4.1 Defining "Needs"*

Generally, the pavement needs refer to the treatments required to keep the pavement ride surface and structural health in good condition. Several performance measures have been used to measure the condition of pavement in TxDOT PMIS: Distress Score, Ride Score, and Condition Score. Among these performance measures, the Condition Score is used to measure the overall State-of-Good-Repair (SGR) of pavements.

Also, according to FHWA staff and recommendations from the *AASHTO Standing Committee on Performance Management (SCOPM) Task Force Findings on National-Level Performance Measures*, the International Roughness Index (IRI) is a likely to be included in MAP-21 final rulemaking. This measure, similar to the Ride Score, measures the smoothness of the roadway surface and can be used to represent user satisfaction with driving conditions. The SCOPM recommends that a minimum condition level for rural interstate segments should be set at less than or equal to 20 percent of segments rated poor (IRI>170) based on IRI. Currently, most pavements in Texas are in much better condition than this threshold.

Considering TxDOT best practices, both the Condition Score and IRI are proposed to be used as performance measures to evaluate the SGR for pavements in Texas.

Two types of analyses will be conducted by the Consultant Team: unconstrained needs assessment and financially-constrained scenarios. Unconstrained needs refer to the pavement treatments and timings that maintain pavements at a targeted condition level. Typically, the target is to avoid any poor condition pavement. If the forecasted budget is not enough to implement all the recommend treatments in the unconstrained needs, financially-constrained analysis can be conducted to select treatments that can optimize the pavement performance under the available budget.

## *4.2 Predicting Performance*

To realize the benefits of performance-based decision-making in long-term planning, reliable statistical models based on real data are critical. A comprehensive set of performance models have been developed for the TxDOT PMIS via TxDOT Project 0-6386; the Consultant Team recommends application of these models for development of the TTP. Additionally, the Consultant Team plans to develop a similar set of models to capture IRI predictions, which can be used for monitoring system performance as part of the upcoming Texas Transportation Asset Management Plan.

The TxDOT PMIS divides pavements into three types: Asphalt Concrete Pavement (ACP), Continuously Reinforced Concrete Pavement (CRCP), and Jointed Concrete Pavement (JCP). The performance models for each type of pavement will be discussed in the following sections.

### 4.2.1 Performance Prediction for Asphalt Concrete Pavement

Asphalt concrete pavement's performance is affected by climate and subgrade types. The state is divided into 4 zones based on climate and subgrade (Figure 1):

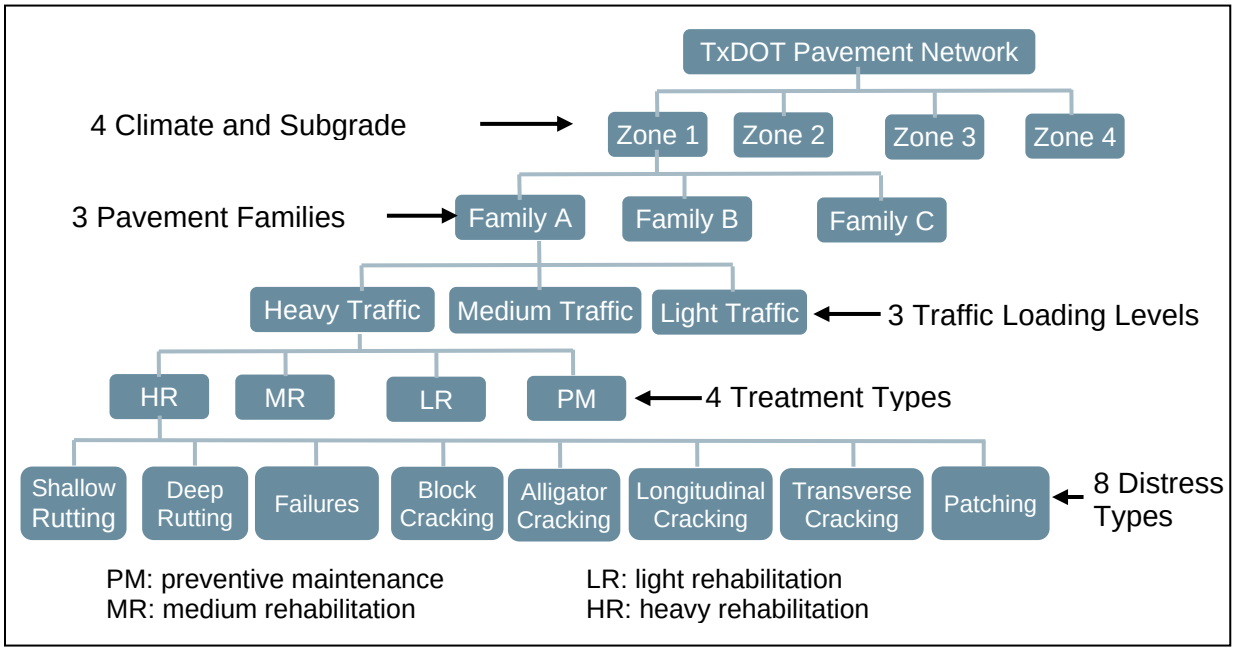
- **Zone 1:** wet-cold climate and poor, very poor, or mixed subgrade
- **Zone 2:** wet-warm climate and poor, very poor, or mixed subgrade
- **Zone 3:** dry-cold climate and good, very good, or mixed subgrade
- **Zone 4:** dry-warm climate and good, very good, or mixed subgrade

In each zone, pavements are divided into three families based on pavement material types:

- **Pavement Family A:** includes thick, Intermediate, and overlaid ACP
- **Pavement Family B:** includes composite and concrete pavement overlaid with ACP
- **Pavement Family C:** includes thin and thin-surfaced ACP

For each pavement family, pavements are further divided into three traffic levels: light traffic, medium traffic, and heavy traffic. Under each traffic level, there will be post-treatment performance models for preventive maintenance, light rehabilitation, medium rehabilitation, and heavy rehabilitation. Within each of these categories, the following post-treatment performance models are to be analyzed: shallow rutting, deep rutting, failures, block cracking, alligator cracking, longitudinal cracking, transverse cracking, patching, and ride score models.

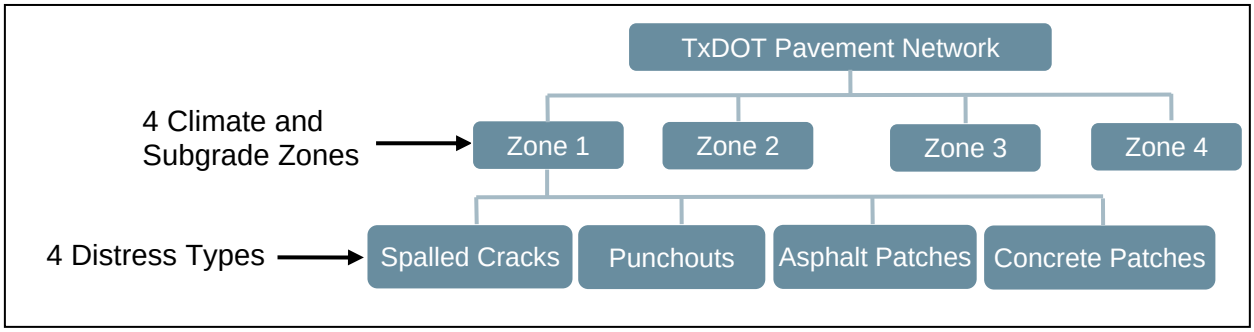
**Figure 1: Illustration of Groupings of ACP Performance Models (Source: TxDOT, 2012)**



### 4.2.2 Performance Prediction for Continuously Reinforced Concrete Pavement

Similarly, continuously reinforced concrete pavements follow the same zone classification as for ACP (Figure 2). CRCP has performance models for spalled cracks, punchouts, asphalt patches, concrete patches, and ride score.

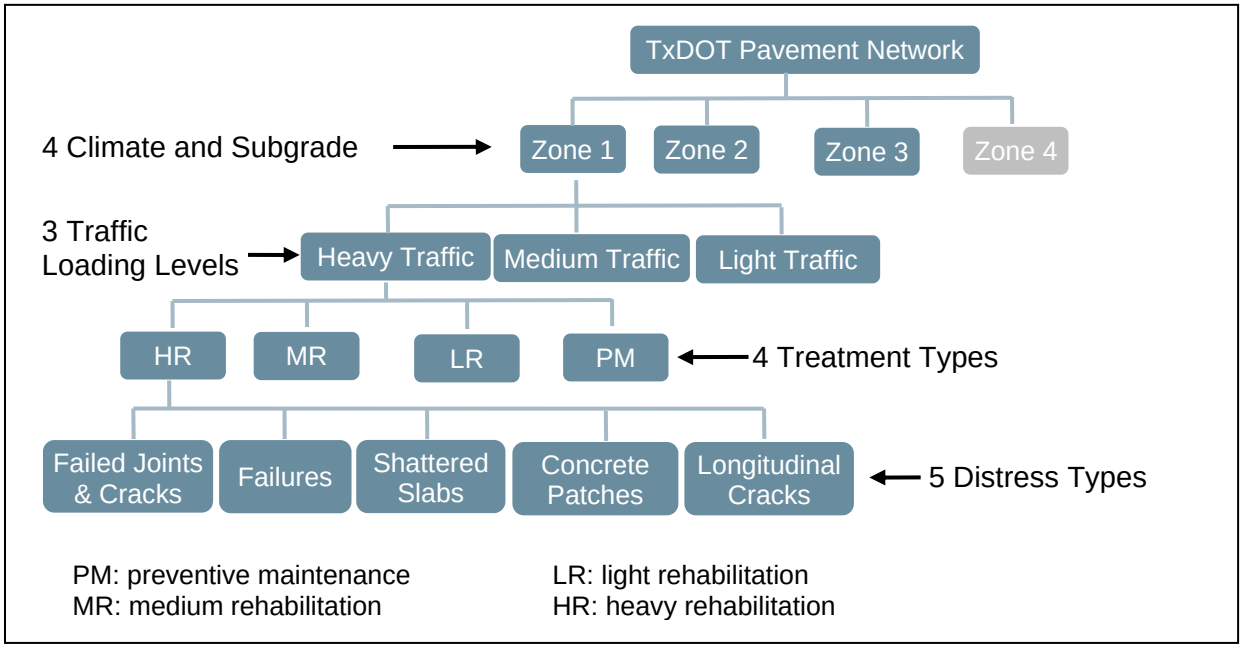
**Figure 2: Illustration of Groupings for CRCP Performance Models (Source: TxDOT, 2012)**




### 4.2.3 Performance Prediction for Jointed Concrete Pavement

The same classification of zones is used for jointed concrete pavements (JCP). The only difference is that currently there is no JCP in Zone 4 (TxDOT, 2012). Following the same traffic level classification and treatment categories as those for ACP, post-treatment performance models were developed for each treatment category at each traffic level and in each zone. These post-treatment performance models include failed joints and cracks, failures, shattered slabs, concrete patches, longitudinal cracks, and ride score models.

**Figure 3: Illustration of Groupings for JCP Performance Models (Source: TxDOT, 2012)**



For detailed performance models of these three types of pavement, please refer to the report: *FHWA/TX-12/0-6386-3 Evaluation and Development of Pavement Scores, Performance Models and Needs Estimates*.

## 4.3 Identifying Investments

The performance models discussed in Section 4.2 will be used to predict pavement conditions. Based on the predicted conditions, decision trees in TxDOT PMIS can be applied to identify pavement treatments.

### 4.3.1 Asphalt Concrete Pavement Decision Tree

ACP treatments are identified based on ride quality and pavement distresses, including failures, alligator cracking, block cracking, longitudinal cracking, transverse cracking, patching, deep rutting, and shallow rutting. Tables 1–3 present treatments based on each distress for different traffic levels. In the tables, treatments are identified based on one distress or ride quality range. Therefore, a section may have several different distresses, but the trigger will be based on the distress that generates the highest needs estimate suggestion.

**Table 1: Needs Estimate Trigger Criteria for ADT from 0 to 99**

| Distress | Needs Estimate Suggestion | | | | |
|---|---|---|---|---|---|
| | NN | PM | LR | MR | HR |
| Ride Score | - | - | - | - | - |
| Failures | 0 | 1 to 2 | 3 to 4 | 5 to 7 | 8 or more |
| Alligator Cracking | 0% to 2% | 3% to 24% | 25% to 49% | 50% to 79% | ≥80% |
| Block Cracking | 0% to 7% | 8% to 15% | 16% to 23% | 24% to 29% | ≥30% |
| Longitudinal Cracking | 0' to 50' | 51' to 125' | 126' to 175' | ≥176' | NA |
| Transverse Cracking | 0 to 4 | 5 to 6 | 7 to 8 | ≥9 | NA |
| Patching | 0% to 7% | 8% to 41% | 42% to 54% | 55% to 84% | ≥85% |
| Deep Rutting | 0% to 6% | 7% to 8% | 9% to 10% | 11% to 12% | ≥13% |
| Shallow Rutting | 0% to 7% | 8% to 11% | 12% to 15% | ≥16% | NA |

Notes:
HR: heavy rehabilitation
LR: light rehabilitation
MR: medium rehabilitation
NN: need nothing
PM: preventive maintenance

**Table 2: Needs Estimate Trigger Criteria for ADT from 100 to 999**

| Distress | Needs Estimate Suggestion | | | | |
|---|---|---|---|---|---|
| | NN | PM | LR | MR | HR |
| Ride Score | - | - | - | - | 0.1 to 1.5 |
| Failures | 0 | 1 | 2 | 3 | 4 or more |
| Alligator Cracking | 0% to 2% | 3% to 19% | 20% to 44% | 45% to 59% | ≥60% |
| Block Cracking | 0% to 7% | 8% to 15% | 16% to 23% | 24% to 29% | ≥30% |
| Longitudinal Cracking | 0' to 50' | 51' to 100' | 101' to 150' | 151' to 200' | ≥201' |
| Transverse Cracking | 0 to 3 | 4 to 6 | 7 to 8 | ≥9 | NA |
| Patching | 0% to 7% | 8% to 31% | 32% to 44% | 45% to 74% | ≥75% |
| Deep Rutting | 0% to 6% | 7% to 8% | 9% to 10% | 11% to 12% | ≥13% |
| Shallow Rutting | 0% to 7% | 8% to 11% | 12% to 15% | 16% to 18% | ≥19% |

Notes:
HR: heavy rehabilitation
LR: light rehabilitation
MR: medium rehabilitation
NN: need nothing
PM: preventive maintenance

**Table 3: Needs Estimate Trigger Criteria for ADT from 1000 to 4999**

| Distress | Needs Estimate Suggestion | | | | |
|---|---|---|---|---|---|
| | NN | PM | LR | MR | HR |
| Ride Score | - | - | - | - | 0.1 to 1.5 |
| Failures | 0 | 1 | 2 | 3 | 4 or more |
| Alligator Cracking | 0% to 2% | 3% to 14% | 15% to 39% | 40% to 54% | ≥55% |
| Block Cracking | 0% to 7% | 8% to 15% | 16% to 19% | 20% to 27% | ≥28% |
| Longitudinal Cracking | 0' to 25' | 25' to 100' | 101' to 150' | 151' to 200' | ≥201' |
| Transverse Cracking | 0 to 2 | 3 to 6 | 7 | 8 | ≥9 |
| Patching | 0% to 3% | 3% to 21% | 22% to 34% | 35% to 64% | ≥65% |
| Deep Rutting | 0% to 4% | 5% to 8% | 9% to 10% | 11% to 12% | ≥13% |
| Shallow Rutting | 0% to 4% | 5% to 9% | 10% to 13% | 14% to 18% | ≥19% |

Notes:
HR: heavy rehabilitation
LR: light rehabilitation
MR: medium rehabilitation
NN: need nothing
PM: preventive maintenance

**Table 4: Needs Estimate Trigger Criteria for ADT Greater than or Equal to 5000**

| Distress | Needs Estimate Suggestion | | | | |
|---|---|---|---|---|---|
| | NN | PM | LR | MR | HR |
| Ride Score | - | - | - | - | 0.1 to 2.0 |
| Failures | 0 | 1 | 2 | 3 | 4 or more |
| Alligator Cracking | 0% to 2% | 3% to 9% | 10% to 34% | 35% to 49% | ≥50% |
| Block Cracking | 0% to 3% | 4% to 11% | 12% to 19% | 20% to 27% | ≥28% |
| Longitudinal Cracking | 0' to 24' | 25' to 100' | 101' to 150' | 151' to 175' | ≥176' |
| Transverse Cracking | 0 to 2 | 3 to 4 | 5 to 6 | 7 to 8 | ≥9 |
| Patching | 0% to 2% | 3% to 11% | 12% to 24% | 25% to 54% | ≥55% |
| Deep Rutting | 0% to 4% | 5% to 7% | 8% to 9% | 10% to 11% | ≥12% |
| Shallow Rutting | 0% to 4% | 5% to 9% | 10% to 13% | 14% to 18% | ≥19% |

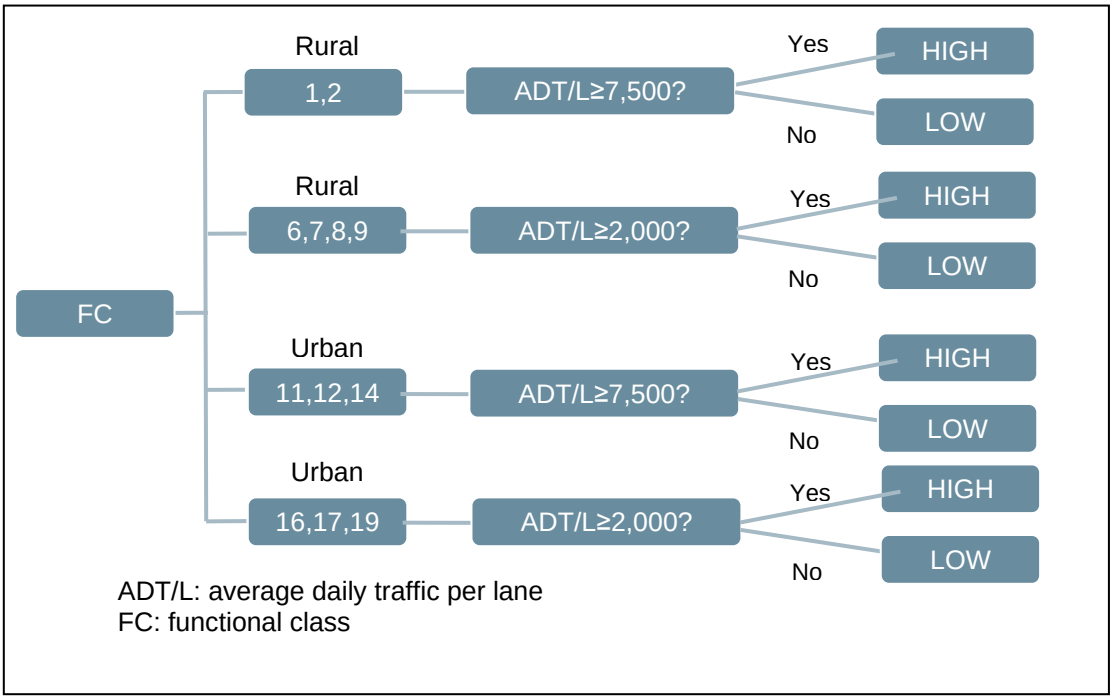
Notes:
HR: heavy rehabilitation
LR: light rehabilitation
MR: medium rehabilitation
NN: need nothing
PM: preventive maintenance

Performance models for ACP in Section 4.2.1 are used to predict pavement conditions during the planning horizon. Then, based on pavement conditions, life-cycle cost analysis and decision tree are applied to find the most cost-effective set of treatments and timings for each pavement section during the planning horizon to maintain the pavement in good condition while minimizing the life-cycle cost.

### 4.3.2 Continuously Reinforced Concrete Pavement

CRPC's decision tree has two parts: the Functional Classification and the ADT level classified as High or Low (Figure 4).

**Figure 4: Functional Classification ADT High/Low Decision Tree (TxDOT, 2012)**



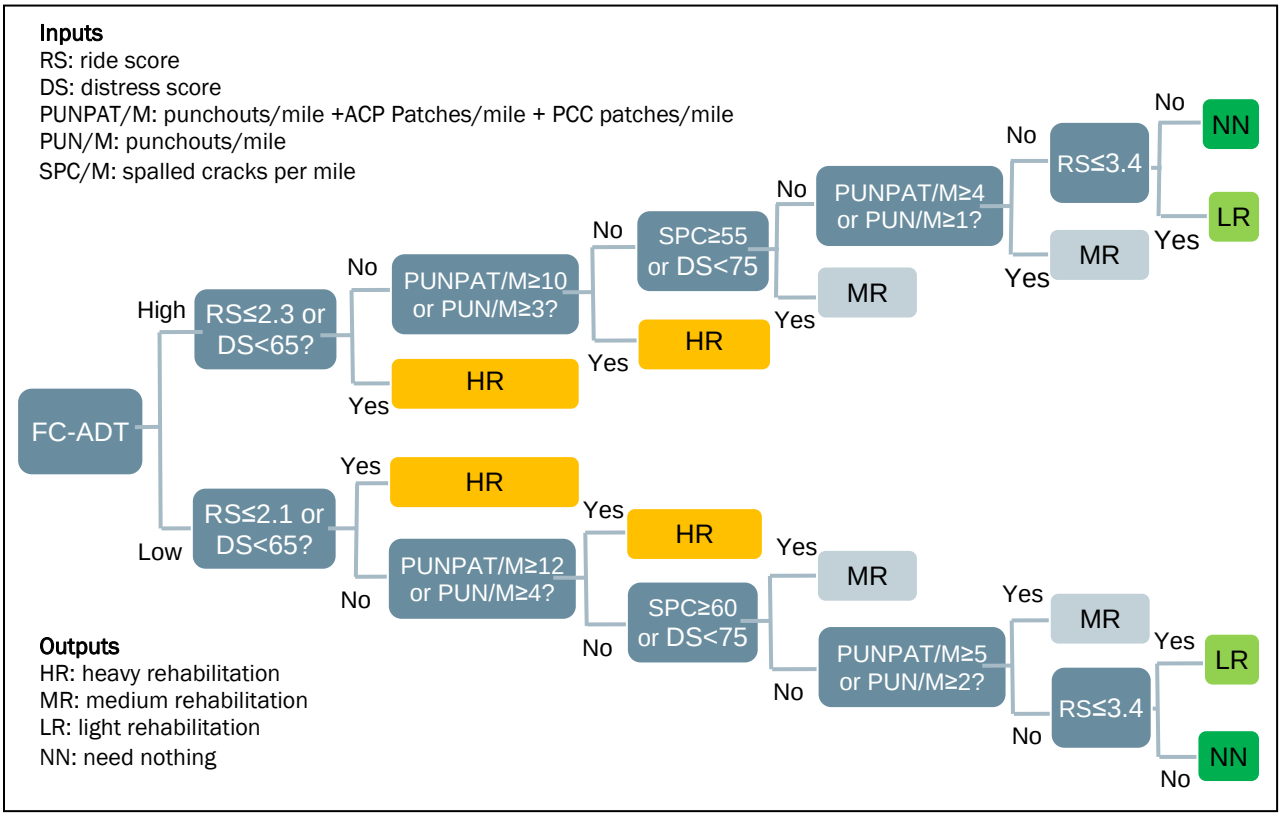

**Notes:**

Functional Classes:

| Rural: | Urban: |
|---|---|
| 1 = Interstate | 11 = Principal Arterial (Interstate) |
| 2 = Principal Arterial | 12 = Principal Arterial (Other Freeway) |
| 6 = Minor Arterial | 14 = Principal Arterial (Other) |
| 7 = Major Collector | 16 = Minor Arterial |
| 8 = Minor Collector | 17 = Collector |
| 9 = Local | 19 = Local |

For treatment identification, there are four levels of treatments: Need Nothing (NN), Light Rehabilitation (LR), Medium Rehabilitation (MR), and Heavy Rehabilitation (HR). Based on the condition and traffic levels, treatments can be identified using the decision tree displayed in Figure 5.

**Figure 5: Pavement Needs Estimation Tree (Source: TxDOT, 2012)**

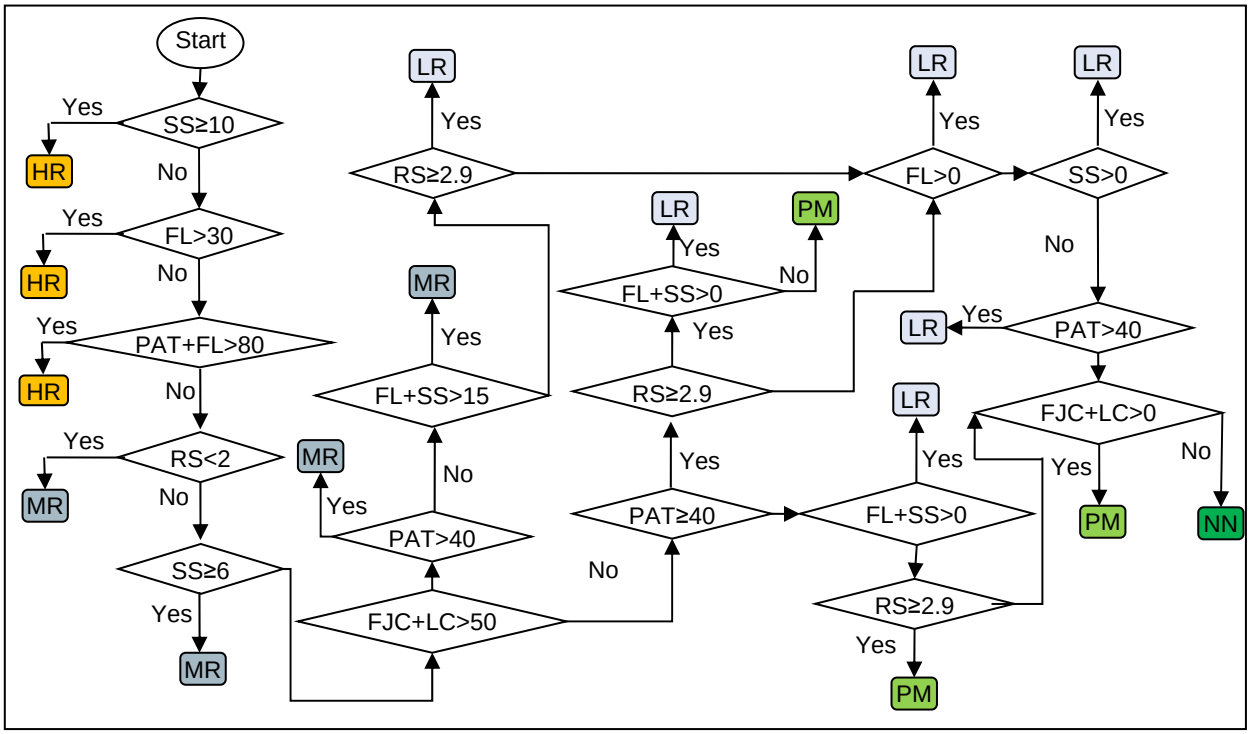



Performance models in Section 4.2.2 are used to predict pavement conditions during the planning horizon. Based on the pavement conditions, using life-cycle cost analysis and the decision tree presented in Figure 5, the set of treatments and timings for each pavement section during the planning horizon can be identified.

### 4.3.3 Joint Concrete Pavement

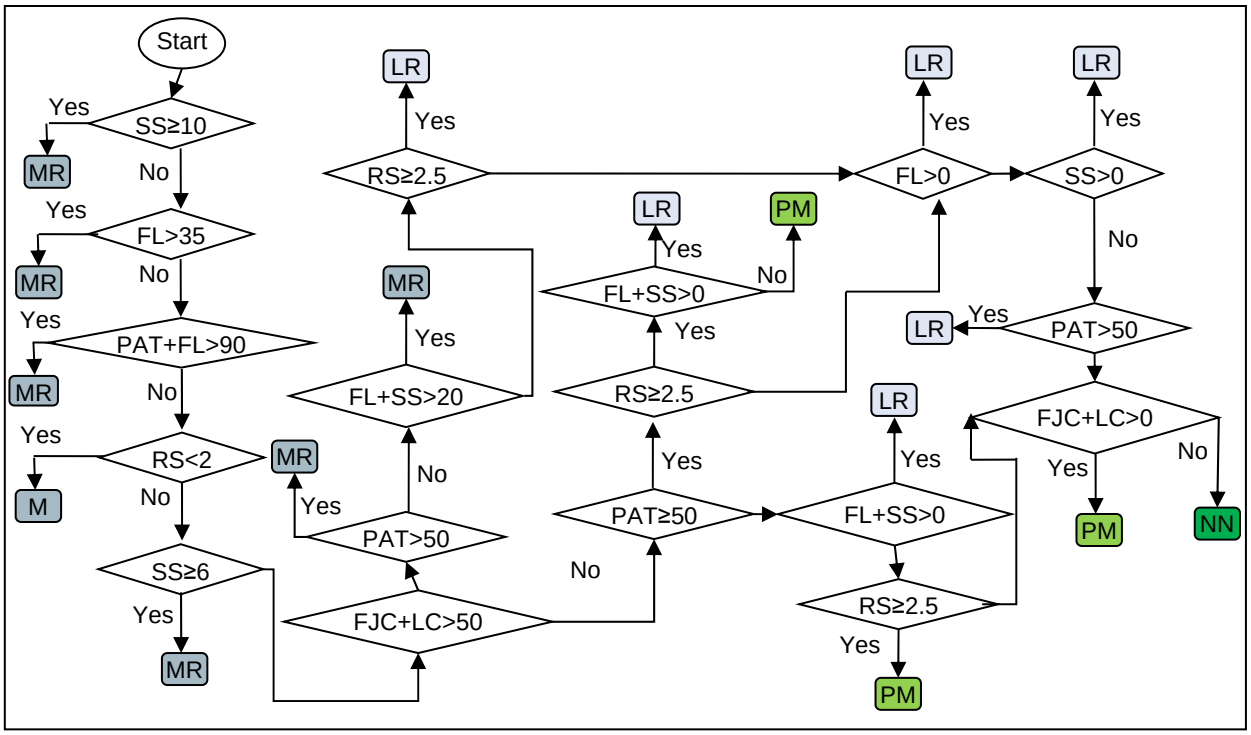
Similarly, a decision tree is used to identify treatments for each JCP section based on traffic levels and pavement conditions. Figures 6 and 7 present the decision trees for high traffic JCP and low traffic JCP, respectively. The determination of traffic levels are presented in Table 5.

**Figure 6: High Traffic JCP Decision Tree for JCP (Source: TxDOT, 2012)**




Notes:
FJC: failed joints & cracks, %failed
FL: failures, number/mile
PAT: concrete patches, number/mile
RS: ride score
SS: shattered slabs, % slabs

**Figure 7: Low Traffic JCP Decision Tree for JCP (Source: TxDOT, 2012)**




Notes:
FJC: failed joints & cracks, %failed
FL: failures, number/mile
PAT: concrete patches, number/mile
RS: ride score
SS: shattered slabs, % slabs

**Table 5: Decision Tree for Traffic Levels (Source: TxDOT, 2012)**

| Functional Class | | Traffic Level | |
|---|---|---|---|
| Area | Functional Class Code | High | Low |
| Rural | 1,2 | ADT/L >=7,500 | ADT/L < 7,500 |
| | 6 | ADT/L >=3,000 | ADT/L < 3,000 |
| | 7,8,9 | ADT/L >=2,000 | ADT/L < 2,000 |
| Urban | 11,12,14 | ADT/L >=7,500 | ADT/L < 7,500 |
| | 16 | ADT/L >=3,000 | ADT/L < 3,000 |
| | 17,19 | ADT/L >=2,000 | ADT/L < 2,000 |

Note:
ADT/L: average daily traffic per lane

Performance models for JCP in Section 4.2.3 are used to predict pavement conditions (i.e., distresses and ride score) during the planning horizon. Then, based on pavement conditions, life-cycle cost analysis and decision tree are applied to find the most cost-effective set of treatments and timings for each pavement section during the planning horizon to maintain the pavement in good condition while minimizing the life-cycle cost.

## *4.4 Evaluating Alternatives*

Pavement needs assessment can be conducted both at the project- and network-levels. At the project level, decision trees are used to identify treatments for each pavement section based on predicted pavement condition. However, during the planning horizon, there could be several possible combinations of treatments and timings. Life-cycle cost analysis is applied to identify the optimal set of treatments and corresponding timings that can minimize the life-cycle cost of the pavements while maintaining the pavement sections in good condition. The sum of all the pavement section needs represent the unconstrained pavement needs for the entire network.

At the network-level, when the predicted revenue is not enough to cover all the unconstrained needs, financially-constrained analysis may need to be conducted. In this process, a large number of investment alternatives are available. The prioritization/optimization techniques are adopted to identify the alternative that can optimize the pavement performance using the limited budget. Due to the uncertainty of future funding levels, scenarios for a range of budgets will be analyzed in order to compare potential tradeoffs.

## *4.5 Assessing "Needs" and Financial Constraints*

Unconstrained needs refer to the pavement treatments required to avoid having pavement sections in a poor state-of-repair during the planning horizon. Through a bottom-up approach, the cost of treatments recommended over the planning horizon will be combined to assess network needs.

Financially-constrained analysis represents the best performance outcome that can be achieved with funding less than the unconstrained needs total. As part of this process, the Consultant Team will consider expected pavement performance outcomes for a range of budgets given findings from the revenue forecasting task team and potential allocation strategies. For each scenario, the projects will be identified to maximize system performance given an overall budget [which can be broken down by National Highway System (NHS) and Non-NHS].

Best practices for financially-constrained analysis is to apply prioritization/ optimization principles. This is done by scoring projects based on a set of performance measures; for example, metrics could be the Pavement Condition Score (PCS) and IRI. For each candidate project, a generalized utility is used to measure the benefit of its implementation on a normalized scale. The utility is calculated as:

*Total Utility = $w_1$ * [(condition score after the project implementation) - (condition score before the project implementation)-)] * AADT * lane-miles + $w_2$ * [(normalized IRI after the project implementation) - (normalized IRI before the project implementation)-)] * AADT * lane-miles*

Since Pavement Condition Score and IRI have difference scales (Condition Score: 1-100; IRI: 1-950), IRI is normalized to 1 to 100 in the above equation where 100 represents the lowest IRI and 1 represents the highest IRI. $w_1$ and $w_2$ are weights of Pavement Condition Score and IRI, respectively. Since the Pavement Condition Score is the main performance measure currently used by TxDOT and already incorporates pavement ride quality, $w_1$=0.8 and $w_2$=0.2 are suggested in the above equation. In addition, the above equation incorporates annual average daily traffic (AADT) to make sure the pavement sections with higher traffic volumes have higher priority for programming. Based on the utility for each project, the benefit/cost ratio can be calculated as:

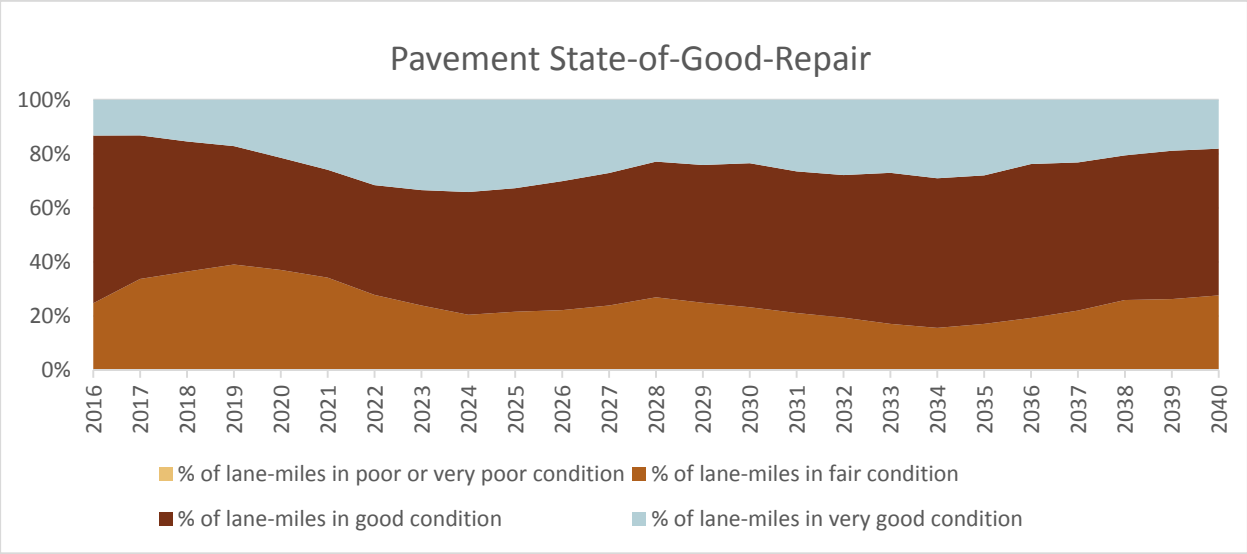
*Benefit/Cost Ratio = Total Utility / Project Cost*

The benefit/cost ratio can be used to prioritize candidate projects to provide a general overview of the importance of each project. Then, optimization techniques, i.e., integer programming, will be used to select projects that maximize the total utility of all projects under available budget. In the optimization, performance target can be set to make sure the target can be met. In addition, to avoid very poor or very rough pavements, the pavements with very poor or very rough condition will have a higher programming priority.

For both unconstrained and financially-constrained needs, the following outputs will be provided:

- Pavement treatments, timings, and costs for each pavement section over the planning horizon
- Total investment needs/costs in dollars by function class, by pavement type, by district, and by county
- Pavement State-of-Good-Repair (Figure 8) based on Pavement Condition Score and IRI over the planning horizon by function class, by pavement type, by district, and by county.

**Figure 8: Illustration of Pavement State-of-Good-Repair over Planning Horizon**



# Texas Transportation Plan

## Tech Memo 3.2: Bridge/Culvert

January 15, 2014

## Acknowledgements

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- Figure 9: Example Linkage Between System Performance and Investment Level

# 1.0 Introduction

An understanding of future system needs is critical for effective transportation planning. Using data-driven techniques to predict future highway/bridge performance, potential peaks in preservation expenditures can be anticipated and communicated to stakeholders in time to solicit essential revenue sources. In supporting the long-range Texas Transportation Plan (TTP), this technical memo describes best practices (also consistent with MAP-21) for analyzing financially-unconstrained needs and assessing financially-constrained scenarios for state-controlled bridges and NBI-length culverts including structures on the National Highway System (NHS), Texas trunk system, and Interstate system. This work will be conducted in Task for of the TTP.

The memo is organized into four sections:

1. Scope of Bridge Analysis
    a. Types of Investment
    b. Reviewed TxDOT Structural Publications
2. Data Collection
    a. Data Availability and Sources
    b. Gaps in Data and Recommendations
3. Needs Determination
    a. Defining "Need"
    b. Predicting Performance
    c. Identifying Investments
    d. Evaluating Alternatives
    e. Assessing "Needs"
4. Financially-Constrained Scenarios
    a. Project Prioritization
    b. Optimizing Performance

# 2.0 Scope of Analysis

The following subsections provide a summary of the types of financial need, or investment, considered in the analysis and the scope of services included for consideration in the TTP.

## *2.1 Types of Investment*

Bridge/culvert investments in existing infrastructure can most generally be classified as maintenance and repair, painting, rehabilitation, improvement, structure replacement, emergency, and other (Table 1).

**Table 1: Pontis Work Item Groupings**

| Action Group | Work Items |
|---|---|
| Maintenance and Repair | Routine/preventive maintenance, minor element repair, major element repair |
| Painting | Zone/partial paint, replace paint system |
| Rehabilitation | Element rehabilitation, overlay deck/slab, replace element, replace superstructure |
| Improvement | Widen structure, raise structure, strengthen structure, scour remediation, fatigue remediation, seismic retrofit |
| Structure Replacement | Remove structure, replace structure |
| Emergency | Temporary cribbing |
| Other | Various |

The decision of when to apply these investments can be based on a combination of asset age and performance. Texas preservation policy is to cyclically apply routine/preventive maintenance, conduct reactive maintenance upon emergency, and to plan for rehabilitation, improvement, and replacement activities based on asset performance.

## *2.2 Reviewed TxDOT Structural Publications*

Bridge/culvert information management at the TxDOT is conducted by the Bridge Division. This division supports the planning, design, review, construction, and inspection of over 50,000 structures – about 89 percent more than any other state.

As part of agency efforts, various publications are readily available for consultants/contractors. The following documentation was obtained/reviewed by the CH2M HILL-led team prior to developing the proposed unconstrained needs methodology (txdot.gov):

- Annual Bridge Facts (2008 through 2012)
- Annual Bridge Unit Costs (2009 through 2011)
- Construction and Maintenance
  - Asbestos Management on TxDOT Bridge Projects, Bridge Division Workshop: Bridge Deck Workshop, Bridge Division Workshop: Drilled Shaft Inspectors Workshop, Guidelines for Handling Asbestos, Header Type Bridge Joints, Precast Concrete Stay-in-Place Forms for Bridge Decks, Saw-Cutting Grooves on Bridge Decks, Shop Plan Contacts, Underwater Drilled Shaft Construction – Geotech, Welding Certifications
- Design
  - Design Example for Two Drilled Shaft Footing Using Strut-and-Tie Method, Design Example for Elastomeric Bearings for Prestressed Concrete Beams, Design Software Programs, Detailing Guide, Pile Type Selection – Geotech, Prestressed Concrete I-Beams Distribution Factor Spreadsheet, Prestressed Concrete U-Beams Distribution Factor Spreadsheet, Quality Assurance/Quality Control Guide, Recommended Beam Spacings, Recommended Span Lengths for Double-T Beams, Recommended Span Lengths for I-Girders, Recommended Span Lengths for Slab Beams, Recommended Span Lengths for Load and Resistance Factor Design (LRFD), Box Beams, Rectangular Reinforced Concrete Caps, Shear Design Spreadsheets, Steel Bridge Design Preferred Practices
- Geotechnical Resources
  - Approved Concrete Block Retaining Wall Systems, Approved Mechanically Stabilized Earth (MSE) Panel Systems, Drilled Shaft Design Examples, Loss of Backfill in Mechanically Stabilized Earth, MSE Wall Design Example, Piling Design Examples, Proprietary Retaining Wall System Review, Spread-Footing Wall Design Example, Tied-Back Wall Design Examples, Texas Secondary Evaluation and Analysis for Scour (TSEAS)

- Inspection
  - Critical Inspection Finding Report, Coding Guide
- Biannual Report on Texas Bridges (2002 through 2012)
- Substructure/Superstructure Design Examples and Spreadsheets
- Texas Bridge Underclearance
- Bridge Geometry System (BGS) User's Guide, Version 9 (Draft)

Additionally, the Consultant Team reviewed the 2013 Unified Transportation Program (UTP), 2035 Statewide Long-Range Transportation Plan (SLRTP), 2030 Committee Report – *It's About Time: Investing in Transportation to Keep Texas Economically Competitive*, Bridge Inspection Manual, Bridge Performance Measure Determination file, Bridge Project Development Manual, the 2011 Texas Transportation Institute Study – Framework for a Comprehensive Bridge Management and Information Systems (BMIS), and various Metropolitan Transportation Plans (MTPs).

# 3.0 Data Collection

## *3.1 Data Availability and Sources*

Given the size and complexity of information collected on Texas structures, a series of subsystems make up the Texas Bridge Management Information System (Figure 1):

- Design and Construction Information System
- Maintenance Management Information System
- Bridge Inventory, Inspection, and Appraisal System
- PonTex
- Pontis
- Financial Information Management System
- Texas Permit Routing Optimization System

Using these systems, TxDOT maintains histories of maintenance activities, bridge component (deck, superstructure, substructure) and element (AASHTO Core Elements) conditions, cost data, and geographic locators. Due to technical difficulties in obtaining access to core element data, the focus of the analysis team has been to compile component bridge inspection ratings.

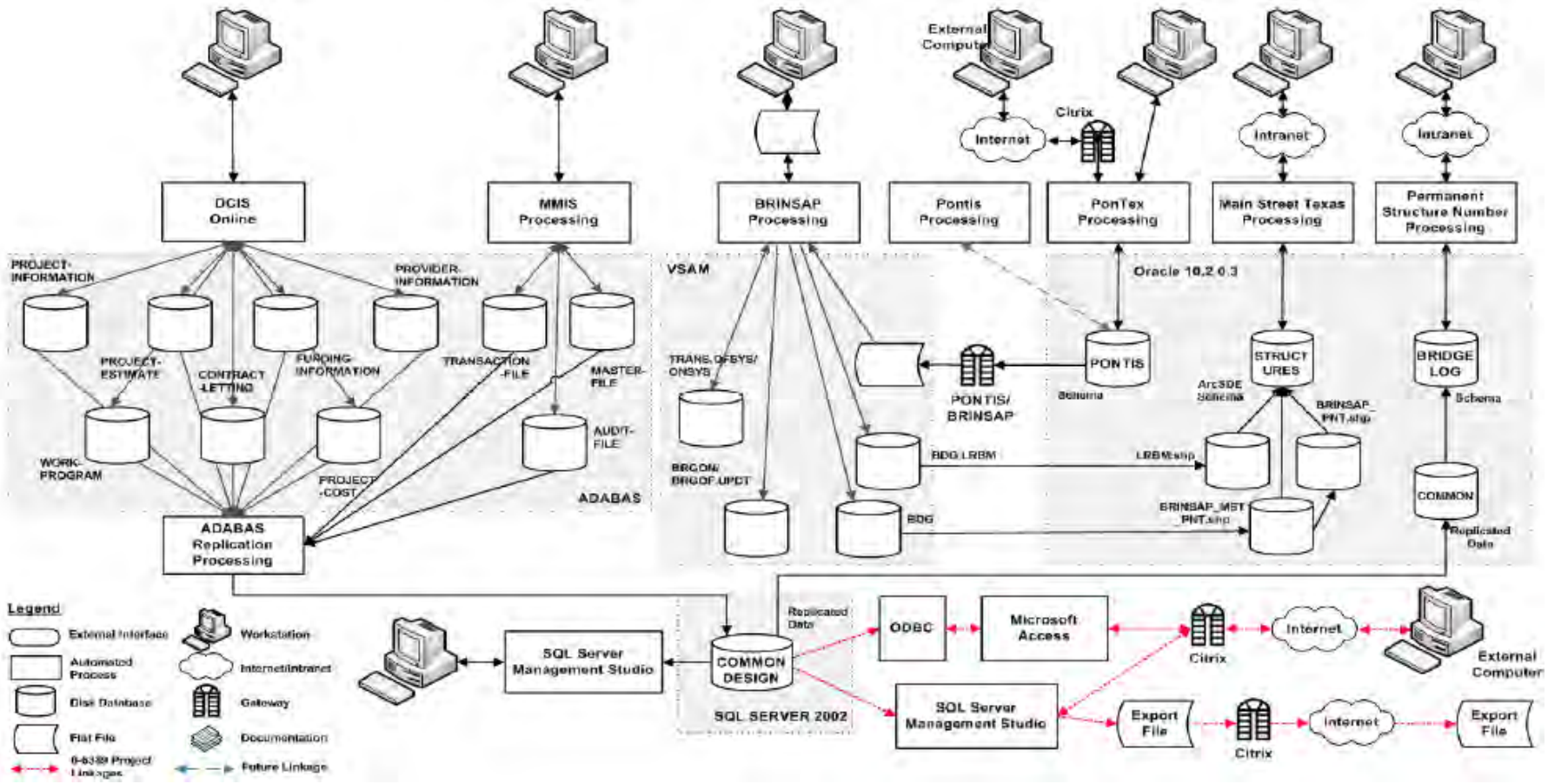
Component ratings for bridges and culverts greater than 20 feet in length are stored both in the Texas BMIS and are reported annually (with a slight reduction in data fields) in the National Bridge Inventory (NBI). The CH2M HILL-led team has put in a data request to obtain recent and historical bridge inspection and cost data but in the meantime have compiled historical bridge data between 1992 and 2012 for Texas from the NBI.

As part of NBI reporting, the following structural condition ratings are available for analysis:

- Condition ratings for the deck, superstructure, substructure, scour, and channel/channel protection
- Additional ratings for deck geometry, structural evaluation, inventory, and sufficiency
- Structurally deficient and functionally obsolete status.

In addition to preservation data, operational data on traffic volumes have been obtained from the T-Log and RHiNO systems to support widening/expansion decisions. Aggregated average maintenance/repair cost values have also been obtained from the TxDOT annual Bridge Unit Cost publication series.

**Figure 1: Bridge-Related Systems at TxDOT**




(Quiroga, Weissmann, Koncz, Le, Li, & Wimsatt, 2011)

## 3.2 Gaps in Data and Recommendations

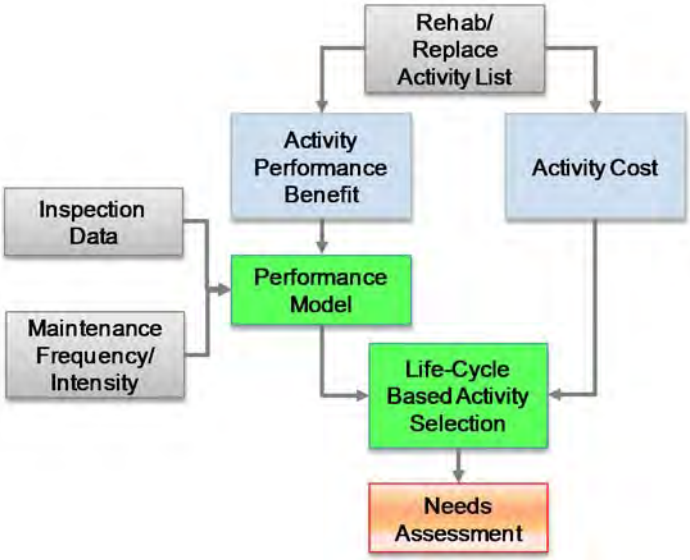
As the analysis team waits for the bridge data request to be fulfilled by TxDOT, anticipated gaps in information include:

- **Access to Core Element Data** – This data is not necessary to assess planning level needs, but would support a more precise needs assessment total, particularly for validating short-term project selections.
- **Additional Cost Data** – The bridge unit costs obtained from TxDOT publications are highly aggregated and does not provide a breakdown by work item or major repair/replacement activity. Should the Financial Information Management System have additional details, a more accurate needs number may be reached through the Coonsultant Team's analysis.
- **Historical Repairs** – In order to estimate the effectiveness of major repairs and maintenance strategies, historical records can be used to supplement assumptions made in the following section. With sufficient repair records, deterioration models could be more accurately calibrated for bridges with varying maintenance strategies.

# 4.0 Needs Determination

To make sense of varying TxDOT information sources, the Texas Transportation Institute (TTI) – in a 2011 study funded by the Federal Highway Administration (FHWA) and TxDOT – has recommended a comprehensive framework based on the principles proposed in National Cooperative Highway Research Program (NCHRP) Report 590. A similar methodology is proposed herein via the framework in Figure 2. This process serves as the basis of CH2M HILL's Transportation Asset Management (TAM) Tools, which are proposed to be used to automate the needs assessment.

**Figure 2: Proposed Unconstrained Needs Assessment Methodology**



By defining what performance is "needed", a data-driven approach that predicts performance for varying maintenance intensities, economically evaluates repair/replacement activities, and aggregates cost-effective projects across the network can be used to assess long-term unconstrained needs. The following subsections provide a high-level summary of the methods proposed to estimate system needs for the TTP.

## *4.1 Defining "Needs"*

The unconstrained needs for bridges and culverts (greater than 20 feet in length) is defined as the anticipated amount of dollars required to avoid having structurally deficient structures (a MAP-21 performance measure for the NHS) on state-controlled structures. In addition to these needs, considerations for reducing functionally obsolete and sub-standard for load structures will be determined at the time of repair/replacement activities. In Texas, the state-of-good-repair (SGR) is then defined as having a system of bridges/culverts that are not:

Structurally Deficient = either having a deck/superstructure/substructure/culvert condition rating of 4 or less or a structural evaluation/waterway adequacy rating less than 2

Functionally Obsolete = either having a structural evaluation/waterway adequacy/deck geometry/underclearances/approach roadway alignment of 3 or less

Sub-standard for load = designed load carrying capacity less than state legal load.

To help track bridge performance, the MAP-21 consistent measures in Table 2 have been identified by TxDOT for monitoring performance on the NHS (Interstate and non-Interstate). These measures indicate thresholds for when maintenance activities of varying intensity are called for, which are then added to repair/replacement system needs.

**Table 2: TxDOT Bridge Performance Measures and Descriptions**

| Measure(s) | Description |
|---|---|
| Percent Structurally Deficient Deck Area on NHS and non-NHS | Percent of system deck area that have structures deemed Structurally Deficient |
| Count of Bridges and Percent Deck Area with Cyclic Maintenance Needs | Number of structures and deck area of structures with a deck/superstructure/substructure/or culvert rating of 7 or higher |
| Count of Bridges and Percent Deck Area with Preventative Maintenance Needs | Number of structures and deck area of structures with a deck/superstructure/substructure/or culvert rating of 5 or 6 |
| Count of Bridges and Percent Deck Area with Rehabilitation or Replacement Needs | Number of structures and deck area of structures with a deck/superstructure/substructure/or culvert rating of 4 or less |

From provided file "TxDOT Bridge Performance Measure Determination"

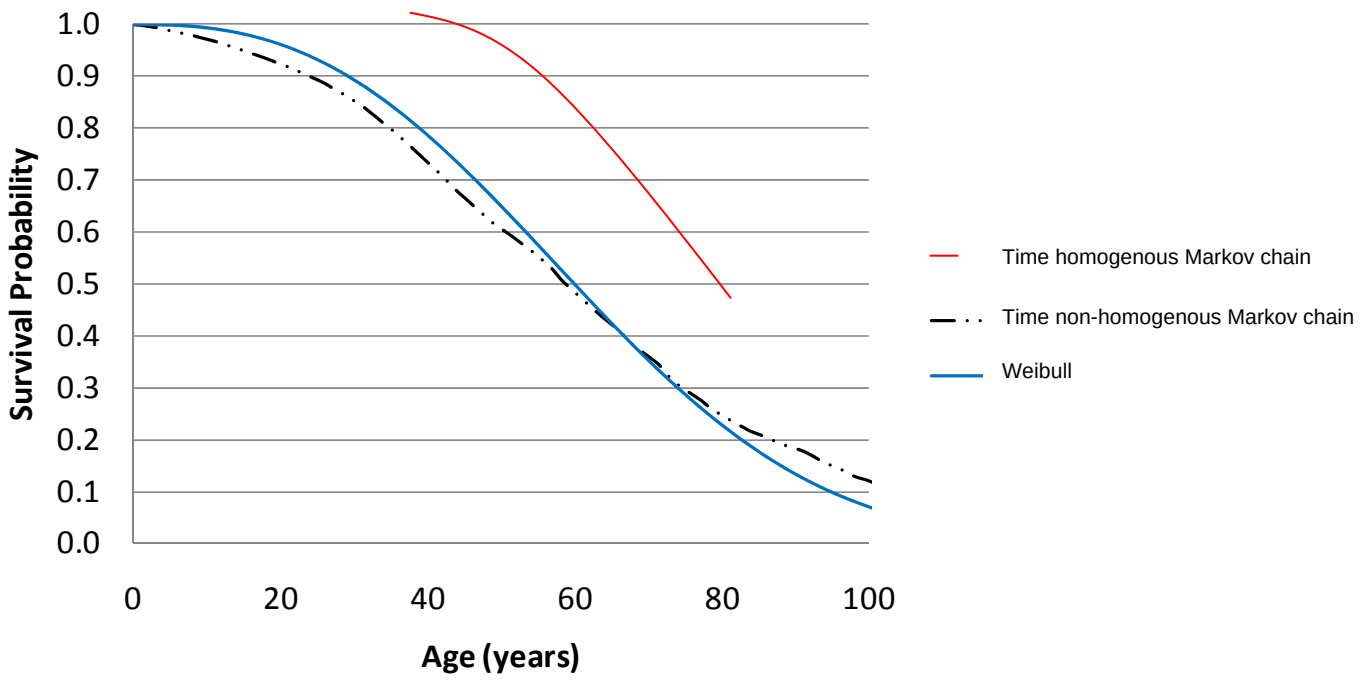
## 4.2 *Predicting Performance*

To aid long-term analysis, structural performance and traffic forecast models can be calibrated to predict future conditions.

### 4.2.1 Structural Performance Modeling

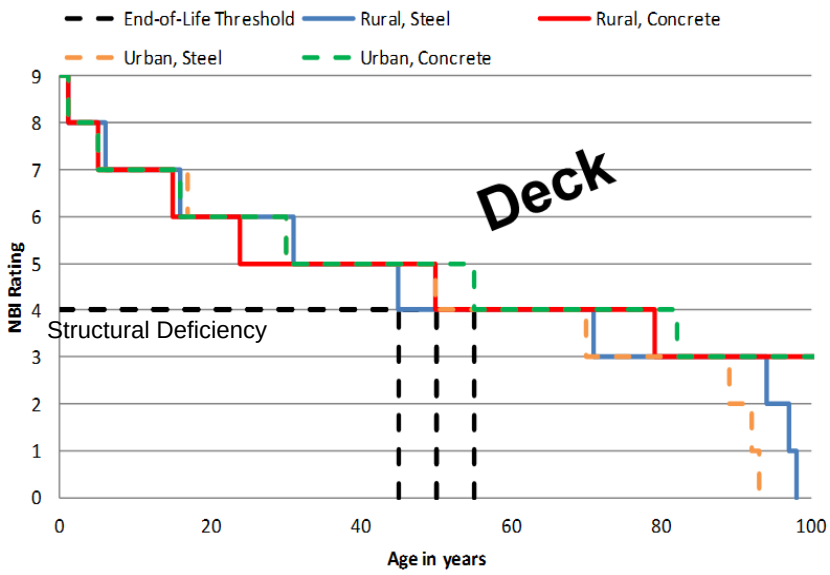
Consistent with TTI recommendations, Markovian analysis is a common technique for projecting bridge/culvert condition ratings. An advancement to the TTI approach, however, is the use of time-non-homogenous (deterioration rates allowed to vary with time) Markov chains; these models are representative of the Weibull functional form assumed in Pontis v5.2 (Figure 3).

**Figure 3: Comparison of Bridge Deterioration Models**




Markov chains are built by linking deterioration rates over time. These rates can be observed or regressed against explanatory variables based on historical inspections. Often referred to as transition probabilities, the deterioration rates represent the probability of transitioning from one condition state to the next given the age and initial condition rating of the asset. As these probabilities are multiplied over time, the likelihood of being in any condition state at any point in time can be approximated; the most likely condition rating at every point in time is used to build the average performance curve starting from the age and condition rating at the time of the most recent bridge inspection (Figure 4).

**Figure 4: Example Time Non-homogenous Markov Chains for Existing Bridge Decks**




| Group | Estimate |
|---|---|
| Rural, Steel | 45 yrs |
| Rural, Concrete | 50 yrs |
| Urban, Steel | 50 yrs |
| Urban, Concrete | 55 yrs |

The Concultant Team proposes to generate these average performance curves (scaled to expert opinion as necessary) for a variety of asset groupings based on the following:

- Existing/new construction status (if components built after 2010, then an assumed "life" of 100 years – far beyond the planning horizon of 2040 – is assumed until structural deficiency)
- Steel/concrete material type (predominant superstructure material for bridges)
- Urban/rural geographic setting
- Deck/super/sub/culvert component
- Non-NHS, NHS Non-Interstate, NHS Interstate functional classifications

Additional groupings of assets for modeling purpose are to be explored by the Consultant Team pending a sufficient number of historical observations.

### 4.2.2 Traffic Forecasts

Alongside structural condition ratings, traffic volumes are essential for evaluating the sufficiency of bridge/culvert assets. Estimates of average daily traffic volumes are used to estimate the deck geometry rating (traffic levels compared against bridge width) and structural evaluation rating (traffic levels compared against bridge inventory rating, in conjunction with component condition ratings).

As part of NBI reporting, recent and forecasted traffic volumes are included on each bridge asset. Additionally, traffic volumes are available in the TxDOT RHiNO file with forecasts in the T-Log. Further supplementing traffic volumes is the SAM-v3 model that can be used to estimate the grow traffic counts by adding the forecasted change in traffic volumes between an existing model run and future scenario model runs.

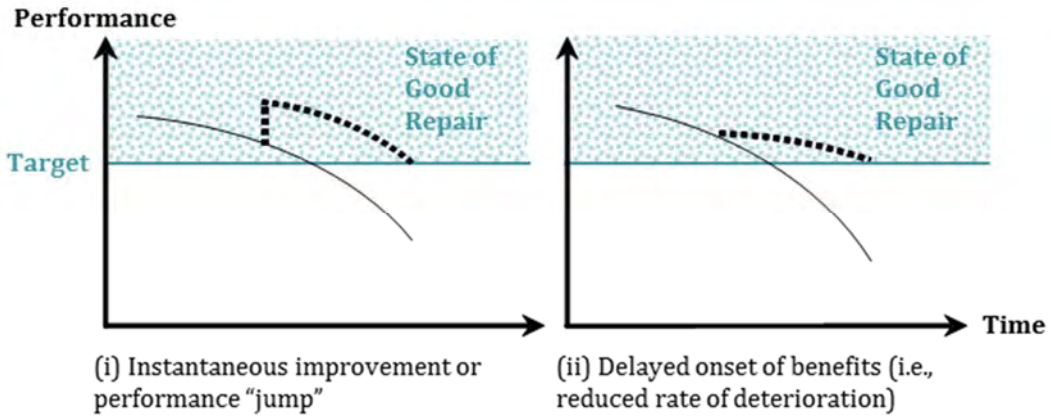
The Consultant Team will start by interpolating recent and forecasted traffic volumes in the NBI assuming exponential growth. These volumes will be validated against the remaining data sources and may be alternatively used, so as to determine if widening widening activities may be required for a bridge/culvert structure.

## *4.3 Identifying Investments*

In preserving bridge and culvert assets, a combination of cyclical maintenance activities and performance-based repair/replacement activities are to be evaluated by the analysis team. Cost and performance impact assumptions corresponding to each activity will be used to build the unconstrained needs.

Performance impacts resulting from an activity can result in an instantaneous improvement in performance and/or a reduced rate of deterioration (Figure 5). The Markovian models will be used to quantify the effectiveness of such activities.

**Figure 5: Activity Performance Benefits**




In the following sections, assumptions of programmable activity benefits and costs are detailed based on past project experience and expert judgment for making more applicable for Texas. Opportunities for updating benefit and cost assumptions will be pursued through contact with bridge/culvert leads within TxDOT.

### 4.3.1 Bridge Activities

With the desire to minimize expenditures across the life-cycle of bridge assets, a focus is placed on routinely applying preventive/minor corrective maintenance activities. Given the importance of including both routine and life-extending preservation, the activities in Table 3 are recommended to be included in determining TxDOT network needs. These more minor activities are expected to reduce the rate of bridge deterioration.

**Table 3: Bridge Maintenance Activities**

| Work Item | Proposed Frequency | Cost |
|---|---|---|
| Deck & Substructure Flushing/Washing | 1 year | Rural: $0.50/SF<br>Urban: $0.65/SF |
| Deck Surface Patching | 2 years | Rural: $0.25/SF<br>Urban: $0.30/SF |
| Deck Structural Repairs | 10 years | Rural: $6.50/SF<br>Urban: $8.00/SF |
| Barrier Repair | 10 years | Rural: $1.00/SF<br>Urban: $1.25/SF |
| Spot Joint Sealing/Repair | 15 years | Rural: $6.50/SF<br>Urban: $8.00/SF |
| Deck Thin Overlay – Epoxy/Asphalt* | 15 years | Rural: $9.50/SF<br>Urban: $12.00/SF |
| Spot Joint Replacement* | 15 years | Rural: $6.50/SF<br>Urban: $8.00/SF |
| Spot Bearing Repair* | 15 years | Rural: $3.75/SF<br>Urban: $4.75/SF |
| Spot Bearing Replacement* | 10 years | Rural: $9.00/SF<br>Urban: $11.00/SF |
| Spot Repaint Steel Beams * | 15 years | Rural: $9.50/SF<br>Urban: $12.00/SF |

Notes:
Cost data assumptions based on past project expereinece and expert opinon; cost data and assumptions will be updated with TxDOT feedback for Task 4 analysis

*As a result of the more intensive maintenance activities (cycles to start once a Deck condition rating of 6 is reached), a 5-year extension of time until the superstructure or substructure becomes structurally deficient is expected with an additional 15 years for the bridge deck.

**In the case of new construction, a more aggregated assumption is made given uncertainty in maintenance needs: Years 0 – 10: Rural – $0.40/SF; Urban – $0.50/SF; Years 11 – 25: Rural – $0.95/SF; Urban – $1.20/SF; Years 26+: Rural – $2.95/SF; Urban – $3.70/SF

For both a reduced rate of deterioration and an immediate jump in performance, a set of major repair/replacement activities are to be evaluated based on predicted condition ratings. These activities are to be evaluated in various combinations, each representing a package of multiple work items, described as follows:

- **Superstructure Rehabilitation** – This Activity is composed of work items Beam End Repair and Fracture Critical Member Repairs (intended to cover other miscellaneous repairs for non-fracture critical steel and concrete bridges).
- **Substructure Rehabilitation** – This Activity is composed of work items Bearing Repair, Bearing Replacement, and Substructure Repair.
- **Deck Structural Overlay** – This Activity is composed of work items Deck Structural Overlay and Joint Replacement (joint replacement @ 50%, assumed not all joints replaced).

- **Deck Replacement** – This Activity is composed of work items Deck Replacement, Barrier Replacement, and Joint Replacement.
- **Superstructure Replacement** – This Activity is considered a single work item.
- **Bridge Replacement** – This Activity is the complete replacement (deck, superstructure, and substructure) of the existing bridge in kind.

As a result of these activity packages, an immediate "jump" in performance is expected along with a reduced rate of deterioration. The performance benefits or jumps assumed for the analysis are listed in Table 4.

**Table 4: Bridge Repair/Replacement Activity Benefits**

| Activity | Benefit (Improvement in NBI condition rating) |
|---|---|
| Superstructure Rehabilitation | Super: + 1 |
| Substructure Rehabilitation | Sub: + 2 |
| Superstructure and Substructure Rehabilitations | Super: + 1; Sub: + 2 |
| Deck Structural Overlay | Deck: + 2 |
| Superstructure Rehabilitation & Deck Structural Overlay | Deck: + 2; Super: + 1 |
| Substructure Rehabilitation & Deck Structural Overlay | Deck: + 2; Sub: + 2 |
| Superstructure and Substructure Rehabilitations & Deck Structural Overlay | Deck: + 2; Super: + 1; Sub: + 2 |
| Deck Replacement & Superstructure and Substructure Rehabilitations | Deck: + 9; Super: + 1; Sub: + 2 |
| Superstructure Replacement and Substructure Rehabilitation | Deck: + 9; Super: + 9; Sub: + 2 |
| Bridge Replacement | Deck: + 9; Super: + 9; Sub: + 9 |

Notes:
Condition improvement assumptions based on past project experience and expert opinion; assumptions will be updated with TxDOT feedback for Task 4 analysis

*For steel structures, a full painting add-on option will be included as an alternative for activities involving a superstructure rehabilitation; generally it is assumed that a full painting will add 30 years until structural deficiency of the superstructure when combined with a rehabilitation.

**For posted structures deemed sub-standard for load, a one-time strengthening work item (+50% cost) will be added to the superstructure rehabilitation.

***For functionally obsolete structures due to an insufficient deck geometry rating (assumed rating of 4 or less), widening (+50% cost) is to be added on top of any replacement activity.

****For functionally obsolete structures due to an insufficient underclearance (assumed rating of 3 or less), raising (+20%) will be added to any rehabilitation/replacement activity.

The benefits of applying these more major repair/replacement activities are to be economically weighed against the corresponding cost estimate. Cost estimates and assumptions to be used in evaluating repair/replacement activities are listed in Table 5. These costs with built-in contingency dollars have been compiled based on past experience and are subject to validation with the TxDOT average unit cost report and any additional cost information available from TxDOT's Financial Information Management System. For specific activities, costs can be determined based on scope of work and structure size – so as to reflect economy-of-scale savings, which can be interpolated.

**Table 5: Bridge Repair/Replacement Activity Costs**

| Scope of Work Code | Construction Cost per SF of Smallest Structure | Construction Cost per SF of Largest Structure | Smallest Structure (in Thousand SF) | Largest Structure (in Thousand SF) |
|---|---|---|---|---|
| **Deck** | | | | |
| Rehab (Minor) | Rural: $65/SF<br>Urban: $80/SF | Rural: $45/SF<br>Urban: $55/SF | 5 | 20 |
| Rehab (Major)* | Rural: $65/SF<br>Urban: $80/SF | Rural: $45/SF<br>Urban: $55/SF | 5 | 20 |
| Replacement | Rural: $100/SF<br>Urban: $130/SF | Rural: $70/SF<br>Urban: $90/SF | 2 | 15 |
| **Superstructure** | | | | |
| Rehab (Minor) | Rural: $50/SF<br>Urban: $65/SF | Rural: $40/SF<br>Urban: $50/SF | 3 | 15 |
| Rehab (Major)* | Rural: $70/SF<br>Urban: $90/SF | Rural: $50/SF<br>Urban: $65/SF | 3 | 15 |
| Replacement | Rural: $115/SF<br>Urban: $145/SF | Rural: $70/SF<br>Urban: $90/SF | 0.7 | 15 |
| **Substructure** | | | | |
| Rehab (Minor) | Rural: $75/SF<br>Urban: $95/SF | Rural: $50/SF<br>Urban: $65/SF | 1 | 15 |
| Rehab (Major)* | Rural: $125/SF<br>Urban: $160/SF | Rural: $75/SF<br>Urban: $95/SF | 1 | 15 |
| Replacement | Rural: $225/SF<br>Urban: $285/SF | Rural: $115/SF<br>Urban: $145/SF | 0.7 | 15 |
| **Painting** | | | | |
| Full Paint | Rural: $60/SF<br>Urban: $75/SF | Rural: $45/SF<br>Urban: $55/SF | 3 | 20 |
| **Roadway Factor** | | | | |
| Replace | 2.5 | 1.75 | 1.5 | 15 |
| Rehabilitation | 1.9 | 1.3 | 1.5 | 15 |

Notes:
Cost data assumptions based on past project experience and expert opinion; cost data and assumptions will be updated with TxDOT feedback for Task 4 analysis
*The major scope of work is presumed to be required for all assets at or above 60 years of age
**Rehabilitation costs are assumed to double when correcting for structural deficiency
***Additional costs are to be estimated as a percentage of construction cost: Rehabilitation Design – 30%; Replacement Design – 27%; Mobilization – 5%; Right-of-Way – 25% (for total bridge replacement projects only); Utilities – 2% (for total bridge replacement projects only); Roadway Factor – varies 130% to 250% as shown in table.

### 4.3.2 Culvert Activities

Similar to bridge activities, maintenance items to grow needs for traffic-carrying culverts greater than 20 feet are listed in Table 6.

**Table 6: Culvert Maintenance Activities**

| Work Item | Proposed Frequency | Cost |
|---|---|---|
| Culvert Flushing/Washing | 1 year | Rural: $0.50/SF<br>Urban: $0.65/SF |
| Roadway Surface Patching | 2 years | Rural: $0.25/SF<br>Urban: $0.30/SF |
| Culvert Structural Repairs | 10 years | Rural: $6.50/SF<br>Urban: $8.00/SF |
| Barrier Repair | 10 years | Rural: $1.00/SF<br>Urban: $1.25/SF |
| Joint Sealing/Repair | 15 years | Rural: $6.50/SF<br>Urban: $8.00/SF |
| Roadway Thin Overlay – Epoxy/Asphalt* | 15 years | Rural: $9.50/SF<br>Urban: $12.00/SF |
| Joint Replacement* | 15 years | Rural: $6.50/SF<br>Urban: $8.00/SF |
| Scour Protection* | 15 years | Rural: $3.75/SF<br>Urban: $4.75/SF |
| Spot Repaint Steel Frame * | 15 years | Rural: $9.50/SF<br>Urban: $12.00/SF |

Notes:
Cost data assumptions based on past project experience and expert opinion; cost data and assumptions will be updated with TxDOT feedback for Task 4 analysis

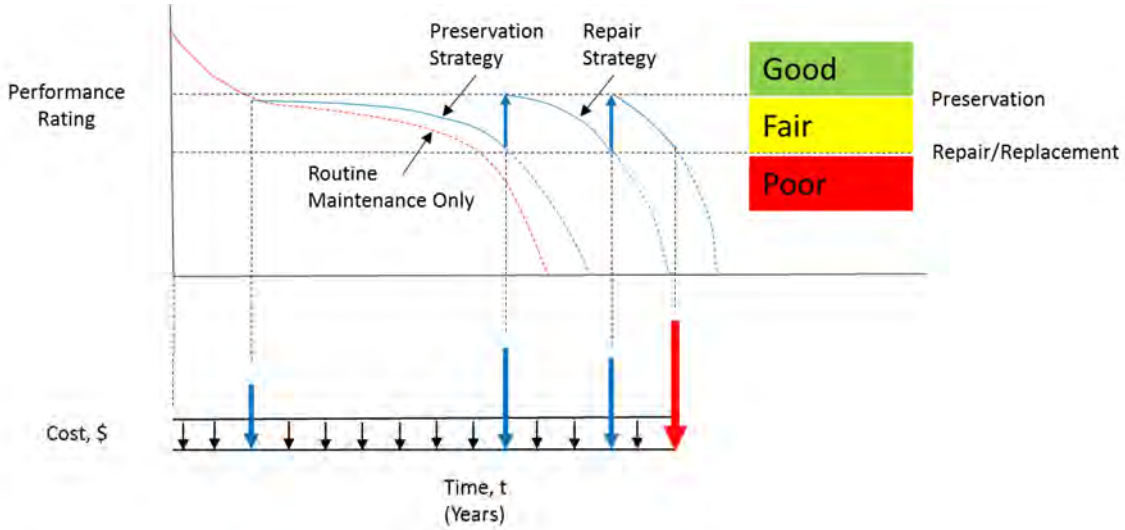
*As a result of the more intensive maintenance activities (cycles to start once a Culvert condition rating of 6 is reached) a 15-year extension until structurally deficient

With fewer primary components, major activities for culverts are considered to be either a rehabilitation or replacement activity. For this more limited activity set, performance jumps in the culvert condition rating are considered to be +1 for the rehabilitation activity and +9 for the replacement activity. Costs for rehabilitations are assumed to be $1,250 per linear foot of length and replacements are assumed to be $5,000 per linear foot of length.

## *4.4 Evaluating Alternatives*

With routine/preventive maintenance costs to be compiled on a cyclical basis throughout the 30-year planning horizon, major repair/replacement activities are to be evaluated on the basis of life-cycle cost. As shown in Figure 6, cash flow diagrams can be linked to performance profiles over time.

**Figure 6: Activity Timings and Life-Cycle Cost Analysis (LCCA)**




By evaluating all feasible repair/replacement activities – considered 5 years prior to predicted structural deficiency – and a do-nothing option, alternative profiles can be compared using a life-cycle cost metric (e.g., benefit-cost ratio, equivalent uniform annualized cost, net present value). The profile that minimizes life-cycle cost is then recommended for each asset.

Feasibility of applying activities is determined based on the following assumptions:

- Repair/replacement activity must improve dominating component (i.e., component expected to become structurally deficient first).
- Replacement activities of major structures (over 100,000 SF) are considered impractical.
- Bridges or culverts with a NBI rating of 3 or less are presumed to be beyond cost-effective repair and must be replaced.
- Painting activity is only applicable for steel structures that have never been painted or had a full painting occurring more than 30 years ago.
- One-time strengthening activity is to be required with superstructure rehabilitation activities for sub-standard for load structures (bridge posting rating of 4 or less).
- One-time widening is to be included with any replacement activity for structures with insufficient capacity (deck geometry rating of 4 or less).
- One-time raising/lowering is to be included with any repair/replacement activity for structures with inadequate underclearance (underclearance rating of 3 or less).

Under these assumptions, the selection of activities will be further validated by comparing recommended projects to those listed in Texas Metropolitan Transportation Plans and the Unified Transportation Plan.

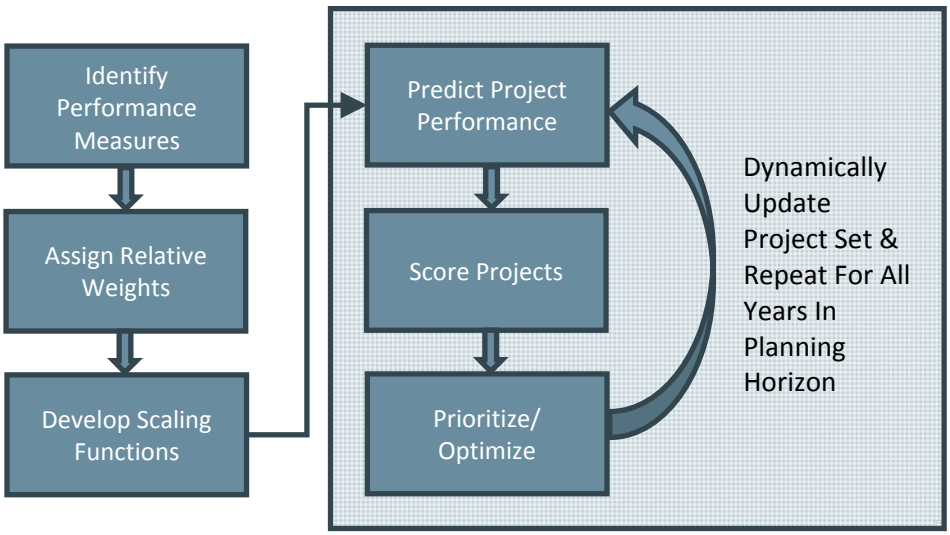
### 4.4.1 Assessing "Needs"

With a set of maintenance and repair/replacement activities, corresponding activity costs and benefits, data-driven predictive models, and application of life-cycle cost analysis, the final unconstrained needs is then the sum of the most cost-effective activity profiles for all state-controlled bridge and culvert assets. This "bottom-up" approach will support MAP-21 requirements and estimation and monitoring of performance measures identified by TxDOT. The ultimate needs total is to be validated by TxDOT staff and reevaluated for evolving assumptions and considerations of contingency.

## 5.0 Financially-Constrained scenarios

Recognizing that the anticipated revenues may not be sufficient to address all projects identified in the unconstrained analysis, a financially-constrained methodology is proposed herein (Figure 7).

**Figure 7: Proposed Financially-Constrained Analysis Methodology**




Note: CH2M HILL proposed methodology for TxDOT TTP

With various needs and priorities across the state, decision-makers must weigh multiple objectives when selecting projects. To help guide this typically subjective process, the CH2M HILL-led team proposes a more transparent, performance-based framework that identifies a baseline set of projects. Through this more quantitative approach, a repeated process for assessing performance tradeoffs can be utilized to inform stakeholder decisions.

### *5.1 Project Prioritization*

In order to compare diverse projects and performance measures, decision science techniques can be used to score bridge/culvert projects. For instance, it is recommended that TxDOT consider prioritizing projects based on both a reactive (worst-first) and a proactive (opportunity for savings) basis. By addressing threats (represented by the structural evaluation rating) and opportunities

(represented by life-cycle cost savings), TxDOT can link risk management processes to project programming. Comparisons between these dissimilar metrics can be done by normalizing the performance values on a common scale. A common approach, consistent with the Pontis v5.2 software and AASHTO TAM Guide recommendations, is to use utility scaling [typically on a 0 (worst) to 100 (best) scale] – where utility represents a unitless measure that is consistent with decision-maker preference for various outcome levels (Figure 8).

**Figure 8: Utility Scaling Functions**

By combining weights and scaled performance values, a score representative of agency preferences can be obtained:

$$Score = Weight_1 * (Utility\ After\ Project_1 - Utility\ Before\ Project_1) +$$

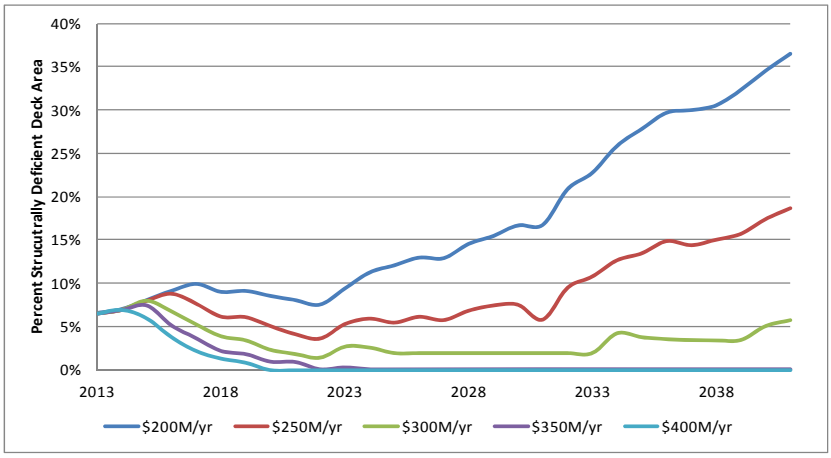
$$Weight_2 * (Utility\ After\ Project_2 - Utility\ Before\ Project_2)$$

An initial ranking of projects can then be reviewed, with iterative changes to weights and scaling functions so as to more closely reflect intended agency preferences and priorities.

## *5.2 Optimizing Performance*

Once a prioritized list has been developed, mathematical optimization can be applied to develop a draft set of projects that maximize system performance (represented by the program score) given financial constraints. This process can be readily replicated for any budget level, allowing for the assessment of statewide performance tradeoffs (Figure 9). Such curves can additionally aid short- and long-term performance target setting.

**Figure 9: Example Linkage Between System Performance and Investment Level**




As a result of the constrained methodology, the analysis team will be able to identify a draft set of prioritized bridge/culvert projects, an understanding of performance tradeoffs relative to investment level, and realistic targets that may be achieved at the expected funding level.

# Texas Transportation Plan

## Tech Memo 3.3: Transit and Passenger Rail

January 15, 2014

## Acknowledgements

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# 1.0 Introduction

This Technical Memorandum for Transit and Intercity Bus (Tech Memo #3: Transit Analysis Methodology) addresses the methodology to be employed to determine the long-term investment needs for transit systems in Texas in Task 4 of the TTP. The methodology described below is based on the Federal Transit Administration's (FTA's) national-level approach for transit condition and performance reporting, which contributes to the biennial Congressional Conditions and Performance Report and National State of Good Repair (SGR) Assessment. This methodology is also consistent with FTA's expected requirements for transit systems under MAP-21. (A list of abbreviations and acronyms is included as Appendix D.)

Both transit and intercity bus services are referred to collectively as "transit services" throughout the memo. The memo is organized into three sections:

1. Scope of Transit Analysis
    a. Type of Investment
    b. Transit Services Included
2. Transit Needs Determination
    a. Current Inventory Data and Conditions
    b. Financial Assumptions
    c. Estimation of Preservation and Service Expansion Needs
    d. Major New Service Project Collection
    e. Constrained Funding Scenarios
3. Investment Prioritization for Transit
    a. Prioritization Routine
    b. SGR Backlog Impacts

The methodology for Passenger Rail mode is also included in the Memo (Section 2.2.2).

# 2.0 Scope of Transit Analysis

The following sections provide a summary of the types of financial need, or investment, considered in the transit analysis and the scope of transit services included for consideration in the Texas Transportation Plan (TTP).

## *2.1 Types of Investment*

Investment needs are divided into their intended usage categories in this study. The financial needs related to these investments include both capital and operating costs. These usage categories include:

1. **Preservation:** the capital reinvestment required to maintain existing assets in a state of good repair (SGR). Reinvestment needs include rehabilitation and replacement of transit assets, as

well as annual capital maintenance (ACM) needs. Preservation also includes the cost of operation and maintenance (O&M) of existing assets for current service levels.

2. **Service expansion:** the capital investments and O&M costs for projected growth in service levels based on projected growth in ridership. Service expansion includes fleet expansion and related facility expansion in response to growth in population and underlying demand. It does not include the addition of services into new geographic areas or addition of new modes of transit.
3. **Major new service:** the capital investments and related O&M costs to significantly improve transit performance via enhancements to core capacity or extension of services into new areas or modes.

## *2.2 Transit Services Included*

There are more than 70 transit agencies operating in Texas, with most agencies providing multiple modes of service under varying contractual arrangements. Given the complexity and breadth of services offered, it is critical to define which transit and intercity bus services are included for consideration in the TTP. The following sections detail both the services which are included in the scope of this analysis and also how those services are categorized for the purposes of reporting.

### 2.2.1 Modes Included in Analysis

All transit modes will be included in the TTP analysis. The transit modes currently operating in Texas, as reported to the National Transit Database (NTD) are:

- Commuter rail
- Light rail, which includes street car operations
- Hybrid light rail
- Commuter bus, which includes some intercity bus services
- Motor bus
- Demand response, which includes demand response taxi services
- Ferry boat
- Vanpool

There are also intercity bus services operated by private operators, such as Greyhound, who do not report to NTD. These services often share multimodal transfer hubs with local bus operators, and their services have also benefited from public funding in the past via FTA's Over-the-Road Bus Grants program. While their private fleet assets are not considered as part of the transit analysis, any shared public facilities or assets with public investment will be included. TxDOT will provide accounting from PTMS or other grant information to determine which intercity bus investments to include.

In addition to the modes listed above, the transit and intercity bus task includes analysis of system-wide assets. These are assets that are not linked to a specific mode but exist to support the

operations of an entire agency. Examples of system-wide assets include administrative buildings and communications equipment, such as phones and network cabling.

Inventory, conditions, and investment needs will be reported by mode, as well as by service provider (as seen in Section 2.2.4).

### 2.2.2 Passenger Rail Methodology

It is important to distinguish between commuter rail services and passenger rail services, as the methodology for assessing needs is different for these intercity modes. Commuter rail services are a transit rail mode, which are administered or operated by transit agencies, and are regulated, defined, and funded by the FTA. These systems must also comply with Federal Rail Administration (FRA) regulations. Transit rail services are included in the methodology described in this memo (no heavy rail services are reported for Texas so they do not appear in the transit modes listed above).

Passenger rail services are operated by providers such as Amtrak, which are also regulated and partially funded by the FRA. However, these services do not report to the FTA as transit services. Passenger rail services are also intercity, so tend to be longer distance. These services are included for consideration in a separate sub-task with projections based on the Texas Rail Plan (TRP).

Expansion plans for intercity rail are currently produced and updated on a regular basis for successive editions of the TRP. Rather than trying to reproduce that work as a parallel effort, intercity rail investment and operating cost needs for the TTP will therefore be obtained from the most recent version of the TRP, but limited to those sections of the plan that address intercity passenger needs (freight needs are addressed in a different methodology document). The intercity passenger rail plan of the TRP is currently being updated by a consultant team that supports TRP. The intercity passenger rail component of the TTP will be based on that update. This approach has been confirmed with the TxDOT Passenger Rail Division staff.

### 2.2.3 Services Included in Analysis

Transit operators can be grouped into two different categories for the purposes of project funding: agencies that receive funding directly from the FTA for capital and operating expenses, and agencies that are sub-recipients of funding through TxDOT. Sub-recipients tend to be small urban or rural transit providers, while direct recipients are larger urban operators. For the purposes of the TTP, all agencies are included, though the focus of the analysis will be on TxDOT sub-recipients.

Transit services are also divided between two categories: directly operated (DO) services and contracted services (PT). Both types of service are reported to NTD for the purposes of tracking service levels and assets. Both types of service also require capital investments and O&M expenditures. However, capital investments in PT services are harder for agencies to determine, as contractors often include the cost of capital in operating contracts. Both types of service will be included in the TTP analysis, though needs related to PT services may be less detailed than those related to DO services.

Appendix A lists all of the agencies, modes and service types which are considered "in scope" for the TTP under transit and intercity bus services.

### 2.2.4 Grouping of Service Providers for Reporting

There are 25 Metropolitan Planning Organizations (MPOs) in Texas, each of which has developed a long-term plan for transportation projects in their area called either a Metropolitan Transportation Plan (MTP) or a Regional Transportation Plan (RTP). As noted below in Section 3.2.1, the MTPs serve as a data source for Major New Service projects and a sense check on the analysis of Service Expansion and Preservation investments. Most of the agencies engaged in MPOs are either large Metropolitan Transit Authorities (MTAs) or smaller urbanized system providers, both of which are funded under §5307 by the FTA.

There are also 38 rural agencies that provide transportation in nonurbanized areas of Texas. In several cases these rural agencies also provide limited service in urbanized areas, and receive FTA §5307 funds from the local designated recipient (as a contractor or direct recipient). Additionally, in other cases the rural transit district also serves as an urban transit district, and may be a direct recipient of FTA §5307 funds. In order to report on the needs and condition of transit assets, these rural operators have been grouped as nonurbanized providers, funded under §5311.

There is also separate FTA funding for the Seniors and Individuals with Disabilities Program (§5310). Any size operator can provide §5310 services, so this group will be reported separately from the size categories listed above.

The grouping of individual agencies is shown in Appendix A. While the outputs of analysis are grouped for reporting, the detailed data on each agency will be available to TxDOT for purposes of verification and public comment.

## 3.0 Transit Needs Determination

The following sections provide a high-level summary of the methods used to estimate transit system needs for the TTP. The summary includes:

- Current Inventory Data and Conditions
- Financial Assumptions
- Estimation of Preservation and Service Expansion Needs
- Major New Service Project Collection
- Investment to Address "Urban Collar" Growth
- Constrained Funding Scenarios.

### *3.1 Current Inventory Data and Conditions*

A summary of all the data needs and sources described below is also provided in Appendix B.

### 3.1.1 Sources of Data

Data on the current inventory of transit assets was gathered from multiple sources, depending on the asset type. **Exhibit 1** summarizes how asset types are categorized by the FTA for transit services.

**Exhibit 1: FTA Transit Asset Hierarchy**

| Asset Category | Types of Assets Included |
|---|---|
| Guideway Elements | • Trackwork defined by<br>– Type of track (curve, tangent, turnout)<br>– Type of attachment (embedded, ballasted, direct fixation)<br>• Guideway structures defined by<br>– Type of structure (underground, at-grade, or elevated)<br>– Type of service (light rail, commuter rail, heavy rail)<br>• Special structures, such as fencing<br>• Bus guideway by type |
| Facilities | • Buildings defined by<br>– Function (administration, maintenance, etc.)<br>– Building component (if applicable)<br>• Equipment defined by type (maintenance, furniture, IT)<br>• Central Control<br>• Storage Yards<br>• Major Shops |
| Systems | • Electrification defined by mode<br>• Revenue collection, including in-station and on-board<br>• Communications, including radio and phone systems<br>• Train Control<br>• Utilities, including drainage and HVAC |
| Stations | • Building by type<br>• Access<br>• Parking by type |
| Vehicles | • Revenue Vehicles defined by<br>– Mode<br>– Vehicle type (e.g., bus 40 ft hybrid)<br>• Non-Revenue |

For revenue vehicles, the initial source of data will be the inventory reported to the NTD in 2012. For rural revenue vehicles, the mode served by each vehicle record was not reported. To complete the data required for analysis (Section 3.3.1 below) the vehicles for rural services were divided into modes based on the reported proportion of services to NTD (in the 2012 Subrecipient Service Data table). This initial fleet inventory will be improved based on Public Transportation Management System (PTMS) inventory data, provided by TxDOT. Improvements will include updated vehicle counts to reflect the most recent data and adjusted useful lives to reflect actual agency practices.

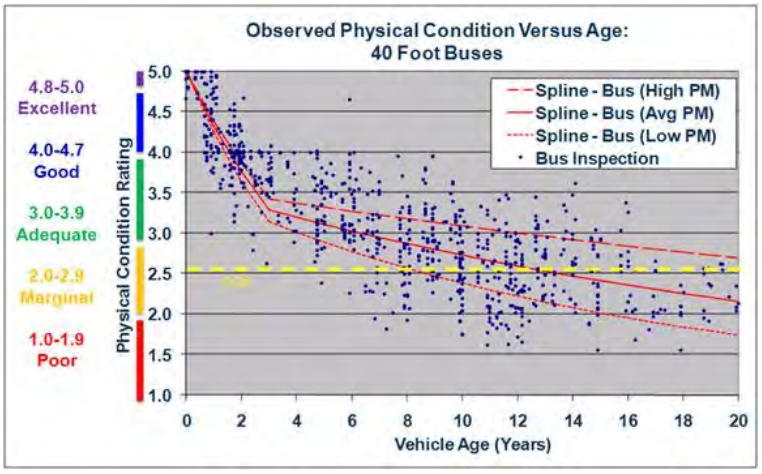
The primary source of data for the remaining asset types was the most recent data reported by agencies to the FTA for use in the Transit Economic Requirements Model (TERM). TERM is used to estimate transit investment needs at the federal level, and is the basis for the Preservation and Service Expansion analysis completed for TxDOT. The inventory contained in TERM was accessed from various sources, including direct agency reporting, previous industry studies, and condition estimates done for the FTA. As with the NTD data, any inventory records provided by TxDOT with more recent or more accurate information will be used to improve the analysis.

Some of the inventory records in TERM are 'generated' records based on set relationships between vehicle fleets, employees, and supporting infrastructure. For example, there are rural agencies that do not report to NTD in enough detail to determine the inventory for their supporting facilities and systems. In this case, the quantity and cost of furniture, phones, utilities, and others are generated based on an understanding of the quantity of vehicles or staff operating in the system. In order to minimize the impact of generated records on the analysis, any additional data available from TxDOT, either through PTMS or Texas Transportation Institute (TTI), will be used to update the inventory.

### 3.1.2 Estimation of Current Conditions

The snapshot of current transit services will be presented based on 2012 NTD data and any updates provided by TxDOT.

Condition estimates for the state-wide transit system will be aggregated based on the condition of each asset in the inventory described above as of the start year for analysis, presumably 2013. Asset conditions in TERM are based on FTA's decay curves, which use age as the basis for determining condition. While direct physical evaluation of the condition of an asset provides more accurate condition ratings, this approach is not feasible for a state-wide project such as the TTP. The benefits of using FTA's decay curve approach include:




- Using a common scale for all asset types, such as the FTA's five-point rating scale for all asset types (5=like new/excellent through 1=poor), so wide differences in asset useful life across asset types are addressed by a common scale.
- Decay curves are available for all transit asset types.
- Decay curves predict condition as function of age and include asset utilization and other factors for some assets.

- Accurate and complete asset ages are easier, quicker, and cheaper to collect than on-site condition assessments.
- Decay curves are dynamic as they allow the condition of an asset to be reevaluated each year of analysis.
- Decay curves reflect the actual decay experiences of U.S. transit assets.

The five-point scale for rating transit asset conditions is illustrated in more detail below in **Exhibit 2**.

**Exhibit 2: FTA Condition Rating Scale**

| Condition | FTA Rating | Description |
|---|---|---|
| Excellent | 5 | • New asset<br>• No visible defects |
| Good | 4 | • Asset showing minimal signs of wear<br>• Some (slightly) defective or deteriorated component(s) |
| Adequate | 3 | • Asset has reached its mid-life (condition 3.5)<br>• Some moderately defective or deteriorated component(s) |
| Marginal | 2 | • Asset reaching or just past the end of its useful life (reached between 2.75 and 2.5)<br>• Increasing number of defective or deteriorated component(s) and increasing maintenance needs |
| Poor | 1 | • Asset is past its useful life and is in need of immediate repair or replacement<br>• May have critically damaged component(s) |

These condition ratings do not imply that an asset is unfit for service or unsafe, though low ratings may mean that the likelihood of sub-optimal performance is increased (that is, reliability and availability performance may decrease).

## *3.2 Financial Assumptions*

A basic set of financial assumptions is required to estimate capital and O&M costs for transit operations over time. These assumptions include unit replacement costs, life cycle costs, and inflation rates. The assumptions used in this analysis are presented below.

However, these assumptions can be applied with varying degrees of consistency based on the data source. For example, the unit cost to replace vehicles for Preservation or Service Expansion is uniform across the inventory based on TxDOT input. At the same time, projects taken from MTP/RTPs may use different unit costs for vehicles based on regionally specific purchasing agreements or cost profiles. In general, the assumptions below will be applied to the TEX Lite model, described in Section 3.3.1, while individual MPO assumptions will apply to their own MTP/RTP projects.

### 3.2.1 Unit Costs

Developing and maintaining quality databases for transit asset inventory is very resource intensive. Many transit agencies do not have the resources available to continuously update their inventory with the required level of detail for unit cost reporting. As such, some assumptions have been made to fill in the unit replacement costs of revenue vehicles specific to Texas. The initial "price list" for revenue vehicles, which will be verified by TxDOT based on recent procurements, is attached in Appendix C.

Similarly, generated assets and any asset reported to FTA, PTMS or TTI without an associated cost will rely on default unit cost assumptions. Each asset type included in TERM, and TERM Lite (the individual agency version of TERM federal), has an associated default unit cost. These have been determined through industry studies and previous agency submissions to the FTA. If a unit cost was submitted by an agency to TERM federal, that cost applies.

### 3.2.2 Cost Inflation

The needs reported for capital and O&M are in year of expenditure dollars (YOE), as per TxDOT requirements for MPOs. In order to inflate current dollars to YOE, an inflation rate of 4% will be used (unless costs reported by planning entity have already been adjusted for inflation). This rate is recommended by TxDOT for long-term planning. However, the largest MPO in the state – Houston Galveston – uses a much lower inflation rate at 2.54%. This means that direct comparison to individual MPO needs will not always be possible. The 4% inflation rate will be applied to Preservation and Service Expansion needs for all agencies. This rate applies to these estimates because asset inventory and ridership are used in TEX Lite to develop estimates, as described below, instead of a list of projects.

However, as some MPOs do not report the inflation rate used in their analysis of Major New Service projects, there is no way to determine the un-inflated (i.e., current dollar) value of those projects. For this reason, a single inflation rate cannot be used for Major New Service projects. The YOE values reported for these projects will be based on whatever inflation rates were used by the individual MPO, which may vary across the state.

### 3.2.3 Funding Growth

In order to determine the impact of constrained funding on future asset conditions and the backlog, preliminary capital funding scenarios need to be developed. CH2M HILL will coordinate with TxDOT on historic funding levels and potential future funding to generate these preliminary scenarios. More detailed and final funding scenarios will be developed in Task 6.

Carryover of capital budgets from year to year is an option within TEX Lite's budget constraint scenarios. For the purposes of this analysis, it is assumed that transit agencies can carry over capital funds into future years.

## *3.3 Estimation of Preservation and Service Expansion Needs*

While some Texas MPOs have included Preservation and Service Expansion funding in their MTP/RTPs, some have not included these estimates due to expected budget constraints or lack of detail regarding transit expenditures. Therefore, an external model will be used to generate a state-wide unconstrained needs estimate for these two investment types.

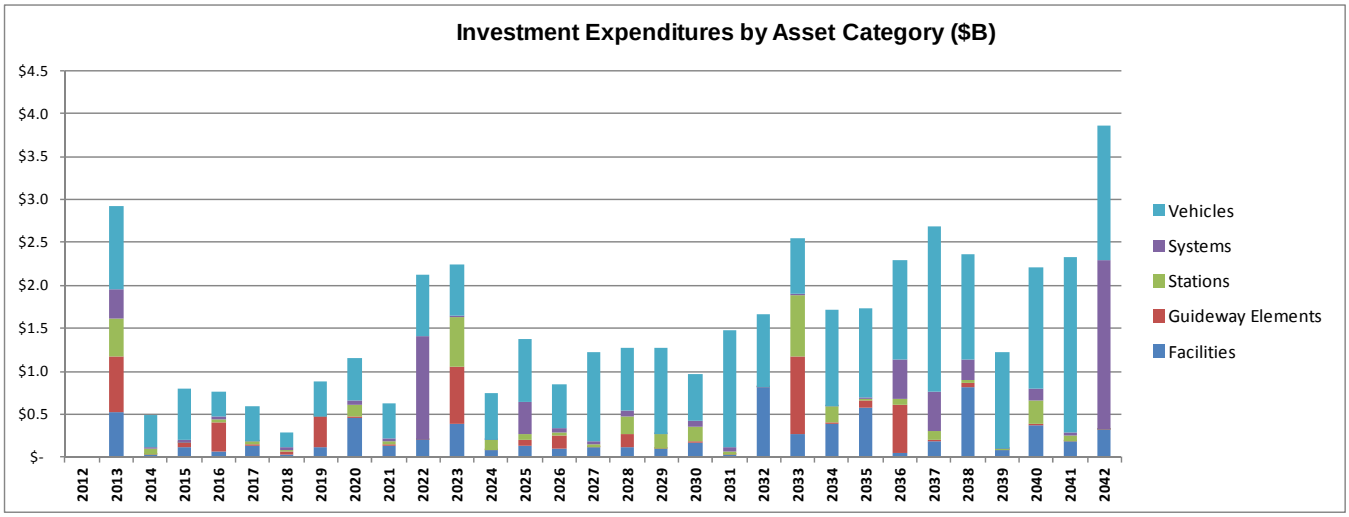
The MTP/RTPs will serve as a 'sense check' on the results of the following methodology. However, as noted above in Section 3.2.2, individual MPOs may be using different inflation rates than those used in this study. Therefore, a one-to-one cost comparison is not appropriate for the purposes of this analysis.

### 3.3.1 TEX Lite

In order to estimate capital and O&M needs for Preservation and Service Expansion, the most recent version of FTA's TERM Lite was customized to model Texas transit asset needs out to 2040. TEX Lite estimates the total level of reinvestment needed to reach and maintain SGR. For this analysis an asset is in a "state of good repair" if it does not exceed its useful life and does not require rehabilitation (rehab). If no reinvestment action can be taken for an asset that is due for replacement or rehabilitation as a result of budget constraints, that asset will go into the SGR backlog.

To project reinvestment needs TEX Lite determines the age and condition of assets in each year of the projection (that is, from current year to 2040) and uses life cycle profiles to determine if rehabilitation or replacement is needed, and the associated costs. Life cycle profiles are described in more detail below as they are critical to the outputs of the model. Cost inflation is then applied to the costs in each year (4% annually, as recommended by TxDOT). **Exhibit 3** is an example output of TEX Lite which shows the total reinvestment need in each year by category of asset.

**Exhibit 3: TEX Lite – Example Investment Expenditures by Asset Category**



TEX Lite was customized for TxDOT to include O&M cost modeling based on the same algorithms used in TERM federal. The O&M costs are based on changes in fleet size over time and baseline O&M cost relationships which are defined by mode. As O&M costs are dependent on fleet size in the model, the O&M costs for Preservation and Service Expansion are estimated simultaneously as the fleet grows. However, O&M costs will be reported for existing fleet (Preservation) and expansion fleet (Service Expansion) separately.

TEX Lite's projections of O&M costs may not include many of the 5310 agencies listed in Appendix A, as most of these agencies do not own revenue fleet vehicles to put in inventory. For these agencies an alternative projection method will be developed in collaboration with TxDOT, based on their understanding of 5310 operations and funding.

All investment needs will be estimated initially using an "unconstrained" scenario, where funding is not limited. Under this scenario, the current SGR backlog will be eliminated in the first year of projections because all investment needs can be met with unconstrained funding. It is important to note that this analysis assumes it is possible to eliminate the current deferred maintenance backlog in one year and to reinvest at a rate that continues to keep the backlog at zero. In reality this is not likely to occur as each agency has restricted capacity to access right of way and passenger facilities for the purposes of construction and may not be able to expend the reinvestment capital required in any given year. It is also not realistic to assume that funding will be entirely unconstrained, as described in Section 3.5.

### 3.3.2 Life Cycle Profile Components

The life cycle of an asset is defined by three components: the useful life, the rehab policy, and the annual capital maintenance needs. The useful life determines when an asset requires replacement and is set in years. If no agency useful life has been provided or cannot be determined from TTI provided inventory, TEX Lite will use default assumptions for each asset type. However, unique environmental features, usage patterns and maintenance regimes can impact the useful life of an asset at a specific agency. If possible, useful lives have been entered for agency records.

Rehab policies are also generally unique to an agency based on their maintenance approach and/or asset management plans. As TEX Lite is being used for state-wide analysis of transit needs, rehab policies must remain generic. The following components have been set to defaults by asset type based on previous FTA research:

- **Number of Rehabs Allowed:** This setting determines the number of rehabs the model will "perform" for each asset type over a full asset life-cycle, with zero (0) to five (5) rehabs per asset as options.
- **Rehab Age:** This setting determines the timing of each rehab as a percent of the asset's useful life (the model will ultimately round this value to a specific age). For example, if an asset is given

a useful life of 20 years, and there is a value of "50%" for one of these rehabs, the tool will assume all assets of this type and useful life will require a rehab at 10 years of age (20 × 0.50).

- **Rehab Cost:** Similarly, this setting determines the cost of each rehab as a percent of the asset's replacement value. For example, if an asset is given a replacement value of $100,000 and there is a value of "25%" for the cost of a rehab, the tool will assume all assets of this type and replacement cost will require a rehab of value $25,000 ($100,000 × 0.25).

Finally, an annual capital maintenance setting greater than zero allows the user to ensure that a small amount of reinvestment occurs for assets of that type every year of the 20-year analysis period. Hence, if the value of an asset is $100,000 and the user enters a value of "0.25%" for annual capital maintenance, TEX Lite will assume all assets of this type and replacement cost will require an annual investment amount of $250 ($100,000 × 0.0025). Annual capital maintenance is intended to help address reinvestment needs that are small on average but recurring in nature.

### 3.3.3 Ridership Projections

TEX Lite also provides projections of new Service Expansion needs (including fleet vehicles, facilities, and O&M costs) based on ridership growth factors for each mode at each agency. The growth rates are currently based on analysis of historical ridership data reported to the NTD. Specifically, this preliminary analysis focused on growth in unlinked trips for Texas urbanized areas (UZAs) segmented by population size of the urbanized area and mode (**Exhibit 4**). If growth rates were negative according to NTD data, the model assumes flat ridership (0% growth) for calculations. These growth rates are intended for preliminary analysis only.

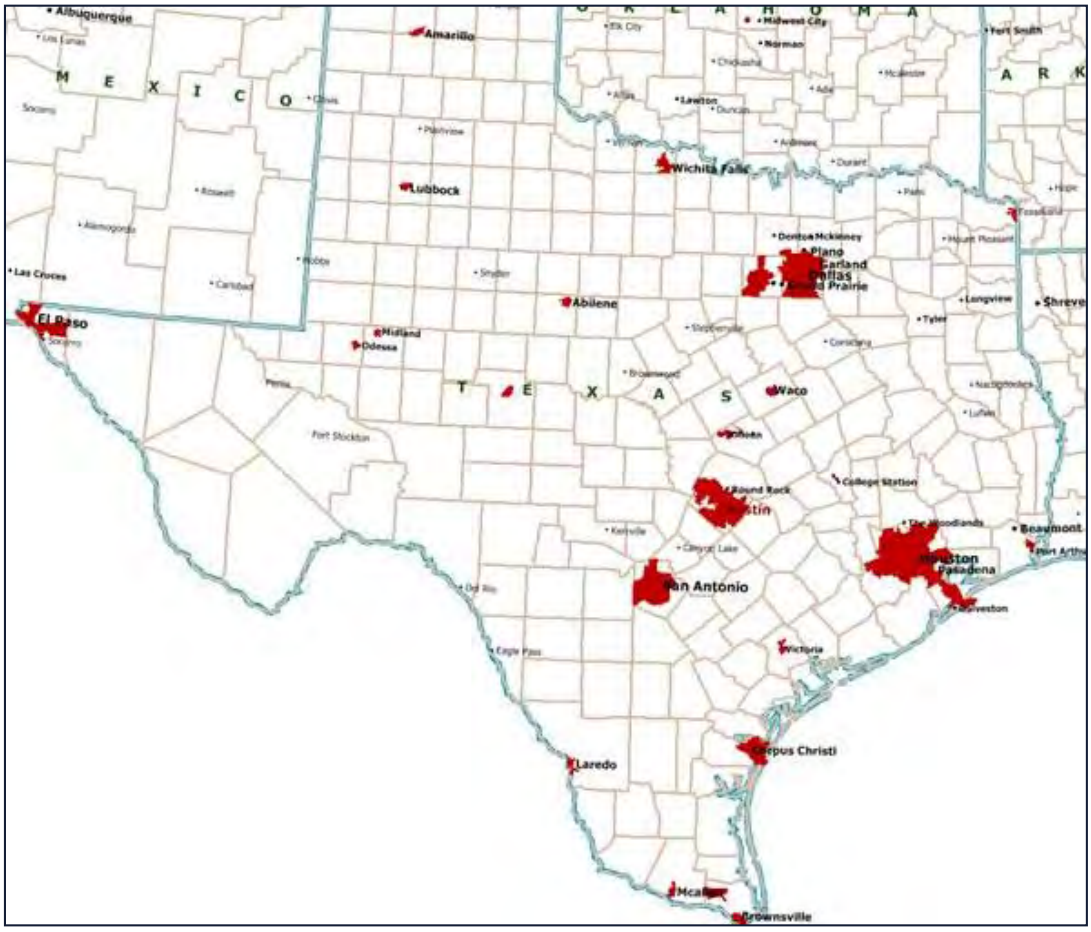
**Exhibit 4: Preliminary Ridership Growth Rates by UZA Sizes**

| UZA Size | System Mode | Growth Rate |
|---|---|---|
| Over 1 Million | Commuter Rail | -0.18% |
| | Demand Response | 4.28% |
| | Light Rail and Hybrid Light Rail | 1.93% |
| | Motor Bus | -3.71% |
| | System-wide | 2.33% |
| | Vanpool | 9.33% |
| Over 200 Thousand | Demand Response | 12.70% |
| | Ferry Boat | 10.78% |
| | Light Rail and Hybrid Light Rail | -21.66% |
| | Motor Bus | 3.85% |
| | System-wide | 8.04% |
| | Vanpool | 9.33% |
| Under 200 Thousand | Demand Response | 7.05% |
| | Light Rail and Hybrid Light Rail | 0.65% |
| | Motor Bus | 6.54% |
| | System-wide | 5.37% |

The preliminary growth rates shown above will be replaced with SAM-V3 analysis of fixed route transit demand in urban areas when available. **Exhibit 5** highlights in red the UZAs that SAM V3 will cover, including:

- Corpus Christi
- Laredo
- San Antonio
- Austin
- Waco
- Dallas-Ft Worth
- El Paso
- Abilene
- Midland
- Odessa
- Houston
- Port Arthur
- Victoria
- McAllen
- Harlingen
- Brownsville
- Texarkana
- Lubbock
- Wichita Falls
- Amarillo
- Killeen

**Exhibit 5: SAM V3 Projection Areas**

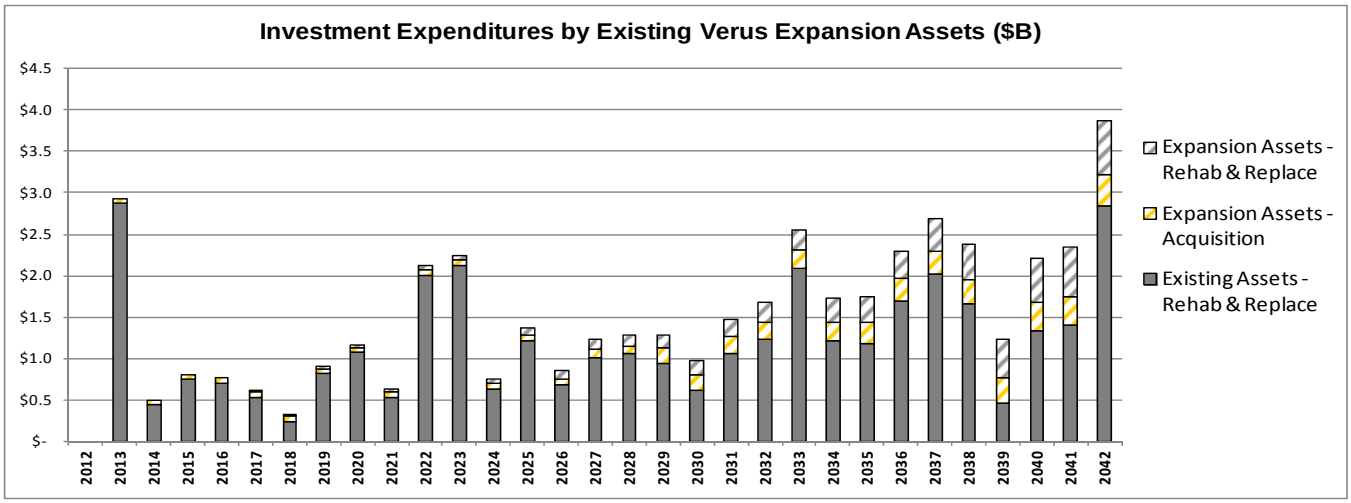



The fixed route services that will be projected by SAM V3 include urban bus, commuter rail, light rail (including streetcar), and hybrid light rail in the areas noted above. Any urbanized areas with fixed route services that fall outside these areas, such as College Station-Bryan, and fixed route rural bus and ferry boat will not be projected by SAM V3. Demand response and vanpool in both urban and rural areas will also be excluded. For all of the agencies that fall outside of the SAM V3 analysis,

final ridership rates will be projected in coordination with TxDOT using historical trends and potential population or demographic changes.

Ridership growth rates are used by TEX Lite to estimate the rate at which existing vehicle fleets must expand to maintain current vehicle capacity utilization (i.e., "maintain performance") given the trend rate of increase in ridership for each study area over the next 25 years. The algorithms used to increase fleet are based on TERM federal. While investing in fleet expansion, TEX Lite also estimates the required level of infrastructure investment needed to support the increasing fleet. These investments include maintenance facilities, and expanded rail guideway assets, including track, systems, and stations. Once new assets are 'acquired' in the model for Service Expansion, TEX Lite begins to estimate their reinvestment needs over time. As seen in **Exhibit 6,** the Service Expansion component of TEX Lite can be reported in both acquisition and reinvestment capital, alongside the Preservation capital needs.

**Exhibit 6: TEX Lite – Example Investment Expenditures for Existing and Expansion Assets**




All of TEX Lite's projected investment costs for Service Expansion are based on standard cost values maintained in the TERM federal database for asset types which were obtained through FTA capital cost research.

## *3.4 Major New Service Project Collection*

The most recent MTP/RTPs will be used to determine the investment needs for Major New Services. Each MPO reports projects at a different level of detail and with different associated costs. Many MPOs also report a different scope of planning for transit services, with some projecting only the next few years of needs. Given this differential in detail, TxDOT has proposed that TTI harmonize long-term Major New Service plans for Urbanized agencies which will replace MPO plans where appropriate.

The *Texas Rural Transportation Plan 2035 – Final Report* will be used as a basis for rural and TxDOT-financed urbanized transit Major New Service needs, with a potential update from TTI to 2040.

### 3.4.1 Review of Existing Transit Plans

The most recent MTP/RTPs will be used to determine the investment needs for Major New Services. Each MPO reports projects at a different level of detail and with different associated costs. As much as possible, the costs included or excluded in project estimates will be reported as part of the review. If 'normalization' is required for these costs, then the consultant will confirm which costs should be in/out of scope with TxDOT representatives and develop estimates for those costs excluded from some project plans.

Exhibit 7 provides a summary of the MPO and rural plans that will be reviewed and considered throughout TTP development.

**Exhibit 7: TxDOT Plans for Coordination with TTP**

| Plan/Program | Developed By | Time Period (FY) | Most Recent Date Published |
|---|---|---|---|
| Texas Rural Transportation Plan 2035 – Final Report | TxDOT | 25 years | June 28, 2012 |
| Abilene MTP | MPO | 2010-2035 | Jan 12, 2010 |
| Amarillo MTP | MPO | 2010-2035 | Oct 20, 2011 (Revised) |
| Brownsville MTP | MPO | 2010-2035 | Dec 9, 2009 |
| Bryan/College Station MTP | MPO | 2010-2035 | Feb 9, 2011 |
| Capital Area RTP (CAMPO 2035) | MPO | 2010-2035 | May 24, 2010 |
| Corpus Christi MTP | MPO | 2010-2035 | Jul 1, 2013 (updated project list) |
| El Paso MTP (Amended Mission 2035) | MPO | 2010-2035 | Dec 7, 2012 |
| Harlingen San Benito MTP | MPO | 2010-2035 | Dec 9, 2009 |
| Hidalgo County MTP | MPO | 2010-2035 | Jul 18, 2013 (Amended) |
| Houston Galveston RTP (Bridging Our Communities 2035) | MPO | 2010-2035 | Jan 25, 2011 |
| Killeen-Temple (Mobility 2035) MTP | MPO | 2010-2035 | Oct 21, 2009 (Revised) |
| Laredo MTP | MPO | 2010-2035 | Dec 11, 2009 |
| Longview MTP (Transportation 2035) | MPO | 2010-2035 | Jun 21, 2012 (Revised) |
| Lubbock MTP | MPO | 2012-2040 | Aug 21, 2012 |
| Midland-Odessa MTP | MPO | 2010-2035 | Nov 30, 2009 |
| North Central Texas MTP (Mobility 2035-Update 2013) | MPO | 2010-2035 | June, 2013 (Updated) |

**Exhibit 7: TxDOT Plans for Coordination with TTP**

| Plan/Program | Developed By | Time Period (FY) | Most Recent Date Published |
|---|---|---|---|
| San Angelo MTP | MPO | 2010-2035 | Jan, 2013 (Revised) |
| San Antonio-Bexar County (Mobility 2035) MTP | MPO | 2010-2035 | Dec 7, 2009 |
| Sherman Denison (Transportation Outlook 2035) MTP | MPO | 2010-2035 | Apr 25, 2012 (Amended) |
| South East Texas Regional Planning Commission (SETRPC) MTP | MPO | 2010-2035 | Apr 19, 2013 |
| Texarkana MTP | MPO | 2010-2035 | Oct 1, 2009 |
| Tyler Area MTP | MPO | 2010-2035 | Apr 22, 2010 (Revised) |
| Victoria UZA MTP | MPO | 2010-2035 | Dec 11, 2012 (Amended) |
| Waco MTP (Connections 2035) | MPO | 2010-2035 | Aug 2010 (Amended) |
| Wichita Falls MTP | MPO | 2010-2035 | Jun 4, 2012 (Revised) |

Where possible, committed sources of funding for projects will be identified as these projects will (theoretically) not compete for future funding with those projects that are currently 'unfunded'. The total investment needs related to Major New Service projects, and the proportion of needs that are funded/unfunded will also be reported. If these estimates cannot be determined through review of plans and interface with TxDOT planners, alternative means of estimating Major New Service needs will be considered given the time and budget available.

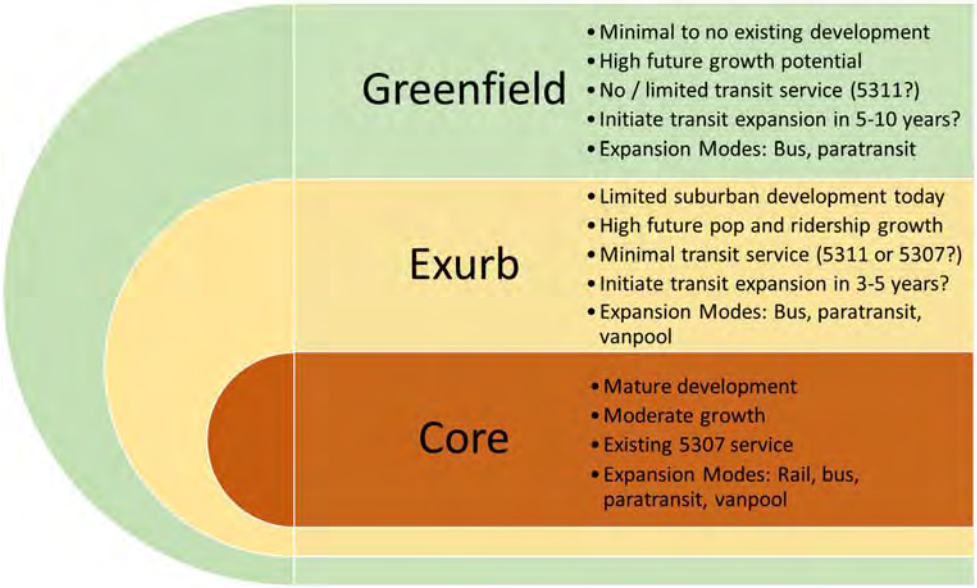
### 3.4.2 O&M Costs for Major New Services

Most MPO financial plans do not include the O&M costs related to Major New Service projects. As such, the O&M costs associated with these projects will be estimated using the relationship between the new fleet size and O&M costs which are built into TERM federal. If an agency has reported O&M costs related to new services, these costs will be used instead of estimates.

## *3.5 Investment to Address "Urban Collar" Growth*

Texas's major urbanized areas – including Houston, Dallas, Austin and San Antonio – are undergoing rapid and significant growth. Much of this growth is concentrated in "collar" areas that surround the urban core and includes "exurb" regions, which currently have lower density development with little or no existing fixed-route transit services, as well as "greenfield" sites with little or no development and no fixed-route transit service. Both of these collar areas, as seen in **Exhibit 8**, are likely to require transit investment over the 25 year time horizon covered by the plan.

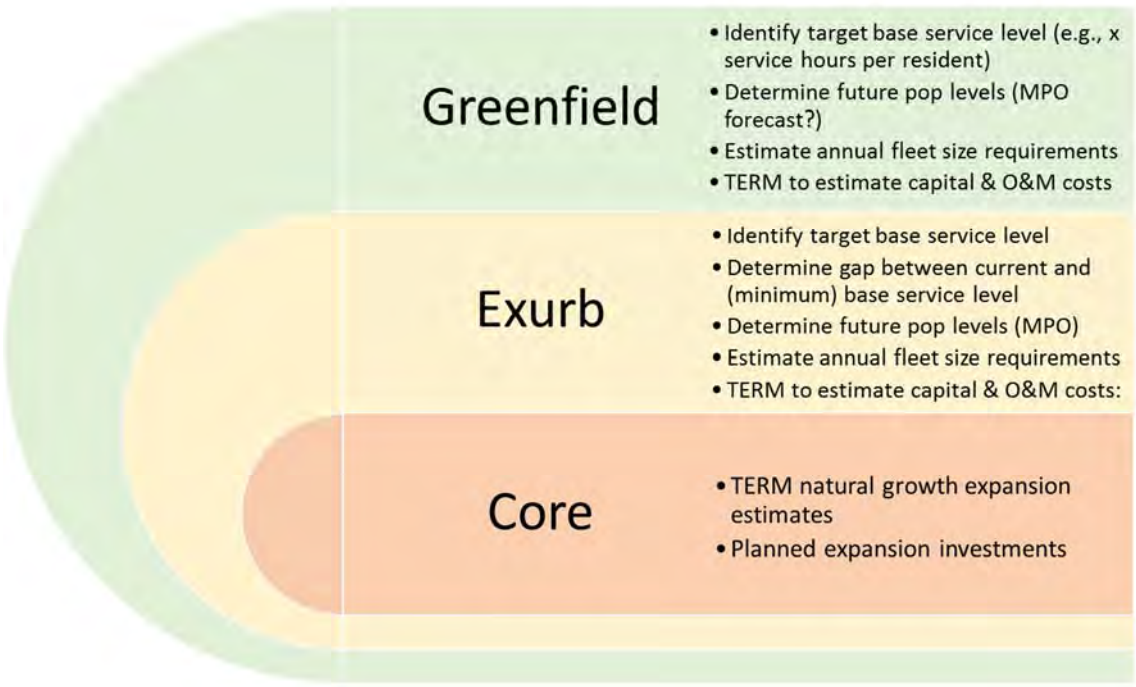
**Exhibit 8: UZA Core and Collar Regions**




Given the characteristics of these exurb and greenfield regions (none to minimal existing transit service but significant anticipated increase in transit demand), the approaches proposed above to cover natural growth needs for existing transit operations (3.3) and review of plans for major new expansion investments (3.4) may not capture the significant expansion investment needs required in the long term. Rather, the proposed approach to assessing urban collar capital investment and O&M cost needs will rely on the following analysis components/steps:

1. **Establish a base (minimum) transit service standard for collar regions:** This standard will most likely be based on a ratio of service levels per resident (e.g., hours or miles of revenue service per capita). The actual base service standard can be based on existing ratios of service per resident for more developed suburban areas within the same UZA (e.g., existing hours of transit service per resident in developed areas of Austin could be used to develop a future standard "target" for undeveloped collar regions around the Austin core).
2. **Obtain annual projections of population growth for the exurb and greenfield regions:** Population growth forms the driver to estimate total service hour needs based on the base service standard target (and in turn investment needs), as seen in **Exhibit 9**. Annual growth projections will be obtained at the county level through 2050 from the Texas State Data Center.
3. **Estimate annual service level requirement based on population forecasts and existing transit services:** Use the base service standard to estimate the total service hour or mile requirement for all projections years. Forecast will need to take into account areas that already have some level of service towards the standard (or areas that exceed the standard).

**Exhibit 9: Methodology for Investment Projections in Collar Areas**




4. **Estimate fleet and facility requirements to support projected service levels:** Annual fleet and facility requirements will be estimated outside of TEX Lite. These investment needs will then be entered into TEX Lite as expansion records to estimate capital expansion costs and O&M operating costs for these services throughout the 30-year time horizon. Some consideration will need to be made of whether there is a lag between the time a given service level is warranted vs. the expected time to plan, procure, and launch these expansion transit services (e.g., 5 to 10 years delay?). Collar region transit services may include bus and paratransit (and potentially vanpool).

**Challenges:** Key challenges in implementing this approach include the following:

1. Identifying the collar boundaries (including those for "greenfield" and "exurb" locations)
2. Determining any double counting of investment needs that may be captured in growth projections for surrounding areas.

Establishing the base service standard per resident and levels of investment to attain these standards are considered significantly less challenging given the availability of detailed NTD and TxDOT PTMS and related data sources. Determining possible double counting with TEX Lite projections of surrounding areas will be done in conjunction with TxDOT staff.

## *3.6 Constrained Funding Scenarios*

In addition to the transportation challenges due to population growth and an aging population, the Texas transportation system is subject to a common trend across the country: diminishing revenues and higher costs. TxDOT, like most other departments of transportation (DOTs) throughout the

country, is experiencing declining revenues and increasing demands on the transportation system. As noted in the Strategic Plan, funding from traditional sources such as the gas tax cannot keep pace with the growing demands on the system. In addition, recession-induced funding cuts have continued to present challenges to transit agencies while costs continue to inflate faster than fare revenues.

Given these limitations, more realistic scenarios of constrained funding and constrained capacity to expend that funding will be developed to determine the impact on transit asset conditions. CH2M HILL will generate projected revenue streams for the following two scenarios:

- Scenario 1: Expected capital funding (current capital funding forecast)
- Scenario 2: Funding required to maintain the current level of backlog.

The first scenario is based on the growth in capital funding for transit in Texas. Actual capital funding totals reported to NTD for FY2011 and FY2012 will be used for the backlog year and first year of analysis, which are divided into preservation and expansion funding based on past proportions of expenditure. The following year forecasts will be based on a trend rate of increase in capital funding using a weighted average of growth rates reported for funding over the relevant time period in available MTP/RTPs. The resulting 3.7% annual growth rate will be applied to a baseline year. Again, not all MPOs reported growth rates for funding sources, so the weighted average rate will not result in a one-to-one comparison of funding growth for MPOs.

The second scenario is a 'what if' analysis based on roughly maintaining the current value of the SGR backlog for transit. In order to determine the level of funding required to maintain that value, the TEX Lite model uses a 'goal seek' function to determine the correct level of annual investment needed to keep the backlog roughly steady.

## 4.0 Investment Prioritization

To address transit demands amid constrained resources, it is critical to maximize the impact of every dollar spent. This is the value of performance-based planning, which seeks to determine how to invest wisely to achieve goals and improve system performance over time. In this analysis, the issue of prioritizing investments with constrained funding is addressed by prioritizing the replacement or rehab of individual assets based on prioritization criteria built into TEX Lite. The resulting mix of investment actions and assets in the SGR backlog then reflect, roughly, the priorities of the State under constrained funding.

Note: The following prioritization method only applies to capital investments for Preservation of existing assets in TEX Lite. Expansion funding constraints can only be described by the expected funding gap and potential of not meeting transit demands.

## 4.1 Prioritization Routine

For each year of a 25-year model run, TEX Lite first identifies which of the State's assets require some reinvestment action (e.g., rehab or replacement) to attain SGR. Next, the TEX Lite assigns prioritization scores to each of these assets, and the model will reinvest in the highest scoring assets until the expected amount of reinvestment funding for that year is exhausted. Using this prioritization, TEX Lite then determines for each year what assets undergo reinvestment actions and what assets enter the SGR backlog.

A higher-level conceptual overview of TEX Lite's SGR reinvestment needs and prioritization analysis is shown in **Exhibit 10**. This representation emphasizes the model's reliance on the asset inventory data obtained from the agencies, TxDOT and NTD reporting. **Exhibit 10** also highlights the simulation process used for each year of the 25-year period of analysis to:

1. Assess needs for each analysis year
2. Score and rank all potential investment actions
3. Undertake the highest ranked investment actions subject to expected funding capacity.

**Exhibit 10: TEX Lite – SGR Needs Forecasting and Prioritization Tool Combined**

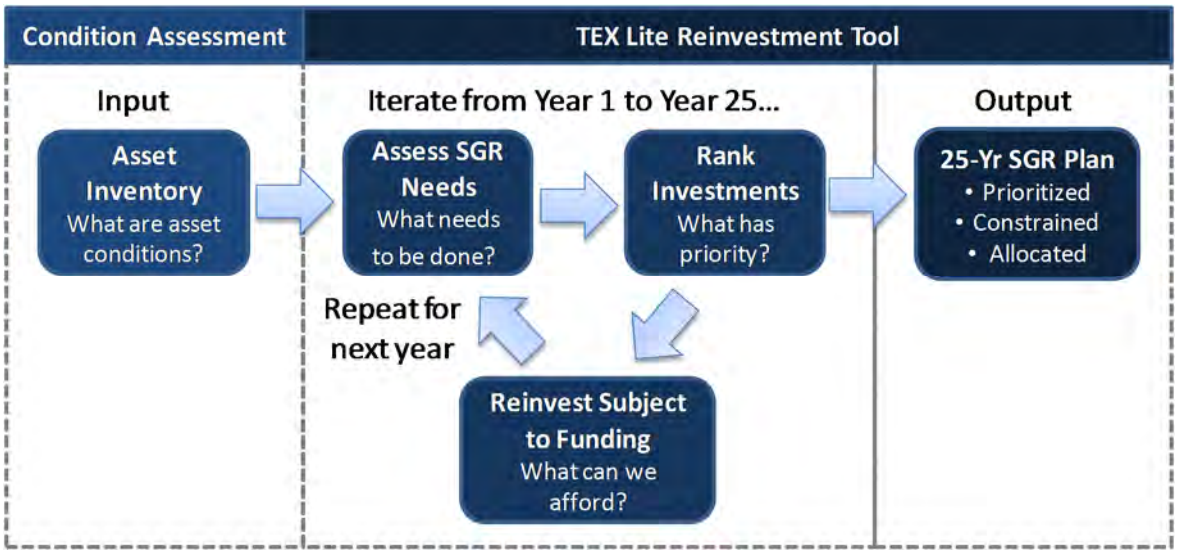
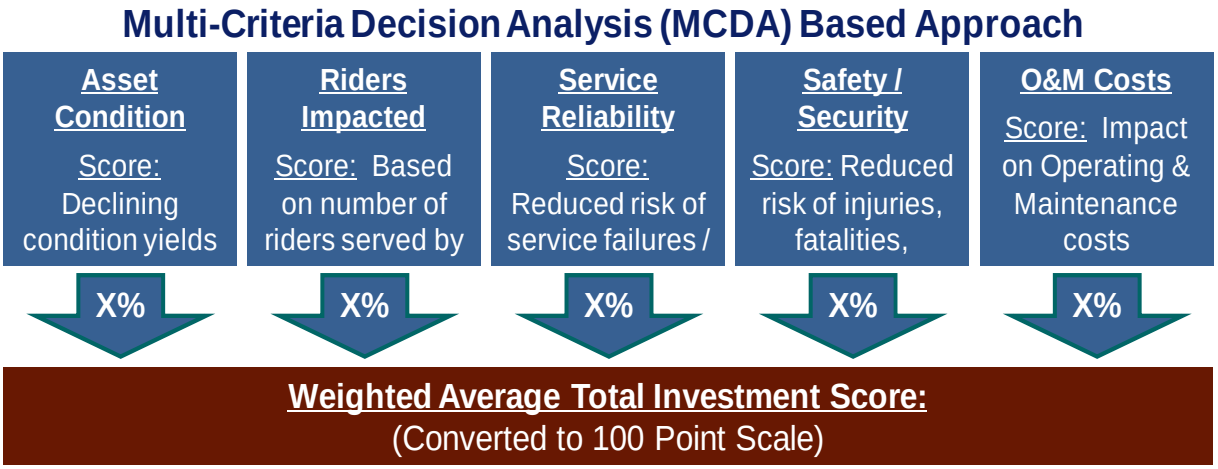



**Exhibit 11** provides an overview of the five investment criteria used to score and rank all potential SGR reinvestment actions – including asset condition, number of riders impacted, and the contribution of reinvestment actions to each of service reliability, safety and security, and O&M cost reduction. The weight placed on each criterion is variable within TEX Lite and hence can be varied to reflect the State's policies or to conduct sensitivity analyses.

**Exhibit 11: TEX Lite – SGR Investment Prioritization Criteria and Scoring**




The process used to score each SGR reinvestment criterion is highlighted in **Exhibit 12**. The weighting of each criterion will be calibrated based on the goals developed for TTP prioritization.

**Exhibit 12: Approach to Scoring by SGR Investment Criterion**

| Criterion | Approach | Dynamic or Static? | Illustration |
|---|---|---|---|
| Asset Condition | • Decay curve based condition estimate<br>– Age based 1 to 5 scale | Dynamic | |
| O&M Costs | • Fixed Score by asset type | Static | |
| Service Reliability & Safety/Security | • Combination of:<br>– Fixed Score by asset type<br>– Dynamic score by asset age | Mixed | |
| Riders Impacted | • Logarithmic score based on share of total agency riders impacted<br>– Scale ensures all assets obtain score | NA | |

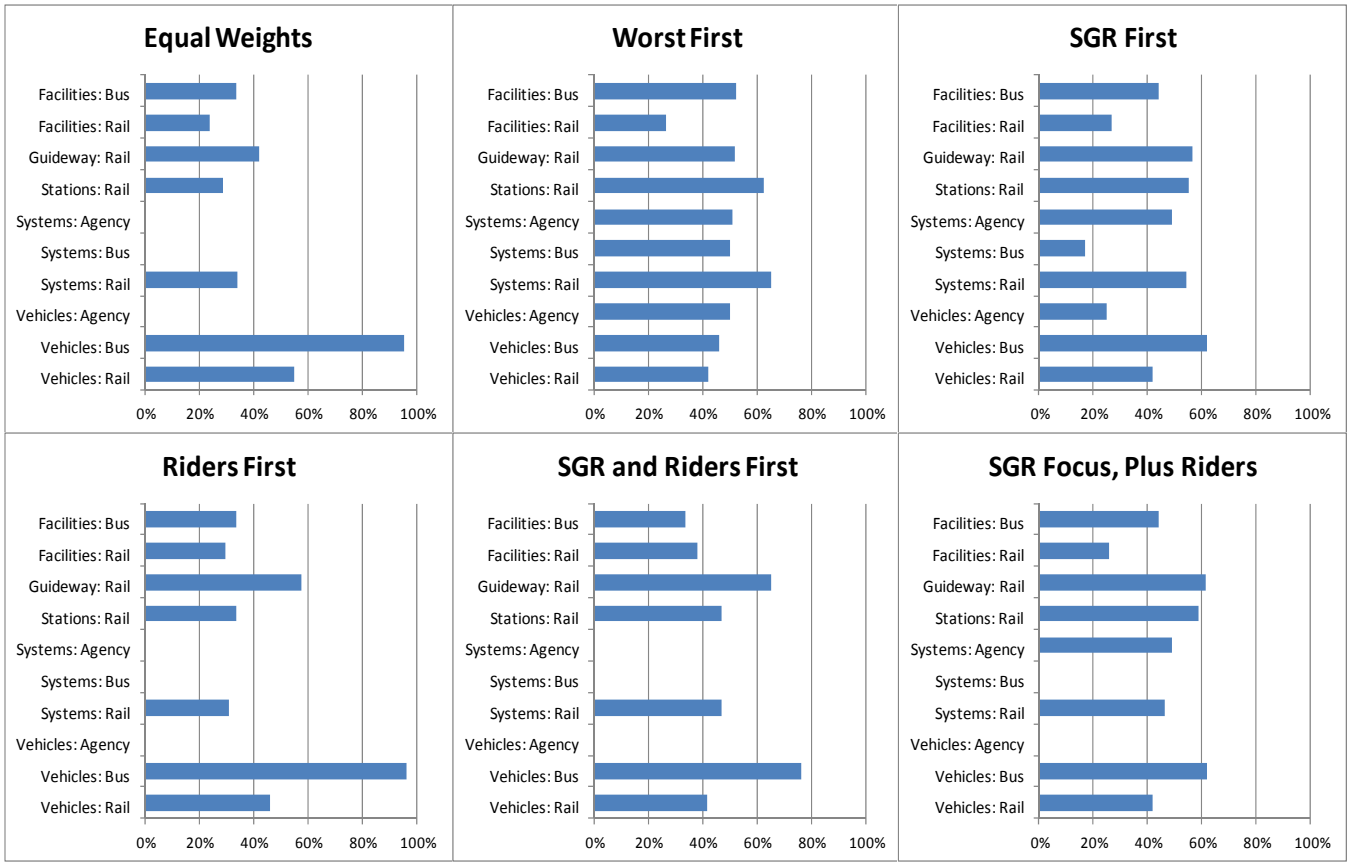
Scoring is "dynamic" throughout the 25-year period covered by each model run for some criteria. Specifically, TEX Lite assesses each asset's condition at the start of each analysis year (including the start or "backlog year"). This evaluation is then used to score and rank potential SGR investments with respect to asset condition, reliability and safety/security (with scoring for reliability and safety/security driven in part by condition). Due to this constant re-evaluation, the scoring for all assets is constantly changing (i.e., is "dynamic") throughout the 25 years of each model run.

## 4.2 SGR Backlog Impacts

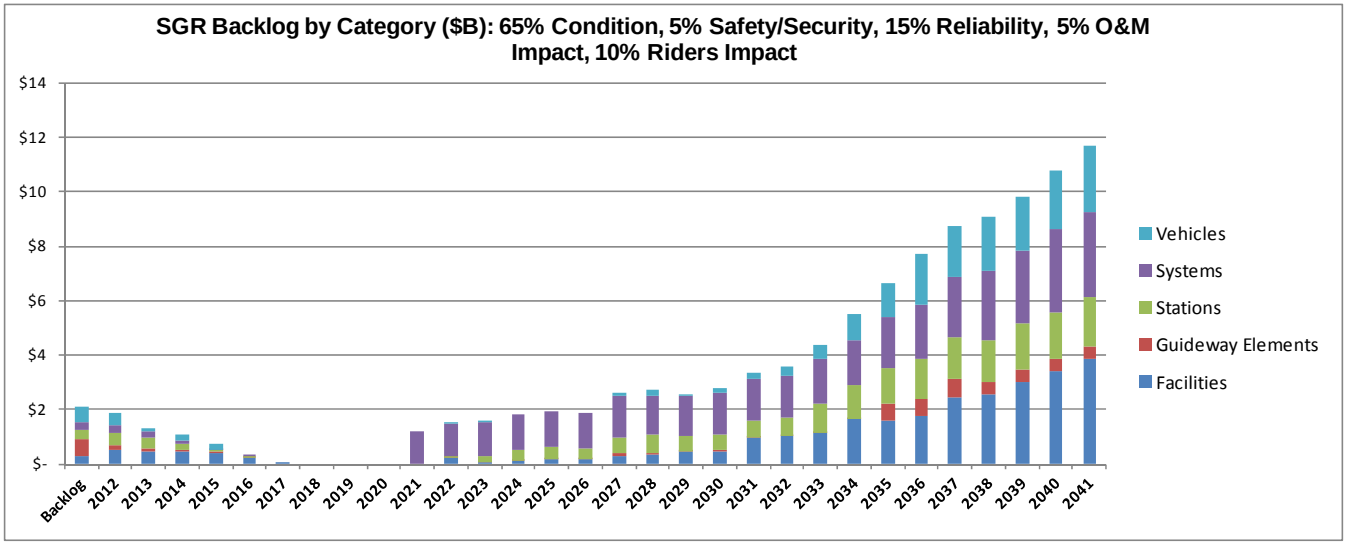
With constrained funding some assets will enter the SGR backlog if they are lower priority for reinvestment. The ranking of each asset type for prioritization and the weighting of the five criteria will determine which assets enter the backlog. The value, or size, of the backlog is not impacted by this ranking. However, the composition of the backlog will be impacted by prioritization rankings.

For example, revenue vehicles tend to rank highly (5 out of 5) for safety and security impacts. When the safety and security criterion is weighted highly, revenue vehicles will rarely enter the SGR backlog. This also means that revenue vehicles will make up a large portion of the investment expenditures in the model. Various approaches to weighting criteria and the resulting impact on investments, and conversely, the backlog are shown in **Exhibits 13 and 14.**

**Exhibit 13: Example Prioritization Criteria Weighting Outcomes for Asset Types**



## Exhibit 14: TEX Lite – Example SGR Backlog Projection with Constrained Funding and Prioritization



## Appendix A: Texas Transit Agency List

Note that private intercity bus operators are not on this list, though any publicly-funded assets related to those services will be captured in inventory as TxDOT provides grant details for those assets.

Agency groupings need to be further discussed with TxDOT in order to allow for reporting agency needs as appropriate for the TTP.

§5307 and §5311 Agencies

| TRS ID | Agency | Agency Grouping |
|---|---|---|
| 6001 | Amarillo City Transit | Urbanized Area |
| 6006 | Mass Transit Department City of El Paso | MTA |
| 6007 | Fort Worth Transportation Authority | MTA |
| 6008 | Metropolitan Transit Authority of Harris County | MTA (Houston) |
| 6009 | Laredo Transit Management Inc. | Urbanized Area |
| 6010 | City Transit Management Company Inc. | Urbanized Area (Lubbock) |
| 6011 | VIA Metropolitan Transit | MTA (San Antonio) |
| 6012 | Waco Transit System Inc. | Urbanized Area |
| 6013 | Port Arthur Transit | Urbanized Area |
| 6014 | City of Brownsville Brownsville Urban System | Urbanized Area |
| 6016 | Beaumont Municipal Transit System | Urbanized Area |
| 6035 | Wichita Falls Transit System | Urbanized Area |
| 6040 | Abilene Transit System | Urbanized Area |
| 6041 | Handitran Special Transit Division City of Arlin | Urbanized Area (City of Arlington – part of Dallas-Fort Worth-Arlington UZA) |
| 6048 | Capital Metropolitan Transportation Authority | MTA |
| 6051 | Corpus Christi Regional Transportation Authority | MTA |
| 6056 | Dallas Area Rapid Transit | MTA |
| 6059 | Brazos Transit District | Urbanized Area (Two: College Station-Bryan and Conroe-The Woodlands), and Nonurbanized |
| 6068 | City of Grand Prairie Transportation Services Depa | Urbanized Area (City of Grand Prairie – part of Dallas-Fort Worth-Arlington UZA) |
| 6070 | City of Mesquite | Urbanized Area (City of Mesquite – part of Dallas-Fort Worth-Arlington UZA) |
| 6081 | Longview Transit | Urbanized Area |
| 6082 | The Gulf Coast Center | Urbanized Area (Two: Lake Jackson-Angleton and Texas City), also Nonurbanized |
| 6084 | Dallas VPSI Inc | Urbanized Area (as subrecipient or contractor of §5307 funds from designated recipient in Dallas-Fort Worth-Arlington UZA) |
| 6089 | City of Tyler | Urbanized Area |
| 6090 | Lower Rio Grande Valley Development Council | Urbanized Area (Two: part of McAllen and Harlingen), and Nonurbanized |
| 6091 | Hill Country Transit District | Urbanized Area (Two: Killeen and Temple), and |

| TRS ID | Agency | Agency Grouping |
|---|---|---|
| | | Nonurbanized |
| 6093 | Texarkana Urban Transit District | Urbanized Area (Texarkana) and Nonurbanized |
| 6095 | Golden Crescent Regional Planning Commission | Urbanized Area (Victoria) and Nonurbanized |
| 6097 | Midland-Odessa Urban Transit District | Urbanized Area (Two: Midland and Odessa) |
| 6099 | City of McAllen McAllen Express Transit | Urbanized Area (City of McAllen, part of McAllen UZA) |
| 6101 | Denton County Transportation Authority | MTA |
| 6102 | Concho Valley Transit District | Urbanized Area (San Angelo) and Nonurbanized |
| 6103 | Fort Bend County Public Transportation | Urbanized as subrecipient or contractor to designated recipient of §5307 funds, also Nonurbanized |
| 6107 | Texoma Area Paratransit System Inc. | Urbanized Area (Two: Sherman and McKinney) and Nonurbanized |
| 6108 | Harris County Community Services Department, Office of Transit Services | Urbanized as subrecipient or contractor to designated recipient of §5307 funds |
| TX001 | Aspermont Small Business Development Center, Inc. | Nonurbanized |
| TX002 | Panhandle Community Services | Nonurbanized |
| TX003 | Ark-Tex Council of Governments | Nonurbanized (but also urbanized for Texarkana, see urban list) |
| TX004 | South East Texas Regional Planning Commission | Nonurbanized |
| TX005 | Central Texas Rural Transit District | Nonurbanized |
| TX008 | Rolling Plains Management Corporation | Nonurbanized |
| TX009 | Bee Community Action Agency | Nonurbanized |
| TX010 | Kleberg County Human Services | Nonurbanized |
| TX011 | Rural Economic Assistance League, Inc. | Nonurbanized |
| TX012 | Community Services, Inc. | Nonurbanized |
| TX013 | SPAN, Inc. | Nonurbanized |
| TX014 | City of Cleburne | Nonurbanized |
| TX015 | Public Transit Services | Nonurbanized |
| TX016 | The Transit System, Inc. | Nonurbanized |
| TX018 | Webb County Community Action Agency | Nonurbanized |
| TX019 | Caprock Community Action Association, Inc. | Nonurbanized |
| TX020 | West Texas Opportunities, Inc. | Nonurbanized |
| TX022 | Texoma Area Paratransit System Inc. | Nonurbanized (but also urbanized for Sherman and McKinney, see urban list) |
| TX023 | Southwest Area Regional Transit District | Nonurbanized |
| TX024 | Lower Rio Grande Valley Development Council | Nonurbanized (but also urbanized for part of McAllen and Harlingen, see urban list) |
| TX025 | Town of South Padre Island | Nonurbanized |
| TX026 | Concho Valley Rural Transit District | Nonurbanized (but also urbanized for San Angelo, see urban list) |
| TX027 | Alamo Area Council of Governments | Nonurbanized |

| TRS ID | Agency | Agency Grouping |
|---|---|---|
| TX028 | Community Action Council of South Texas | Nonurbanized |
| TX029 | East Texas Council of Governments | Nonurbanized |
| TX030 | Heart of Texas Council of Governments | Nonurbanized |
| TX031 | Colorado Valley Transit, Inc. | Nonurbanized, but subrecipient or contractor to designated recipient of §5307 funds |
| TX032 | Golden Crescent Regional Planning | Nonurbanized (but also urbanized for Victoria, see urban list) |
| TX033 | Capitol Area Rural Transportation System | Both: Nonurbanized and Urbanized as direct recipient for San Marcos UZA, and contractor to designated recipient of §5307 funds in Austin UZA |
| TX034 | El Paso County | MTA |
| TX035 | South Plains Community Action Association, Inc. | Nonurbanized |
| TX036 | STAR Transit | Nonurbanized |
| TX038 | City of Del Rio | Nonurbanized |
| TX042 | Fort Bend County Rural Transit District | Nonurbanized |
| TX047 | Senior Center Resources and Public Transit, Inc. | Nonurbanized |

### §5310 Agencies

- 100 D.I.D. Memor Nurs & Rehab Ctr (Dumas)
- Adult Day Activity & Health Center (Lubbock)
- Air Force Village Foundation, Inc. (San Antonio)
- Aliviane NO-AD, Inc. (El Paso)
- Amarillo Multi. Ctr. for the Aging (Amarillo)
- American Red Cross Chisholm Chapter (Fort Worth)
- American Red Cross-Gtr Houston Area Chpt (Houston)
- Andrews Central Smith County (Tyler)
- Austin Groups for the Elderly (AGE) (Austin)
- Austin State Supported Living Center (Austin)
- Austin Travis Center Integral Care (Austin)
- Bastrop Co Emergency Food Pantry & Support Ctr Inc. (Bastrop)
- Big Bend Community Action Comittee, Inc. (Marfa)
- Big Bend Regional Medical Center (Alpine)
- Blessed Sacrament Church Senior Center (San Antonio)
- Booker Booster Club, Inc. dba Twin Oakes (Amarillo)
- Bowie Senior Citizens Project, Inc. (Bowie)
- Buena Vida Adult Daycare Center dba Lutheran Social Services
- C.C. Young Memorial Home (Dallas)
- Camp County Services Industries (Pittsburg)
- Centro de Salud Familiar La Fe, Inc. (El Paso)

- Chillicothe Travelers, Inc. (Chillicothe)
- Christian Senior Services (San Antonio)
- City of Marfa (Marfa)
- City Of Port Isabel (Port Isabel)
- City of San Antonio Support Serv. for Elderly (San Antonio)
- Coastal Bend Rural Health Partnership (Alice)
- Community Health Core (Marshall)
- Dallas County Department of Health & Human Serv. (Dallas)
- Dawson Co. Sr. Cits. Center (Lamesa)
- East Texas Support Services, Inc. (Jasper)
- Eden Hill Communities (New Braunfels)
- Electra Service Corporation (Electra)
- Evangelical Luth Good Sam Soc/dba Pks Good Sam Vge (Odessa)
- Faith In Action Caregiving (Round Rock)
- Farwell Convalescent Center (Farwell)
- Foard County Senior Citizens Corp. (Crowell)
- Foundation for MHMR/Permian Basin (Midland)
- Friendship Center of Montgomery County (Conroe)
- Gateway Community Partners, Inc. (Jacksonville)
- Golden Age Home (Lockhart)
- Good Samaritan Society White Acres (El Paso)
- Goodwill Industries of San Antonio (San Antonio)
- Greater Randolph Area Services Program (Converse)
- Harris County Transportation (Houston)
- Hays County Veterans Administration (San Marcos)
- Hill Country MHMR Center (San Marcos)
- Hockley County Senior Citizens (Levelland)
- Inman Christian Center (San Antonio)
- James L. West Presby. Spec Care Ctr (Fort Worth)
- Jim Hogg County (Hebbronville)
- Kirby Senior Center (Kirby)
- L.U.L.A.C. Project Amistad (El Paso)
- Legacy Assisted Living (Dalhart)
- Lubbock Independent School District Social Education (Lubbock)
- Marian Moss Enterprises, Inc. (Lubbock)
- Mary Lee Foundation (Austin)
- Menard County (Menard County)
- MHMR Services for Concho Valley (San Angelo)
- MHMR Tarrant County (Fort Worth)

- Mission Road Develop. Ctr. (San Antonio)
- Nazareth Hall Nursing Center (El Paso)
- Pecos Senior Center (Pecos)
- Plano Community Homes Sponsor (Plano)
- Prairie Acres Nursing Home (Friona)
- Presa Community Service Ctr. (San Antonio)
- Rio Concho Manor (San Angelo)
- Rio Concho West, Inc. (San Angelo)
- Salvation Army William Booth Garden Apts. (Tyler)
- San Antonio AIDS Foundation (San Antonio)
- San Antonio Lighthouse (San Antonio)
- San Juan de Los Lagos Church (San Antonio)
- Senior Adult Services (Farmers Branch)
- Senior Citizen Project of Chambers County (Anahuac)
- Seven Acres Jewish Geriatric Center (Houston)
- Southwest Key Program, Inc. (Brownsville)
- St. Gregory the Great Parish (San Antonio)
- Starr County Rural Transportation (Rio Grande City)
- Sterling County (Sterling County)
- Texarkana Special Education Center, Inc. (Texarkana)
- Town of Van Horn (El Paso)
- Trinity Terrace Retirement Center (Fort Worth)
- United Cerebral Palsy (Dallas)
- University Medical Center (El Paso)
- Ward County Grandfalls Senior Citizens (Grandfalls)
- Ward County Senior Citizens Center (Monahans)
- Wilmer Senior Center (Wilmer)
- Young County Senior Cub Center (Olney)
- Zapata County (Zapata)

# Appendix B: Data Needs and Sources

| Data Need | Purpose | Source |
|---|---|---|
| Verification of services, agencies in scope and groupings | • Some rural transit districts may provide urban (§5307) service and vice versa – need division of agency assets in order to report properly | TxDOT |
| Intercity bus assets public investment | • Intercity bus inventory<br>• For intercity bus Preservation and Service Expansion Needs | TxDOT – PTMS or §5311 grant history |
| Revenue Fleet Vehicle Inventory | • Update to most recent vehicle counts – particularly for §5310 operators<br>• Calculate agency specific useful lives<br>• For all modes Preservation and Service Expansion Needs | • NTD 2012<br>• TERM Fed<br>• TxDOT: PTMS |
| Facility Inventory | • Verify facility counts by agency and determine date built for facilities<br>• For all modes Preservation and Service Expansion Needs | • NTD 2012<br>• TERM Fed<br>• TxDOT: PTMS and TTI |
| Systems, Equipment and Guideway Inventory | • Verify/replace any generated records with actual inventory<br>• All modes Preservation and Service Expansion Needs | • TERM Fed<br>• TxDOT |
| Vehicle Prices from recent procurements | • Verify Vehicles Price List<br>• All modes unit costs | TxDOT |
| Formula funding – historic and projections | • Projected formula funding for constrained revenue scenarios | TxDOT and CH2M HILL |
| 5310 O&M Cost History and Funding | • For agencies with no transit capital assets, need to determine historic O&M expenditures and funding<br>• Determine method for future O&M costs outside of TEX Lite | TxDOT and CH2M HILL |
| Ridership projections outside of SAM V3 | • Historic trends and future projections for ridership<br>• Demand response, vanpool, ferry and rural bus route Service Expansion projections | TxDOT and CH2M HILL |
| Major New Service Estimates | • Update MTP/RTP details to include similar timeframe and project scope for Major New Service projects<br>• Update *Texas Rural Transportation Plan 2035* for Major New Services | TxDOT (with TTI support) |

# Appendix C: Initial Vehicle Price List

Initial Source: FTA's TERM Federal default pricing. To be updated by PTMS cost data when provided.

| NTD Name | TERM Element | TERM Sub-Element | Cost Year | Soft Cost | Unit Price |
|---|---|---|---|---|---|
| Articulated Bus (60 ft) | Bus | Articulated Bus (60 ft) | 2008 | 0 | $811,137.00 |
| Articulated Bus (60 ft) - CNG | Bus | Articulated Bus (60 ft) - CNG | 2008 | 0 | $811,137.00 |
| Articulated Bus (60 ft) - Diesel | Bus | Articulated Bus (60 ft) - Diesel | 2008 | 0 | $811,137.00 |
| Articulated Bus (60 ft) - Hybrid | Bus | Articulated Bus (60 ft) - Hybrid | 2008 | 0 | $811,137.00 |
| Automobiles | Vans, Cutaways and Autos | Automobile | 2004 | 0 | $26,480.90 |
| Bus | Bus | - | 2004 | 0 | $438,559.24 |
| Bus (<30 ft) | Bus | Bus (<30 ft) | 2008 | 0 | $87,451.00 |
| Bus (<30 ft) - CNG | Bus | Bus (<30 ft) - CNG | 2008 | 0 | $87,451.00 |
| Bus (<30 ft) - Diesel | Bus | Bus (<30 ft) - Diesel | 2008 | 0 | $87,451.00 |
| Bus (<30 ft) - Hybrid | Bus | Bus (<30 ft) - Hybrid | 2008 | 0 | $87,451.00 |
| Bus (30 ft) | Bus | Bus (30 ft) | 2004 | 0 | $261,893.78 |
| Bus (30 ft) - CNG | Bus | Bus (30 ft) - CNG | 2004 | 0 | $261,893.78 |
| Bus (30 ft) - Diesel | Bus | Bus (30 ft) - Diesel | 2004 | 0 | $261,893.78 |
| Bus (30 ft) - Hybrid | Bus | Bus (30 ft) - Hybrid | 2004 | 0 | $261,893.78 |
| Bus (35 ft) | Bus | Bus (35 ft) | 2008 | 0 | $338,665.15 |
| Bus (35 ft) - CNG | Bus | Bus (35 ft) - CNG | 2008 | 0 | $338,665.15 |
| Bus (35 ft) - Diesel | Bus | Bus (35 ft) - Diesel | 2008 | 0 | $338,665.15 |
| Bus (35 ft) - Hybrid | Bus | Bus (35 ft) - Hybrid | 2008 | 0 | $338,665.15 |
| Bus (40 ft) | Bus | Bus (40 ft) | 2008 | 0 | $438,559.24 |
| Bus (40 ft) - CNG | Bus | Bus (40 ft) - CNG | 2008 | 0 | $438,559.24 |
| Bus (40 ft) - Diesel | Bus | Bus (40 ft) - Diesel | 2008 | 0 | $438,559.24 |
| Bus (40 ft) - Hybrid | Bus | Bus (40 ft) - Hybrid | 2008 | 0 | $438,559.24 |
| Commuter rail locomotives | Commuter Rail | Revenue Locomotive | 2004 | 0 | $2,644,328.99 |
| Commuter rail passenger coaches | Commuter Rail | Passenger Car | 2004 | 0 | $2,286,375.00 |
| Commuter rail self-propelled passenger cars | Commuter Rail | Self-Propelled Passenger Car | 2004 | 0 | $2,523,500.00 |
| Cutaway | Vans, Cutaways and Autos | Light-Duty Van | 2009 | 0 | $52,000.00 |
| Ferryboats | Ferry Boat | Ferry Boat | 2004 | 0 | $8,045,195.03 |
| Light rail vehicles (Streetcars) | Light Rail | Street Car | 2008 | 0 | $4,053,788.55 |
| Minivan | Vans, Cutaways and Autos | Mini-Van | 2009 | 0 | $36,000.00 |
| Over-the-road bus | Bus | Over-the-Road Coach | 2009 | 0 | $466,839.00 |
| Sports utility vehicle | Vans, Cutaways and Autos | SUV | 2009 | 0 | $52,000.00 |
| Taxicab sedan | Vans, Cutaways and Autos | Automobile | 2004 | 0 | $26,480.90 |
| Taxicab van | Vans, Cutaways and Autos | Raised Roof Van | 2004 | 0 | $ 46,154.19 |
| Van | Vans, Cutaways and Autos | Medium-Duty Van | 2010 | 0 | $ 65,629.00 |

## Appendix D: Acronyms and Abbreviations

| | |
|---|---|
| ACM | annual capital maintenance |
| DO | directly operated services |
| DOT | department of transportation |
| FRA | Federal Rail Administration |
| FTA | Federal Transit Administration |
| MPO | Metropolitan Planning Organization |
| MTA | Metropolitan Transit Authority |
| MTP | Metropolitan Transportation Plan |
| NTD | National Transit Database |
| O&M | operation and maintenance |
| PT | contracted services |
| PTMS | Public Transportation Management System |
| RTP | Regional Transportation Plan |
| SETRPC | South East Texas Regional Planning Commission |
| SGR | State of Good Repair |
| TERM | Transit Economic Requirements Model |
| TRP | Texas Rail Plan |
| TTI | Texas Transportation Institute |
| TTP | Texas Transportation Plan |
| UZA | urbanized area |
| YOE | year of expenditure |

# Texas Transportation Plan

## Tech Memo 3.4: Bicycle and Pedestrian

January 15, 2014

## Acknowledgements

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## Tables

- Table 1: MPO Bicycle and Pedestrian Plans

# 1.0 Introduction

This memo describes the methodology proposed for assessing the bicycle-pedestrian mode within the Texas Transportation Plan (TTP). Bicycle and pedestrian planning has historically been performed at the local level and often lacks data and tools need to appropriately analyze usage, performance, and long-range forecasts. As interest and participation in these non-motorized modes continues to increase, local, regional, and statewide plans would ideally bring bicycle and pedestrian planning out of an existing informal and piecemeal process into a more formal process supported by data and tools. This will require a commitment at multiple levels of government as well as assistance from the public and advocacy groups.

While bicycle/pedestrian modal data are limited, a methodology for assessing system use and needs is described in the following sections. This methodology will be applied in Task 4 and includes investment types, an overview of agencies and plans reviewed, data availability and sources, information gaps, and methods for needs determination.

# 2.0 Scope of Analysis

The following sections provide a summary of the types of financial need, or investment, to be considered in the analysis for the TTP.

## *2.1 Types of Investment*

Government entities at various levels as well as other organizations and advocacy groups are involved with bicycle and pedestrian facility planning and construction in Texas. Investments within the bicycle/pedestrian mode can take on many forms, but typically involve the following general types of investment:

- Adding connectivity/service expansion
- Maintenance and preservation
- Safety enhancements
- Accessibility and implementation of Americans with Disabilities Act (ADA) standards

## *2.2 Modal Overview – Bicycle/Pedestrian Mode*

### 2.2.1 Overview of Texas Agencies/Departments

TxDOT

At the statewide level, TxDOT's bicycle and pedestrian interests are coordinated by the Statewide Bicycle and Pedestrian Coordinator within the Public Transportation Division. The Coordinator works cooperatively with TxDOT Divisions and Districts, local bicycle/pedestrian coordinators at cities and metropolitan planning organizations (MPOs), bicycle/pedestrian advocacy groups, and with the Federal Highway Administration (FHWA).

TxDOT also operates under a March 23, 2011 "*Memorandum for Guidelines Emphasizing Bicycle and Pedestrian Accommodations.*" These guidelines reflect a federal policy statement emphasizing an increased commitment to, and investment in, bicycle facilities and walking networks. The

guidelines provide District Engineers with guidance regarding the inclusion of bicycle and pedestrian facilities in urban and rural settings with designs constructed according to Texas Accessibility Standards and Americans with Disabilities Act Accessibility Guidelines, as well as the American Association of State Highway and Transportation Officials (AASHTO) *Guide for the Development of Bicycle Facilities* and TxDOT's *Roadway Design Manual*.

TxDOT maintains a Bicycle Advisory Committee within the Transportation Planning and Programming Division. This Committee involves representatives of the public and advises the Transportation Commission on bicycle issues and the Safe Routes to School Program (now part of the Transportation Alternatives Program). The Bicycle Advisory Committee advises the Commission regarding the Texas Bicycle Tourism Trails Act. This act was enacted by the Texas legislature in 2005 to develop bicycle tourism trails that reflect the geography, scenery, history, and cultural diversity of the state. Recommendations are made in consultation with the Texas Parks and Wildlife Department (TPWD) and may include multiuse trails to accommodate pedestrians, equestrians, and other non-motorized users.

### Texas Parks & Wildlife Department

TPWD manages approximately 90 state parks that offer a large variety of trails and roads for mountain biking, cycling, hiking, and nature walks. Trails are rated according to degree of difficulty and are typically included in informational brochures and maps available at each state park. In addition, TPWD manages the Great Texas Wildlife Trails Program, based around nine driving trails that direct users to over 950 destinations to view birds and wildlife. The program's first trail – The Great Texas Coastal Birding Trail (central coast section) – was developed in 1995 and was the nation's first wildlife trail.

### Texas Historical Commission

The Texas Historical Commission (THC) manages the Texas Heritage Trails Program. The Trails Program is a heritage tourism and economic development initiative that encourages communities, regions, and the state to partner and promote Texas' historic and cultural resources. The program is based around 10 heritage regions and scenic driving trails, with some regions promoting cycling.

### Metropolitan Planning Organizations

The 25 MPOs in Texas coordinate bicycle and pedestrian needs on a regional basis via their Metropolitan Plans (MTP) and/or stand-alone bicycle/pedestrian plans. A list of the MPOs and their bicycle/pedestrian plans can be found in Table 1 below (Section 3.1).

### Cities

Many of the larger cities in Texas plan bicycle and pedestrian needs on a local level via city bicycle/pedestrian plans. A list of city bicycle/pedestrian plans associated with cities within the 25 Texas MPOs can be found in Table 1 below (Section 3.1).

### 2.2.2 Overview of Pertinent Transportation Plans, Programs, and Studies Reviewed

Various plans, programs, and studies from government entities were reviewed for the bicycle and pedestrian modes and include the following:

US Department of Transportation and other National Sources

- US Federal Highway Administration (FHWA) National Household Travel Survey (NHTS)
- US Census American Community Survey (ACS)
- National Highway Traffic Safety Administration (NHTSA) Traffic Safety Facts – Bicyclists and Other Cyclists, April, 2013

TxDOT

- Memorandum for Guidelines Emphasizing Bicycle and Pedestrian Accommodations, 2011
- Transportation Alternatives Program
- Texas Bicycle Tourism Trails Act

TPWD

- Great Texas Wildlife Trails Program

THC

- Texas Heritage Trails Program

MPOs

- MTPs/Regional Transportation Plans (RTPs)
- Stand-alone Bicycle/Pedestrian Plans
- Other (see Table 1, Section 3.1)

Cities

- City Bicycle/Pedestrian Plans

In addition to these government entities, other organizations and advocacy groups are involved with bicycle and pedestrian facility planning, construction, and advocacy in Texas. Organizations operating on a national or statewide level and their pertinent plans, programs, and studies include the following:

American Association of State Highway and Transportation Officials (AASHTO)

AASHTO published their "*Guide for the Development of Bicycle Facilities, 4th Edition*" in 2012. TxDOT has implemented these guidelines for the planning, design, construction, maintenance, and operation of facilities that meet the needs of bicyclists and other highway users.

### League of American Bicyclists

The League of American Bicyclists, a national bicycle advocacy and education group, publishes an annual report analyzing U.S. Census Bureau American Community Survey Data regarding bicycling and bicycle commuting, which also ranks cities and states regarding bicycling statistics. The current report is titled "*Where We Ride – Analysis of Bicycling in American Cities, Annual American Community Survey Data Report for 2012.*"

### Bike Texas

Bike Texas was formed in 1991 and is a non-profit bicycle education and advocacy organization whose mission is advancing bicycle access, safety, and education in Texas. Bike Texas's "*Strategic Plan 2014–2019*" details their strategies and goals for Texas-wide bicycle advocacy and education on the national, statewide, and local levels.

### Rails-to-Trails Conservancy

Formed in 1986, the Rails-to-Trails Conservancy (RTC) is a non-profit organization whose mission is to create a nationwide network of trails from former and active rail lines and connecting corridors. RTC's "*America's Rails-with-Trails – A Resource for Planners, Agencies and Advocates on Trails Along Active Railroad Corridors,*" September 2013, provides data, examples, and practical tools to assist planners and advocates with rail-trail concepts and advancement of policies and practices that support rail-trail development.

### Alliance for Biking and Walking

The Alliance for Biking and Walking is a nonprofit organization which serves as a coalition of North America's local and state/province bicycle and pedestrian advocacy organizations. Their U.S. Bicycling and Walking Benchmarking Project is an on-going effort to collect and analyze data on bicycling and walking. Their latest report is titled "*Bicycling and Walking in the United States – 2012 Benchmarking Report*."

# 3.0 Data Collection

## *3.1 Data Availability and Sources – Bicycle/Pedestrian Mode*

### 3.1.1 Source(s) of Asset Conditions

While TxDOT works cooperatively with local governments and advocacy groups regarding bicycle/pedestrian projects and now operates with enhanced emphasis on bicycle/pedestrian facilities (via the March, 2011 "*Memorandum for Guidelines Emphasizing Bicycle and Pedestrian Accommodations*"), MPOs continue to be the main sources of bicycle/pedestrian planning and information within Texas. As discussed above, all 25 MPOs within Texas were surveyed for bicycle/pedestrian modal information within their respective MTPs and/or stand-alone bicycle/pedestrian plans. Table 1 depicts the 25 Texas MPOs reviewed, including information regarding their MTPs and any stand-alone bicycle/pedestrian plans or other pertinent plans and studies.

## Table 1: MPO Bicycle and Pedestrian Plans

| MPO | Location | Bike/Ped Included in MTP? | Additional Studies/Plans |
|---|---|---|---|
| Abilene MPO | Abilene, Texas | Yes | 2004 Abilene Comprehensive Plan<br>2006 City of Abilene Sidewalk Master Plan<br>2008 A Safe Routes to School Master Plan for Abilene |
| Amarillo MPO | Amarillo, Texas | Yes | 2010 Amarillo Hike and Bike Plan<br>2010 Amarillo Comprehensive Plan |
| CAMPO<br>(Capital Area MPO) | Austin, Texas | Yes | 2009 Bicycle Master Plan Update<br>2009 Sidewalk Master Plan<br>2011 Downtown Austin Plan<br>Imagine Austin, 2012 |
| South East Texas Regional Planning Commission (SETRPC) | Beaumont, Texas | Yes | |
| Brownsville MPO | Brownsville, Texas | Yes | 1996 Bicycle and Pedestrian Plan<br>2003 Bicycle and Pedestrian Plan Update<br>Brownsville Comprehensive Plan |
| Bryan-College Station MPO (BCSMPO) | Bryan-College Station, Texas | Yes | 2009 City of College Station Comprehensive Plan<br>2010 Bicycle, Pedestrian, and Greenways Master Plan |
| CRP | Corpus Christi, Texas | Yes | Oso Parkway Plan, 1993<br>Parks Master Plan for Corpus Christi, 2002<br>Corpus Christi Thoroughfare Plan, 2003<br>Corpus Christi MPO Bicycle and Pedestrian Plan, 2005 |
| El Paso | El Paso, Texas | Yes | Regional Bikeways Plan Study, 1997 |
| Harlingen-San Benito MPO<br>(HSB MPO) | Harlingen, Texas | Yes | Harlingen's Vision 2020 Comprehensive Plan First Major Plan Update, 2002 |
| Houston-Galveston Area Council<br>(H-GAC) | Houston-Galveston, Texas | Yes | 2007 Regional Bikeway Plan<br>Pedestrian and Bicyclist Special District Studies<br>Building Better Bikeways, 2009<br>Pedestrian Pathways<br>Bayou Greenway Initiative |
| Hidalgo MPO (HMPO) | Hidalgo, Texas | Yes | Multi-Modal Study, 2007<br>HCMPO Bike Plan, 2012 |
| Killeen-Temple MPO<br>(K-T MPO) | Belton, Texas | Yes | Killeen-Temple MPO Regional Thoroughfare and Bicycle/Pedestrian Plan, 2011 |
| Laredo | Laredo, Texas | Yes | Laredo Urban Transportation Study |
| Longview MPO | Longview, Texas | Yes | |
| Lubbock | Lubbock, Texas | | Texas Metropolitan Mobility Plan, 2006<br>Lubbock CBD Redevelopment Plan, 2006<br>Lubbock Metropolitan Area Bike Plan, 2007<br>2012 Bike Plan Update |
| Midland-Odessa Transportation Organization (MOTOR) | Odessa, Texas | Yes | Midland Master Plan 2025 |

**Table 1: MPO Bicycle and Pedestrian Plans**

| MPO | Location | Bike/Ped Included in MTP? | Additional Studies/Plans |
|---|---|---|---|
| North Central Texas Council of Governments (NCTCOG) | Dallas-Fort Worth, Texas | Yes | Bicycle and Pedestrian Advisory Committee<br>Bike Fort Worth, A Comprehensive Bicycle Transportation Plan, 2009<br>2011 Dallas Bike Plan |
| San Angelo MPO | San Angelo, Texas | Yes | The San Angelo Pedestrian/Transit Access Improvement Plan,<br>The North Chadbourne Corridor Pedestrian/Transit Access Improvement Plan, 2010<br>2005 Bicycle/Pedestrian Plan for the San Angelo Area, Amended 2012<br>San Angelo Comprehensive Plan, 2009<br>2011 Streetscape Master Plan<br>Parks, Recreation & Open Space Master Plan, 2012<br>Bicycle & Pedestrian Improvement Project, 2012 |
| San Antonio-Bexar County MPO (SABC MPO) | San Antonio, Texas | Yes | Bicycle Mobility Advisory Committee<br>Pedestrian Mobility Advisory Committee<br>Complete Streets Resolution, 2009<br>Regional Bicycle Master Plan, 2011<br>San Antonio Bike Plan 2011 + Implementation Strategy<br>Pedestrian Safety Action Plan, 2012 |
| Sherman-Denton MPO (SD-MPO) | Sherman, Texas | Yes | Bicycle and Pedestrian Mobility Plan, 1998 |
| Texarkana MPO | Texarkana, Texas | Yes | Master Bicycle and Pedestrian Plan, 2009 |
| Tyler MPO | Tyler, Texas | Yes | The Regional Trail Plan, 2009 |
| Victoria | Victoria, Texas | Yes | Paseo de Victoria, A Pedestrian and Bicycle Master Plan for Transportation and Recreation, 2013 |
| Waco Urban Transportation Study (WUTS) | Waco, Texas | Yes | Downtown Waco Master Plan |
| WFS MPO | Wichita Falls, Texas | Yes | Bicycle Master Plan, 2005-2030<br>Vision 2020 Wichita Falls, 2008 |

In general, data and information provided by the MTPs and other bicycle/pedestrian plans include the following:

- Maps of bicycle and pedestrian facilities – existing conditions and future projects
- Bicycle/pedestrian program goals and objectives
- Lists of accomplishments/completed projects
- Lists of priority future projects
- Definitions of facility types
- Fiscal information – constraints, priorities, unfunded projects
- Facility design best practices
- Promotion of biking and walking
- Safety information

## 3.2 Gaps in Data and Recommendations – Bicycle/Pedestrian Mode

### 3.2.1 Information Gaps

While interest and participation in non-motorized travel such as biking and walking continues to expand, significant data gaps remain for the bicycle/pedestrian mode. Current usage data and forecasting tools have historically not been available. Consequently, bicycle and pedestrian needs assessments have typically been performed informally, without the measurement and attention given to other modes. In addition, a lack of statewide inventories, a lack of rural area information, and the variable level of detail provided by MPOs and cities presents some data gaps regarding the extent of the existing bicycle/pedestrian network.

### 3.2.2 Recommendations of Additional Data Needed to Address Information Gaps

While national surveys provide some limited data, Texas MPOs that have made significant bicycle and pedestrian investments may provide some data and information regarding bicycle/pedestrian usage. In addition, non-Texas MPOs and other jurisdictions and/or universities have investigated methods to address these common information gaps for the bicycle and pedestrian modes.

# 4.0 Needs Determination

The following sections provide a high-level summary of the methods used to estimate system needs for the TTP. The summary includes how bicycle/pedestrian needs can be defined, identified, and assessed given the data gaps discussed above.

## 4.1 Defining "Needs"

As discussed above, measurement of bicycle/pedestrian usage and future needs assessment is not widely performed and suffers from a lack of available information. However, due to increased focus and participation within these modes, the TTP will estimate system bicycle/pedestrian needs based on available information. With a lack of usage and performance data, needs will be identified and assessed as described below.

## 4.2 Identifying Investments

Identification of bicycle/pedestrian improvement projects with respective costs and benefits can be performed as follows:

1. Compile MPO or city-identified future projects with costs where available.
2. Identify urban area bike/ped system gaps that have no planned projects to address them and could benefit from future construction. Following identification of these system gaps, apply high-level estimated costs to identify potential future project costs and include these in the financial needs determination.
3. Include needs identified in Outreach Round 1.

## *4.3 Assessing "Needs"*

Following the identification of improvement projects as described above, gaps would remain for rural area bicycle/pedestrian needs and maintenance and accessibility needs and costs where not identified by MPOs or cities. Assumptions could be attempted for these, but might be difficult to identify. Nevertheless, the sum of MPO and city-identified future project costs (#1 above) in addition to the high-level estimated projects and costs (#2 above) will provide cost information for statewide bicycle/pedestrian needs.

# Texas Transportation Plan

## Tech Memo 3.5: Aviation

February 28, 2014

## Acknowledgements

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## Table

- Table 1: Expected Growth in Airport Operations

## 1.0 Introduction/Scope

As the Texas state economy continues to grow at one of the fastest rates in the nation, increased demand for aviation services will create an operational challenge for the 292 airports[1] and two heliports for which TxDOT oversees capital development and maintenance programs and administers a block grant program. Aeronautics in the State of Texas had a total economic impact of $59.5 billion ($14.5 billion from general aviation) and supported 771,355 jobs in the State of Texas in 2010. With further forecasted economic growth in oil and gas production and a 61 percent and 80 percent respective growth in population and employment between 2010 and 2040, Texas airports will require significant investment levels to maintain/improve current levels of service.

This memo details a methodology for assessing long-term needs in light of forecasted airport service demand, and identifies data availability and gaps. The scope of the analysis will include the following:

- For all airports (commercial and general aviation) – collect, report, and develop needs based on data extrapolated from the existing 20-year capital program
- Provide recommendations for constrained priorities, as well as ongoing performance monitoring.

Furthermore, per discussions with TxDOT staff, a brief overview of best practices in airport asset management is included to help prepare future plans for a performance-based approach.

The memo is organized as follows:

- Introduction and Scope of aviation analysis
- Aviation demand forecasts
- Airport data availability and asset management best practices
- Methodology for needs assessment

## 2.0 Aviation Demand Forecasts

In 2012 the State of Texas ranked 3rd (behind California and Florida) in Tower Operations (which includes Touch-and-goes and Over flights) with a total of 4,674,903 Operations (Source: FAA). Preliminary estimates, reported in the 2010 Texas Airport System Plan, anticipates general aviation operations (takeoffs and landings) to increase by nearly 20 percent with a 65 percent increase in passenger enplanements between 2010 and 2025. Assuming the corresponding annual compounded growth rate (1.2 percent for general aviation operations and 3.4 percent for enplanements) continues, Texas airport operations can be expected to reach 7.4 million general aviation operations and 165 million passenger enplanements by 2040.

[1] Of the 292 airports, 241 are classified as General Aviation. 26 as Primary Commercial Service, 24 as Reliever, and one non-primary commercial service.

**Table 1: Expected Growth in Airport Operations**

| Demand Measure | 2010 | 2025 | 2040 (extrapolated) |
|---|---|---|---|
| General Aviation Operations | 5.2 Million | 6.2 Million | 7.4 Million |
| Passenger Enplanements | 60.5 Million | ~100 Million | 165 Million |

Source: 2010 Texas Airport System Plan

Texas' two busiest Airports, DFW (Dallas/Ft. Worth International Airport), and IAH (George Bush Intercontinental/Houston Airport) had 27,557,000 and 19,356,000 enplanements respectively in 2010. The FAA predicts that DFW will have an annual compounded growth rate of 1.96 percent while IAH will have a growth rate of 3.18 percent.

With urban growth and further economic development around increasing oil and gas production, airports may need to build longer runways to accommodate larger business aviation aircraft. This new demand could lead to a widening funding gap in the future if it is not properly anticipated and planned for. This recognition leads to the importance of improving data collection and analytical efforts through enhanced TxDOT Airport Asset Management processes.

## 3.0 Data Collection

Along with reviewing future demand projections, the Consultant Team gathered and reviewed the following documents: the 2010 Texas Airport System Plan, the General Aviation Economic Impact Study, the Pavement Management Program, the Routine Airport Maintenance Program (RAMP), and various FAA Reports including Operations counts and TAF Summary Reports.

To further understand the state airport management practices, the Consultant Team compiled the following questions concerning current conditions and long-term investment needs. This informal questionnaire was sent to a random sampling of General Aviation and Commercial airport operators across the state to better understand the data available for integration into the TTP 2040:

1. What is the average lifespan of a piece of airport equipment?
2. Do you have a program or system for tracking airport facility and equipment useful life?
3. Do you have an obstruction plan in your airport layout plan set?
4. Are there any obstructions around the airport impacting normal operations?
5. Do you have any obstruction removal plans? Do you have a Comprehensive Zoning Ordinance that helps limit tall structures and obstructions?
6. When was the last master plan?
7. Was there anything missing in the master plan?
8. Do your fuel farms fully comply with environmental regulations?
9. Do you have a Storm Water Management Plan?

10. Do you have a storm water pollution prevention plan (SWPPP) for your tenants?
11. Do you have your own pavement maintenance program?
12. What type of asset rehabilitation plans do you have (Pavement, Buildings, etc.)?
13. Do you have an adequate capital maintenance budget to keep all of your (airport owned) assets in their best condition for maximizing useful life?
14. Do you get money from TxDOT for capital maintenance each year? If so, how much do you receive?

This informal survey generally found that no common data system is available to identify future projects at the network level.

Discussions with Central Office staff additionally provided information on the System Plan Overview, Capital Programs, and how Capital Needs are supported. Information about the Block Grant Program and the Planning and Engineering Services that are provided to smaller airports were also discussed. As a result of these discussions, TxDOT staff expressed interest in best practices that could be applied to improve the ability to predict and meet future needs. Prior to discussing the needs methodology, a discussion of airport asset management programs is presented herein.

## 4.0 Best Practices

Having adequate asset management programs, obstruction management plans, appropriate funding, and the ability to maintain environmental compliance will benefit the continued growth and robust capital improvement programs of the Aviation Division of the Texas Department of Transportation.

Many airports in Texas do not have asset management programs, complete Pavement Condition Index (PCI) data, or an obstruction management plan, or do not maintain full environmental compliance. In addition, many airports do not fully take advantage of the State's funding system. The following are some best practices applicable to all airports within the Texas Airport System.

### *4.1 Pavement and Building Maintenance (Asset Management Programs)*

Asset management is the planned, proactive, and cost-effective practice of constructing, operating, maintaining, upgrading, and disposing of assets. It can refer to the act of managing assets to achieve the greatest possible return on investment and to optimize the total cost of ownership for the owner. An effective asset management program can cover everything from airport vehicles, buildings, and pavements to security systems, signage, and drainage.

Airport industry best practices regarding the management of physical assets would include strong leasehold maintenance language with enforcement rights for airport owners, as well as lease reversion for longer-term leased assets. The American Association of Airport Executives maintains a data base of best practice standard lease agreements that can be used as a solid starting point for airport owners in need of a better return for their leasing programs.

Currently TxDOT also offers programs to help offset the costs of eligible asset maintenance work items. The first one is the Routine Airport Maintenance Program (RAMP), which covers items such as pavement maintenance, airfield lighting, security, etc. The program will match up to $50,000 per year for each airport that qualifies. In 2012, only 214 airports took advantage of the program. This is an excellent program in that it allows airports to leverage their local maintenance budgets as a means of doubling their civil works airport maintenance programs.

TxDOT also offers funding for construction of new terminal buildings under the Terminal Building Program. The state will split a 50/50 cost share for design and construction up to $1,000,000; 50/50 cost share for vehicle parking and entrance road up to $100,000; and a 90/10 cost share for aircraft parking aprons in addition to the building grant amount. These building and facility renovation programs can be used to revamp and improve the revenue potential for these airport facilities while relieving the airport owner from the high level of maintenance costs associated with older facilities.

A PCI is recommended for establishing a pavement maintenance program at all airports with hard pavement. Currently, many of the state's airports do not have PCIs for their pavements. Having an airport wide PCI for each TxDOT airport would establish a deterioration baseline and set the schedule and timing for more significant capital pavement maintenance. Managing the PCI and resulting maintenance regime would greatly extend the useful life of the more heavily used runway pavements. TxDOT offers a new program that conducts PCI studies annually and establishes a PCI for those airports not currently having one. It is highly recommended that airports take advantage of this service. Having a complete up-to-date PCI is extremely important from a long-term asset management perspective for all airports in the Texas system. As a Federal Block Grant Program state, Texas is able to offer airports within the state system access to maintenance and large capital funding to both maintain and remediate airports with low PCI pavements.

## *4.2 Obstruction Management*

Obstruction management is the proactive act of keeping the airspace around the airport clear of any ground-based obstructions that may impede aircraft either arriving at or departing from a given airport. Obstruction management is extremely important for all airports. Obstructions can create extreme approach or departure routes and are obviously unsafe around airports.

For many airports in the National Airspace System, it is a struggle to keep Runway Protected Zones and Imaginary Surfaces free of obstacles. In many cases this is a maintenance issue related to the funding levels at airports. Federal Aviation Regulation (FAR) Part 77 includes standards for determining obstructions in navigable airspace, which apply to existing and future manufactured objects, objects of natural growth, and terrain. The airport operator is responsible for clearing and protecting the "imaginary surfaces" as defined in Part 77. It is recommended that airports push for a comprehensive zoning plan to help enforce these regulations. If an object is an obstruction to a Part 77 surface, it should be removed if feasible. If not achievable or feasible, the obstruction is subject to FAA analysis under the U.S. Standard for Terminal Procedures Order 7400.2 (TERPS) to

determine if the object is a hazard to air navigation. Hazards that cannot be removed usually result in restrictions in the airspace environment. Federal funds are available for any feasible obstruction removal programs.

Best practices for obstruction maintenance at airports are centered on comprehensive zoning ordinances that are typically enacted by local municipalities. These ordinances are very effective in helping to maintain the full use of airport runways, and instrument approach procedures in locations where they are in force. Many state aviation agencies have compatible legislation that provides an additional layer of support to municipal airport owners regarding airport compatible zoning provisions. Some states also provide a zoning ordinance best practice clearinghouse function for their airports that includes educational programs and blanket zoning ordinances that can easily be adapted to each individual airport and municipality.

## *4.3 Environmental Compliance*

Environmental compliance covers everything from water quality, air quality, and erosion control to fuel farm compliance. Environmental compliance is more important than ever. Not only does the Environmental Protection Agency (EPA) monitor environmental conditions, but there are smaller city and county governmental agencies that are empowered to monitor environmental compliance at the local level.

Fuel farms are required to be maintained under certain standards under the EPA. The EPA also requires a Spill Prevention, Control, and Countermeasure (SPCC) Plan if a hydrocarbon spill from the fuel farm could reach water and/or the airport stores of oil or gas in aboveground quantities of more than 1,320 gallons or completely buried tanks with more than 42,000 gallons below ground. Fuel farms that do not completely comply with state and federal regulations are eligible for funding under the RAMP Program. Additionally, TxDOT offers a very robust funding program for decommissioning and rebuilding fuel farms that are no longer environmentally compliant. The Texas airports should work with and seek advice from TxDOT regarding their fuel farm environmental compliance needs.

## *4.4 Airport Master Plans*

In pulling all of these data collection and airport programs together, it is recommended for Texas airports to maintain an updated master plan. The FAA recommends initiating an airport master plan update for most airports on a 5-year cycle. This best practice helps the state and the airport sponsor plan for future airport needs. The plan should include planning for all traditional short-, medium-, and long-term capital needs. Additionally, for certain airports in the commercial service or reliever airport designation, the FAA will now fund safety and security planning and business/strategic planning modules as part of a master plan update, or possibly as a stand alone. It is highly recommended that the Texas airports take advantage of these planning programs as a means of improving the business/commercial, and safety/security aspects of their airport operations.

Currently, certain rural airports lack the funding to match TxDOT grant funding to perform an airport master plan. Additionally, certain reliever and more substantial general aviation airports have airport master plans that are dated and no longer valid. TxDOT offers these and other airports planning and engineering services that they can take advantage of at a reasonable local match cost. Also, TxDOT, through the Block Grant Program, is very responsive in programming funding for master plan updates for those airports that apply.

# 5.0 Methodology

## *5.1 Unconstrained Needs Assessment*

TxDOT needs assessments have been traditionally developed through the Texas Airport Development System (TADS). The TADS provides a 20-year outlook of identified airport projects throughout the state. For each project the TADS maintains a database including a description, airport location, FAA Priority Score (including individual scoring components), and estimated construction cost.

The needs for the state over the next 20 years are then the total cost of projects in the TADS. From this number, extrapolation techniques (due to a lack of airport data available across the network) are to be applied to estimate long-term needs through 2040. For instance, demand forecasts are one metric that can be linked to current needs to help provide a clearer long-term picture for Texas. This needs total would then represent the cost to remove all current and projected deficiencies with regard to safety/security, statutory emphasis projects, reconstruction/rehabilitation, environment, planning, capacity, standards, and other local projects.

## *5.2 Financially-Constrained Analysis and Performance-Based Recommendations*

As most clearly seen by the current backlog of projects, Texas airport investment levels are not expected to be able to fully fund identified needs. Towards this end, an approach to quantify what can be achieved at reduced funding levels is critical to set realistic performance targets. The proposed framework to support TxDOT in linking performance to investment level is to optimize sets of projects from the TADS for a variety of potential budget levels. This is proposed to be done by maximizing the program FAA priority score relative to the constraining budget by changing which projects can be implemented.

Additionally, performance measures will be analyzed and recommendations will be made to gather/monitor performance data. In the long-term, this information can be reported to provide potential performance scenarios for the state, along with the overall percent needs able to be funded.

# Texas Transportation Plan

## Tech Memo 3.6: Intelligent Transportation Systems

January 15, 2014

## Acknowledgements

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# 1.0 Introduction

The purpose of this memorandum is to describe how the planning team will develop a long-range cost analysis for all Intelligent Transportation System (ITS) devices located in each district of the Texas Department of Transportation to assist with the long-range statewide planning.

The memorandum is organized into the following sections:

1. Scope of Analysis
    a. Investment
    b. Overview
2. Data Collection
    a. Data Availability
    b. Gaps in Data
3. Needs Determination
4. Constrained Analysis

# 2.0 Scope of Analysis

The following sections provide a summary of the types of financial need, or investment, considered in the analysis and the scope of services included for consideration in the Texas Transportation Plan (TTP). Also provided is the agency/stakeholder involvement by district and/or metropolitan planning organization (MPO) and a summary list of the documents reviewed.

## *2.1 Types of Investment*

- **Preservation:** The capital investment required to maintain existing assets in a state of good repair (SGR). Reinvestment needs include rehabilitation and replacement of assets, as well as annual capital maintenance (ACM) needs. This will also include the cost of operating and maintaining (O&M) existing assets for current levels.
- **Service Expansion:** The capital investments and O&M costs for projected growth in levels based on the established long-range plans for each district. Service expansion includes the placement of new ITS devices, and the related expansion to existing facilities in response to growth and demand.
- **Major New Service:** The capital investments and related O&M costs to significantly improve levels of performance via enhancements to existing ITS systems or the extension and placement of new ITS systems and programs into new areas based on the established long-range plans for each district.

## 2.2 *Agency Involvement*

There are multiple agencies/stakeholders (including private groups) within the state of Texas that are or will be responsible for the funding, implementation, and O&M of the existing and proposed ITS assets. In some regions, ITS is managed primarily at the TxDOT District while in other regions ITS planning and implementation are coordinated by regional stakeholders. The stakeholders are identified in each District's or region's ITS Deployment Plan and will not be repeated here. Each region's ITS Deployment Plan identifies the responsible agency(s) but typically does not provide the sharing percentages when multiple agencies are involved. The following sections will identify the different services and agencies currently involved in ITS planning at an aggregated level.

### 2.2.1 Stakeholder Participation

A diverse group of stakeholders provide guidance and input to the development of each District or region's ITS Architecture and Deployment Plans. The stakeholders include not only the TxDOT District, but also numerous other participants:

- City Agencies
- County Agencies
- MPOs
- Emergency Services
- TxDOT Central Office Divisions
- FHWA
- Motor Carrier Administration
- ISPs
- Border Patrol
- School Districts
- Department of Safety

### 2.2.2 ITS Regional Transportation Services

As each TxDOT District developed the ITS Deployment Plan, the projects to be deployed were identified as short-term (<5 years), mid-term (5-10 years), and long-term (20 years). The projects to be deployed were then grouped with other like projects and placed in the categories below:

- Travel/Traffic Management
- Commercial Vehicle Operations
- Emergency/Incident Management
- Maintenance and Construction Operations
- Public Transportation Management
- Information (Archived Data) Management

### 2.2.3 ITS Regional Transportation Plans, Programs, and Studies

The Texas Regional Intelligent Transportation System Architectures website describes the regional architectures for the majority of TxDOT districts, with the major urban centers of Dallas and Houston represented by the regional MPO. Texas began to develop the regional ITS architecture in 2002, with the most recent plan completed by Eagle Pass in 2013. The regions and completion dates are listed below:

- Amarillo—January 2003
- Atlanta—November 2003
- Austin—February 2007
- Beaumont—December 2003
- Brazos Valley (Bryan)—April 2004
- Childress—August 2003
- Corpus Christi—April 2003
- Del Rio—February 2004
- Eagle Pass—October 2013
- El Paso—October 2003
- Laredo—June 2003
- Lower Rio Grande Valley (Pharr)—July 2003
- Lubbock—February 2005
- Lufkin—June 2005
- Paris—May 2005
- Permian Basin (Odessa)—March 2005
- San Angelo—November 2004
- San Antonio—August 2007
- Tyler—July 2003
- Waco—October 2004
- West Central Texas (Abilene and Brownwood)—September 2004
- Wichita Falls—January 2005
- Yoakum—July 2005

There are 25 MPOs in the state of Texas. The MPOs collaborated with TxDOT in the development of the ITS Architecture, but each MPO also produces a long-range regional transportation plan. Typically, the long-range plans address the mobility needs of the study areas from 2010 through 2035 and produce a funded and unfunded project list and included a four-year Transportation Improvement Program (TIP). The plans most often do not break out the ITS architecture needs from the other projects. Plans are available from the following MPOs:

- Abilene MPO
- Amarillo MPO
- Austin MPO (CAMPO)
- Beaumont-Port Arthur MPO (SETRPC-MPO)
- Brownsville MPO
- Bryan-College Station MPO
- Corpus Christi MPO
- Dallas-Fort Worth MPO (NCTCOG)
- El Paso MPO
- Harlingen-San Benito MPO
- Hidalgo County MPO
- Houston-Galveston MPO (HGAC)
- Killeen-Temple MPO (KTMPO)
- Laredo MPO
- Longview MPO
- Midland-Odessa MPO (MOTOR)
- San Angelo MPO
- San Antonio-Bexar County MPO
- Sherman-Denison MPO
- Texarkana MPO
- Tyler Area MPO
- Victoria MPO
- Waco MPO
- Wichita Falls MPO

Each MPO provides a TIP that is developed in accordance with the requirements of metropolitan planning guidance received from the Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA). Some of the specific requirements include:

- Establish a priority list of projects to be implemented during a 4-year period
- Include a financial plan showing the source of funding for each project
- Assure that projects are consistent with the RTP
- Assure that the public is allowed time to comment on the TIP prior to approval
- Assure that the entire metropolitan region is included in the TIP
- Verify that previous TIPs show progress in implementing projects

# 3.0 ITS Data Collection

The following sections provide a summary of the data used to estimate ITS needs in later sections for the TTP. The summary includes:

- Current Inventory provided by TxDOT
- ITS Projects by District
- ITS Data collected from non-TxDOT sources
- ITS Subsystem/Unit Costs

## *3.1 Current Inventory Data*

Each TxDOT District office provided an aggregated summary of ITS devices in place as of 2013. The summary includes the number of devices by type for each district. The devices include the following:

- Digital Message Sign (DMS)
- Closed Circuit Television Camera (CCTV)
- Lane Control Signals (LCS)
- Radar Detection
- Detection Loops
- Highway Advisory Radio (HAR)
- Ramp Meters
- Automatic Vehicle Identification (AVI) Sites
- Flood Warning Sensors
- Weather Sensors

**Table 1 Texas ITS Asset Inventory**

| District | DMS | CCTV | CCTV Wireless | LCS | Radar Detection | Loops | HAR | Ramp Meter | AVI Site | Flood Warning | Weather Sensor | Total | RITA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Abilene (West Central TX) | 4 | 0 | 0 | | | | | | | | | 4 | 4 |
| Amarillo | 13 | 16 | 0 | | | | 1 | | | | 0 | 30 | 29 |
| Atlanta | 10 | 0 | 14 | | 0 | | | | | | 2 | 26 | 0 |
| Austin | 49 | 168 | 0 | 389 | 35 | 2720 | 6 | | | | | 3367 | 301 |
| Beaumont | 19 | 0 | 30 | | | | | | | | | 49 | 19 |
| Brownwood (West Central TX) | 3 | 0 | 4 | | | | | | | | | 7 | 7 |
| Bryan (Brazos Valley Region) | 3 | 6 | 2 | | | | | | | | | 11 | 11 |
| Childress | 0 | 0 | 0 | | | | | | | | | 0 | 0 |
| Corpus Christi | 22 | 40 | 0 | | 5 | | | | | | | 67 | 57 |
| Dallas | 92 | 193 | 118 | 24 | 250 | | | | | | | 677 | 657 |
| El Paso | 50 | 112 | 0 | 206 | 281 | | 13 | | | | | 662 | 264 |
| Ft Worth | 71 | 81 | 98 | | 141 | | | | | 0 | | 391 | 465 |
| Houston | 181 | 636 | 75 | | 165 | 0 | 11 | 86 | 158 | 24 | 23 | 1359 | 1149 |
| Laredo (Laredo/Del Rio/Eagle Pass) | 18 | 23 | 12 | 64 | 14 | 64 | | | | | | 195 | 48 |
| Lubbock | 4 | 15 | 6 | | 4 | | | | | 3 | 0 | 32 | 25 |
| Lufkin | 0 | 0 | 0 | | | | | | | | | 0 | 0 |
| Odessa (Permian Basin TxDOT) | 4 | 0 | 6 | | | | | | | | 1 | 11 | 10 |
| Paris | 4 | 0 | 0 | | | | | | | | | 4 | 0 |
| Pharr (Lower Rio Grande Valley) | 16 | 1 | 0 | | | | | | | | | 17 | 0 |
| San Angelo | 0 | 0 | 0 | | | | | | | | | 0 | 0 |
| San Antonio | 216 | 147 | 19 | 263 | 149 | 1025 | 1 | | | 19 | | 1839 | 720 |
| Tyler | 2 | 0 | 0 | | | | 0 | | | | | 2 | 0 |
| Waco | 6 | 2 | 2 | | | | | | | | | 10 | 7 |
| Wichita Falls | 4 | 0 | 9 | | | 22 | | | | 1 | 8 | 44 | 13 |
| Yoakum | 6 | 0 | 0 | | 1 | | | | | | | 7 | 0 |
| **STATEWIDE** | 797 | 1440 | 395 | 946 | 1045 | 3831 | 32 | 86 | 158 | 47 | 34 | 8811 | 3786 |

**Notes:**
AVI: automatic vehicle identification
CCTV: closed circuit TV
DMS: digital message sign
HAR: highway advisory radio
LCS: lane control signal
RITA: Research and Innovative Technology Administration

The condition or location of each asset is not available at this time.

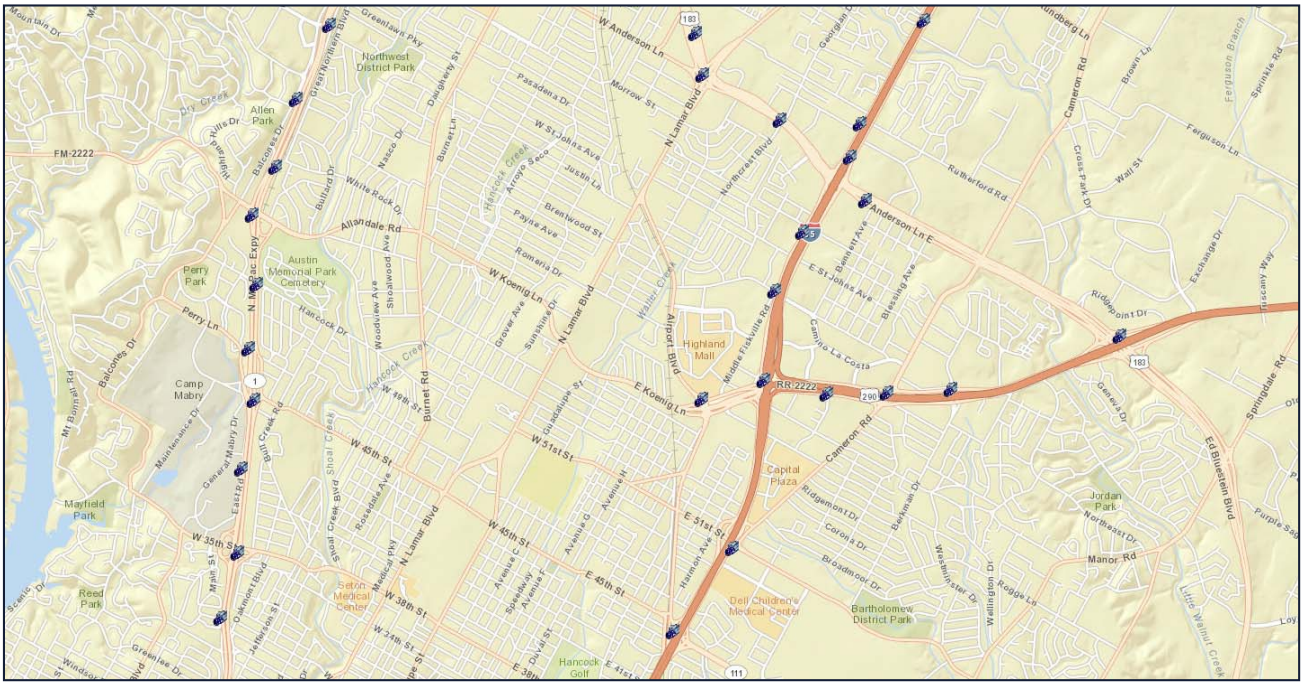
## 3.2 ITS Projects

The ITS Architectural Plans provided by each district identified service packages (formerly known as market packages) to launch and categorize the packages as High Priority, Medium Priority, and Low Priority. Service packages provide an accessible, service-oriented perspective to the National ITS Architecture. Stakeholders from each district were asked to prioritize the service packages. The packages are tailored to fit, separately or in combination, real work transportation problems and needs. Simply put, the packages identify the pieces of the physical architecture that are required to implement a particular ITS service. Each district then selected projects that meet the needs of the priority packages and categorized each project as short-term (<5 years), mid-term (5-10 years), and long-term (10-20 years). Each of the projects identified included an estimated cost, agency responsibility, and funding source (if available). It should be noted that even if a service package is considered high-priority, it could be classified as a long-term project because of funding or prerequisite project requirements, so deployment might not be feasible for several years.

## 3.3 Other ITS Data

The database and shapefiles used in the ITS Asset Viewer on the U.S. Department of Transportation – Research and Innovative Technology Administration (RITA) website was obtained. A screenshot of the ITS Viewer near the interchange of I-35 and State Route 290 in Austin, Texas is included below. This database provides the ITS asset type and location for most devices in place. The database appears to be current through 2012, but does differ from the aggregated summary provided by TxDOT as described in Section 3.1.

**Figure 1 RITA ITS Viewer**



## 3.4 ITS Costs—Capital and O&M

Historical ITS costs are not available from TXDOT. To arrive at a reliable estimate of costs, historical costs will be used from a national database. RITA provides access to its Costs Database which provides cost estimates for ITS deployments. The Costs Database will be used to assist in determining the long-term funding needed to maintain existing ITS assets as well as the capital costs of projects that are to be launched and maintained. The Costs Database provides both unit costs as well as system costs summaries. The unit costs will be used to determine the maintenance and replacement costs while the systems costs can be used to estimate the funds needed to launch future projects.

## 3.5 Gaps in Data and Recommendations

The accuracy of the needs estimate could be improved with additional data.

1. Age of current ITS assets—An accurate age of each device in place would allow for replacement costs to be accurately forecasted, or more specifically, when a specific device would be forecasted to fail. This is not a fatal flaw to determine the overall need, as the age of the devices can be spread out based on the forecasted life span of each device.
2. The life spans of the existing and proposed ITS assets will be based on information provided from the RITA website. The RITA website is an average across the United States and does not take into account the weather conditions of the different parts of the country. If the life spans of devices in Texas vary, that will not be accounted for unless that specific information can be provided.
3. Ideally, updated deployment plans for each district would be provided to identify which of the projects have been launched, implemented, removed/added to the long-range plan. The deployment plans would also include the specific devices to be installed or the forecasted annual maintenance cost for each project.
4. Finally, ideally the RITA database reflecting the ITS assets in place in the state of Texas would match the aggregated summary provided by the districts. While this will not have a direct impact on the needs determination, it would allow more accurate future management of the devices.

# 4.0 Needs Determination

The following sections provide a high-level summary of the methods used to estimate ITS needs for the TTP. The summary includes:

- Assumptions
- Estimate of Preservation and Service Expansion needs
- Major New Service project collection
- Constrained funding scenarios

## *4.1 Financial Assumptions*

A basic set of financial assumptions are required to estimate capital and O&M costs for ITS assets over time. The assumptions include replacement costs, life-cycle costs, and inflation rates; and are presented below.

### 4.1.1 Unit Costs

Developing and maintaining an accurate database for the ITS asset inventory is a resource intensive task in itself. Rather than create the database, RITA has established system costs and unit costs that can be used at both the planning level and the O&M level.

Table 2 shows unit capital costs and O&M costs for select ITS devices in place throughout the multiple districts within TxDOT. The average costs between the high and low estimates will be used for both the capital costs and the O&M costs. All costs are reflected in year 2009 dollars. The unit costs applied to ITS assets in Texas will be adjusted to current year figures.

## Table 2 ITS Cost Elements (USDOT/RITA)

| Subsystem/Unit Cost Element | Lifetime (years)* | Capital Cost ($K) | | O&M Cost ($K/year) | | Description |
|---|---|---|---|---|---|---|
| | | Low | High | Low | High | |
| Inductive Loop Surveillance on Corridor | 5 | 2 | 6 | 0.3 | 0.5 | Double set (four loops) with controller, power, etc. |
| Inductive Loop Surveillance at Intersection | 5 | 7.5 | 13.3 | 0.8 | 1.2 | Four legs, two lanes per approach. |
| Infrared Sensor Active | | 4.7 | 6 | | | Sensors detects movement in two directions and determines vehicle speed, classification, and lane position. |
| Infrared Sensor Passive | | 0.6 | 1.0 | | | Sensor covers one lane and detects vehicle count, volume, and classification. |
| CCTV Video Camera | 10 | 8 | 16 | 1 | 2.0 | Cost includes color video camera with pan, tilt, and zoom (PTZ), cabinet, electrical services, encoder/decoder, and installation. |
| CCTV Video Camera Tower | 20 | 5 | 14 | | | Low cost is for a 35 ft tower. High cost is for 90 ft tower. Includes foundation, pole, conduit, and labor. Camera lowering unit would be additional. Camera tower requires minimal maintenance. |
| Environmental Sensing Station (Weather Station) | 25 | 25 | 42 | 1.6 | 3 | Environmental Sensing Station (ESS), also known as a weather station, consists of pavement temperature sensor, subsurface temperature sensor, precipitation sensor (type & rate), wind sensor (speed & direction), air temperature and humidity sensors, visibility sensors, and remote processing unit (RPU). ESS provide condition data and are basic components of larger Road Weather Information Systems (see RWIS under TMC subsystem). RPU replaced every five years. O&M includes calibration, equipment repairs, and replacement of damaged equipment. O&M costs could be higher if state provided maintenance. |
| Ramp Meter | 5 | 21 | 42 | 1.0 | 2.3 | Includes ramp meter assembly, signal displays, controller, cabinet, detection, and optimization. |
| Software for Lane Control | 20 | 25 | 50 | 2 | 5 | Software and hardware at site. Software is off-the-shelf technology and unit price does not reflect product development. |
| Lane Control Gates | 20 | 66 | 100 | 1.3 | 2 | Per location. |
| Fixed Lane Signal | 20 | 4 | 5 | 0.4 | 0.5 | Cost per signal. |
| Dynamic Message Sign | 10 | 41 | 101 | 2.0 | 5 | Low capital cost is for smaller DMS installed along arterial. High capital cost is for full matrix, LED, three-line, walk-in DMS installed on freeway. Cost does not include installation. |
| Dynamic Message Sign Tower | 20 | 28 | 136 | | | Low capital cost is for a small structure for arterials. High capital cost is for a larger structure spanning three to four lanes. DMS tower structure requires minimal maintenance. |
| Dynamic Message Sign – Portable | 14 | 15.9 | 21 | 0.5 | 1.6 | Trailer mounted full matrix DMS (three-line, 8-inch character display); includes trailer, solar or diesel powered, and equipped with cellular modem for remote communication and control. Operating costs are for labor and replacement parts. |
| Highway Advisory Radio | 20 | 15 | 36 | 0.6 | 1 | Capital cost is for a 10-watt HAR. Includes processor, antenna, transmitters, battery back-up, cabinet, rack mounting, lighting, mounts, connectors, cable, and license fee. Super HAR costs can exceed $9K additional. Primary use of the super HAR is to gain a stronger signal. |
| Highway Advisory Radio Sign | 10 | 4 | 8 | 0.22 | | Cost is for a HAR sign with flashing beacons. Includes cost of the controller. |

**Notes:**
* Not available for all unit cost elements
^ Applicable to ITS Deployment Analysis System (IDAS) software

### 4.1.2 Cost Inflation

The needs reported for capital and O&M are in year of expenditure dollars (YOE), as per TxDOT requirements for MPOs. In order to inflate current dollars to YOE, an inflation rate of 4 percent will be used. This rate is recommended by TxDOT for long-term planning. The largest MPO In the state, HGAC, uses a much lower inflation rate of 2.54 percent, which means that the direct comparison of costs to individual MPOs may vary.

### 4.1.3 Funding Growth

In order to determine the impact of constrained funding on future assets, preliminary capital funding scenarios will be developed. CH2M HILL will coordinate with TxDOT on historic funding levels and potential future funding to generate the preliminary scenarios.

## *4.2 Estimation of Preservation and Expansion Needs*

A model will be derived to calculate both the statewide unconstrained and constrained needs to maintain the existing devices and to provide for future needs.

### 4.2.1 ITS Needs Model

The model will be used to estimate the total level of reinvestment needed to maintain state of good repair (SGR). All existing ITS assets will be assumed to be in the "state of good repair" that is on par with the assumed age of each device. The model will determine for each year the capital costs needed for replacement of existing ITS assets based on the forecasted life span and the O&M cost for each ITS asset that has not reached the end of its useful life.

All investment needs will be initially estimated using an unconstrained scenario where funding is not limited. In reality, this is not likely to occur as each agency has restricted funding and may not be able to expend the reinvestment capital required to maintain ITS assets in SGR.

### 4.2.2 Life Cycle Profiles of Assets

The life cycle of an asset is defined by its useful life, and the annual capital maintenance needs. Both of these figures are provided in Table 2. Because the age of each ITS asset is not available, the age of each asset will be prorated based on the number of devices in place and the stated life span. For example, if a specific ITS device has a life span of 3 years and there are a total of 3 devices in place, the age of each device will be assumed to be 0, 1, and 2 years old respectively for the current year of analysis. Devices will be assumed to be replaced at the end of its useful life cycle, and all other years will require an annual maintenance cost beginning at the end of the first year.

## *4.3 Expansion—Capital & O&M Costs*

The ITS Deployment plans completed by the TxDOT districts provide projects to be implemented over the short-, medium-, and long-terms. Due to the age of each deployment plan, it is necessary to make assumptions of what has or has not been implemented. For the sake of the analysis (with the exception of Eagle Pass), all short-term and mid-term projects are assumed to be implemented

and included in the current inventory of ITS devices. All long-term projects will be assumed to be on track to be implemented in the future. In the unconstrained analysis, all long-term projects will be assumed to be implemented between the current year and 10 years out and allocated equally for each year. O&M costs for each project coming on line will be assumed to be 3 percent per year. The life cycle for each project coming on line will be accordance with Table 2.

## *4.4 Constrained Funding Scenario*

The Texas transportation system is subject to a common trend across the country: diminishing revenues and higher costs. TxDOT, like most other departments of transportation (DOTs) throughout the country, is experiencing declining revenues and increasing demands on the transportation system.

Given the limitations, more realistic scenarios of constrained funding and constrained capacity to expend that funding will be developed to determine the impact on ITS asset conditions. CH2M HILL will generate projected revenue streams for the following two scenarios:

- **Scenario 1:** Expected capital funding (current capital funding forecast)
- **Scenario 2:** Funding required to maintain the current SGR

The first scenario is based on the growth in capital funding in Texas. Actual capital funding totals reported for FY2010 and FY2011 will be used for the first year of analysis. The following year forecasts will be based on a trend rate of increase in capital funding using a weighted average of growth rates reported for funding over the relevant time period in available MTP/RTPs. The resulting 3.7 percent annual growth rate will be applied to a baseline year. Again, not all MPOs reported growth rates for funding sources, so the weighted average rate will not result in a one-to-one comparison of funding growth for MPOs.

The second scenario is a 'what if' analysis based on roughly maintaining the current value of the SGR. In order to determine the level of funding required to maintain that value, the model uses a 'goal seek' function to determine the correct level of annual investment needed to keep the backlog roughly steady.

# Texas Transportation Plan

## Tech Memo 3.7: Statewide Analysis Model (SAM-V3)

February 26, 2014

## Acknowledgements

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## 1.0 Overview

This Technical Memorandum (Tech Memo #3.7) is organized into two sections: travel demand model background; and model network refinement for the Texas Transportation Plan (TTP). The work described in this report consisted of enhancing the Texas Statewide travel demand model (SAM-V3) such that outputs of the traffic model will provide reasonable and replicable forecast year traffic volumes for both the Build (with project) alternatives and No Build (without project) conditions. The following sections provide information on the steps of the development of the traffic forecasts including data inputs, analysis assumptions, and methodology (including any adjustments made to the SAM-V3).

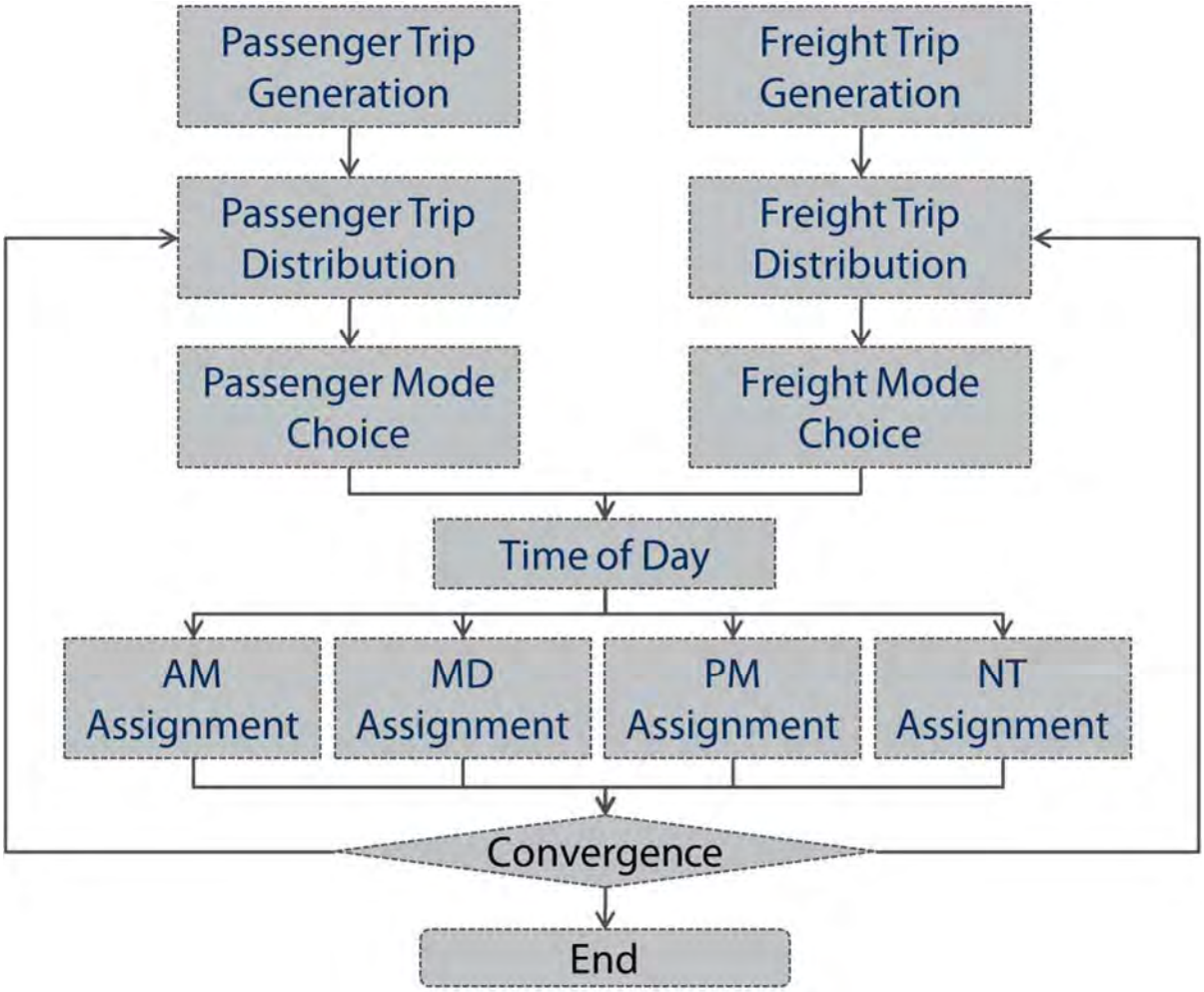
## 2.0 Travel Demand Model Background

Travel demand models forecast traffic volumes based upon the relationship between population (demand) and the transportation system (supply). The same general four steps are found in most travel demand models developed for an urban area: Trip Generation; Trip Distribution; a Mode Choice; and Multimodal Traffic Assignment, which can have a feedback loop for trip distribution through assignment, as discussed later in this memorandum.

The Texas Department of Transportation maintains a robust statewide travel demand model, referred to as the Texas Statewide Analysis Model (SAM). In 2013, the third version of the SAM was completed. The Texas Statewide Analysis Model Version 3 (SAM-V3) is a state of the practice multimodal travel model that provides highway traffic forecasts for both highway passenger travel and freight transport, intercity and high speed passenger rail ridership, freight rail tonnage and train forecasts, and forecasts of air passenger travel to and from Texas airports. The SAM-V3 provides travel forecasts at a level of detail suitable for use in comparative analyses of large-scale transportation corridor projects and other large scale investments. The model can also be used to perform analyses of the transportation outcomes and economic impacts of state-level transportation, land use, and economic policy decisions and strategies.

Figure 1 depicts the designed model structure for the SAM-V3, which shows how passenger trips go through trip generation, distribution and mode choice steps, and then are joined together with freight truck trips at the time of day step. The SAM-V3 has four time of day periods: AM (morning peak), MD (mid-day off-peak), PM (evening peak), and NT (night time off-peak). Finally, the figure shows how congested travel time is fed back to passenger trip distribution so that the distribution is based on more realistic highway travel times.

**Figure 1: Model Structure**




## *2.1 Passenger Models*

The SAM-V3 includes daily trips that are similar to those that occur within an urbanized area, which are no different from those that are modeled in existing urban models. These trips are referred to as daily trips. However when considering statewide travel in a state the size of Texas and interstate travel between Texas and surrounding states, there are much longer trips that may occur over several days that require further refinement of the types of trip purposes defined. The longer and multi-day trips are referred to as infrequent long distance trips. To distinguish between long distance versus daily trips, trips that are less than 150 miles are considered day trips and trips that exceed 150 miles are considered long trips.

Seven internal trip purposes are identified in the SAM-V3 model application:

- Intra-city trips
  - Home based work (HBW)
  - Home based other (HBO)
  - Home based school (HBS – HB school)
  - Non-home based other (NHBO)
  - Non-home based visitor (NHBV – NHB visitor)
- Inter-city trips
  - Infrequent long distance business trips (ILDB)
  - Infrequent long distance other trips (ILDO)

### 2.1.1 Trip Generation

Trip Generation is the first of the four primary steps in the travel demand model process. The result of the Trip Generation step in the travel demand model process is a set of trip productions and trip attractions for each TAZ by trip purpose or, in the case of freight, by commodity. These productions and attractions are used to populate a seed matrix that is passed to the trip distribution step.

By definition, a person trip is a person traveling from one place to another for a defined purpose. Consequently, trip generation is closely related to both the characteristics of a place and a person. Socioeconomic attributes of each TAZ, including the population and employment counts, are utilized by the Trip Generation model to determine the number of trips produced and attracted to each TAZ.

The production rates for the SAM-V3 were derived using 2009 National Household Travel Survey (NHTS) data, more specifically, the 20,000 NHTS add-on surveys sponsored by TxDOT. Trip rates were computed as motorized person trips. Passenger trip productions were then stratified by:

- Four household size categories
- Four income segments
- Eight area type categories.

Both the household size and income stratifications were determined using 2000 Census Transportation Planning Package (CTPP) data.

Trip attractions were estimated from work place surveys for four urban areas in the state and the 2009 NHTS. Attraction rates were estimated by area type, employment type, income group, and trip purpose. The stratification by income group was included to allow income segments to be maintained throughout the model stream for use in the traffic assignment step. This stratification allowed for more accurate analysis of toll facilities and more detailed interpretation of mode choice utilities.

### 2.1.2 Trip Distribution

Trip Distribution is the second step of the traditional four-step model, which identifies the production zone and attraction zone of a trip generated in the trip generation model based on the trip length frequency curve.

The SAM-V3 uses a traditional Gravity Model that distributes trips according to characteristics of land use and the transportation system in the study area. This Newtonian analogy states that the number of trips traveling between any zone pair is a function of the magnitude of the total productions and attractions in the two zones and the travel impedance between the zones. The highway network attributes describe the transportation system characteristics used to measure travel impedance (e.g., distance, travel time, etc.). The model can be mathematically stated as:

$$T_{ij} = P_i \times \frac{A_j \times F_{ij}}{\sum_k A_k \times F_{ik}}$$

Where:

$T_{ij}$ = forecast flow produced by zone *i* and attracted to zone *j*

$P_i$ = the forecast number of trips produced by zone *i*

$A_j$ = the forecast number of trips attracted to zone *j*

$F_{ik}$ = friction factor between zone *i* and zone *k* (F-Factors)

Travel time is used as the measurement of separation between zones for the purposes of applying the Gravity Model, with trip lengths measured in minutes. In the SAM-V3 trip lengths are derived from the NHTS. Separate distribution models are run for the income segments within each trip purpose.

### 2.1.3 Mode Choice

Mode Choice is the third step in the travel demand modeling process. Mode Choice models are used to assign a mode of travel to each person trip.

The passenger mode choice model in the SAM-V3 is structured as a nested logit model. The mode choice models are structured in a manner similar to many urban models in which peak travel times are used for work related trip purposes and mid-day travel times are used for non-work related trip purposes. This structure allows one mode choice model to be run for each trip purpose. The time of day step is located after mode choice, thus avoiding the running of four mode choice models for each trip purpose. Trips can be forecast for auto drivers, auto passengers, intercity rail passengers, high speed rail passengers and air passengers.

Alternative Modes

The transportation modes considered in the SAM-V3 are the following:

- Drive alone
- Share ride 2
- Share ride 3+
- Urban bus
- Urban rail Intercity rail with a combination of 3 access modes and 3 egress modes
  - Drive access, rail access, and walk access respectively
  - Drive egress, rail egress, and walk egress respectively
- High speed rail with a combination of 3 access modes and 3 egress modes
  - Drive access, rail access, and walk access respectively
  - Drive egress, rail egress, and walk egress respectively
- Air travel with a combination of 3 access modes and 3 egress modes
  - Drive access, rail access, and walk access, respectively
  - Drive egress, rail egress, and walk egress, respectively

## *2.2 Freight Models*

The process to address freight performance in the SAM-V3 follows a similar four-step model approach for model development. A four-step model develops trip tables, which are then assigned to modal networks where the resulting modal volumes, routing, and travel time information can then be used to evaluate freight performance by mode. The SAM-V3's freight models were developed using the 2010 Texas centric TRANSEARCH freight flow database produced by IHS Global Insights (IHS), which is a commodity flow database. The following sections describe the individual steps of the four-step freight model in detail.

### 2.2.1 Trip Generation

The freight trip generation model is very similar to the passenger generation model in that both are based upon relationships that are estimated with an observed set of data. In the trip generation model, the Texas TRANSEARCH database provides data on movements of freight to and from Texas counties by Commodity Groups. These movements are used as the dependent variable to estimate the freight trip generation. The trip generation model estimates the tonnage of freight produced at a location, and the freight tonnage attracted to a location (in annual tons), for the 15 commodity groups listed in Table 1.

**Table 1: Commodity Groups**

| Commodity Number | Commodity Name |
|---|---|
| 1 | Agriculture |
| 2 | Mining |
| 3 | Coal |
| 4 | Nonmetallic Minerals |
| 5 | Food |
| 6 | Consumer Manufacturing |
| 7 | Non-Durable Manufacturing |
| 8 | Lumber |
| 9 | Durable Manufacturing |
| 10 | Paper |
| 11 | Chemicals |
| 12 | Petroleum |
| 13 | Clay, Concrete, Glass |
| 14 | Primary Metal |
| 15 | Secondary & Misc. Mixed |

The dependent variable in the development of freight generation equations needs to be a measure of those activities which give rise to freight movements. An appropriate measure of the amount of economic activity by industry is the quantity of employment in each industry. Demographic and economic inputs were developed for the SAM-V3 for industries according to the North American Industrial Classification System (NAICS). Employment totals were aggregated by NAICS defined industry for all traffic analysis zones (TAZs) within each Texas county.

### 2.2.2 Trip Distribution

Trip distribution is the step which determines the flow linkages between the origin of trips and the destinations of trips. In trip distribution, the productions and attractions developed in trip generation are distributed based on distance skims (impedances) to get an origin-destination (O-D) trip table for each commodity group. For each commodity group, the freight distribution model allocates the annual tons produced at an origin to the annual tons attracted to a destination. This distribution process meets the economic theory requirement that trips being distributed from each origin must sum to its productions and that those being distributed to each destination must sum to its attractions.

### 2.2.3 Mode Choice

In freight mode choice, the origin and destination tables developed during trip distribution are allocated to the various modes of travel. Modes include truck, carload rail, and intermodal rail. The incremental logit choice model utilized by the SAM-V3 allows for the consideration of known mode shares derived from the TRANSEARCH database while allowing for changes in mode share stemming from changes in the cost of travel to be considered.

For each of the 15 distinct commodity groups, the freight mode choice model allocates the annual tons distributed between an origin and a destination to the modes available to carry freight between that origin and that destination. The baseline for applying the increments was a Texas focused TRANSEARCH database purchased by TxDOT.

### 2.2.4 External Trips

Freight is also generated at the boundary of the area covered by the SAM-V3, the Texas state line, at points referred to as external stations. The trip generation process used for freight within Texas does not account for freight flows to external locations for which the model does not have information on the socioeconomic characteristics. The water and air modes are recognized to be the domestic portion of a shipment, the foreign portion of the freight shipment is not included in the SAM-V3, and the freight shipment is assumed to begin or end at freight generators within Texas.

A freight model to distribute tonnage between Texas and other US states, Mexican states, and Canadian Consolidated Metropolitan Areas and Provinces was developed for SAM-V3. This freight distribution model required productions and attractions for all Texas-North American Freight Forecasting Model (TX-NAFF) zones external to Texas as well as for zones in Texas. The trip generation procedure described above provides the productions and attractions for all zones in Texas. The model does not, however, estimate productions and attractions for zones outside of Texas. For those zones, the productions and attractions were obtained from the TRANSEARCH database. The trip distribution model then joins the two sets of productions and attractions into trips.

### 2.2.5 Convert Annual Tonnage to Weekday Trucks

While the freight model forecasts freight flows in annual tons, the SAM-V3 highway traffic assignment step assigns vehicles to its model networks to allow for interaction with passenger vehicles. Therefore, the SAM-V3 converts the annual flow of truck tonnages into flows of freight trucks. This is done using annual factors and a table of payload factors, which are unique to each commodity group. The Texas 2010 TRANSEARCH database reports flows both in units, which for the truck mode is trucks, and tons. This TRANAEARCH information was used to develop the table of payload factors. It should be noted that the TRANSEARCH payload factors include only fully loaded trucks.

## 2.3 Joint Passenger and Freight Steps

### 2.3.1 Time of Day

After the passenger and freight mode choice models are run, time-of-day factors are applied to allow for separate traffic assignment for each of four time periods (AM peak, midday, PM peak, and overnight). Diurnal factors by direction were estimated from the 2009 NHTS for passenger trip purposes, and from vehicle classification counts for truck trip purposes. In the SAM-V3, which forecasts both passenger travel and several modes of freight travel, diurnal factors are developed separately for the passenger and freight components, but are applied in the same step, the Time of Day step.

### 2.3.2 Assignment

The assignment of traffic to the highway network is the final step in the traditional modeling process. It assigns trips to the most efficient route based on travel time and cost. The combination of all assigned trips on a roadway network produces an estimate of the flow of traffic.

In SAM-V3, the passenger and freight highway trips are combined and assigned using a multi-class highway assignment procedure. The model was designed to perform at the daily (that is, 24-hour) level with the flexibility to examine four distinct time periods: AM Peak, Mid-Day, PM Peak, and Overnight. Toll analysis is handled with a generalized cost function during traffic assignment. Daily flows of truck tonnages are converted to freight trucks for assignment purposes using payload factors for each commodity group.

#### Feedback Loop

The SAM-V3 includes a feedback loop from the trip assignment step to the trip distribution step. The purpose of the feedback loop is to produce realistic travel times on the highway network for a given analysis year, particularly future forecast years. The feedback loop takes congested travel times from the assignment step and supplies the travel time for the next iteration of trip distribution. During each iteration, a comparison of assigned traffic volumes to previous iterations is performed using the Method of Successive Averages (MSA). The feedback loop iterates until the convergence criterion is met.

## 2.4 Networks

The two basic building blocks of a travel demand model are the transportation system networks and the traffic analysis zones (TAZs). The networks represent the multimodal transportation system, including different categories of roads (such as freeways, arterials, collectors, ramps, etc.). Most travel demand models are structured to rely heavily upon information about the transportation systems. Commonly, the following types of information are retrieved from the network layer:

- Speed of facilities
- Travel time from zone to zone
- Capacity of each facility in the system
- User cost (tolls and operating cost).

Some of these inputs to the travel demand model, in turn, are themselves calculated from additional information about the transportation facilities. While the posted speed limit or the toll for a facility is stored directly on the network layer, network layer attributes such as capacity are calculated based on the physical and functional characteristics of the facility. These characteristics can be stored on the network layer where the characteristics can be modified to test transportation improvement scenarios.

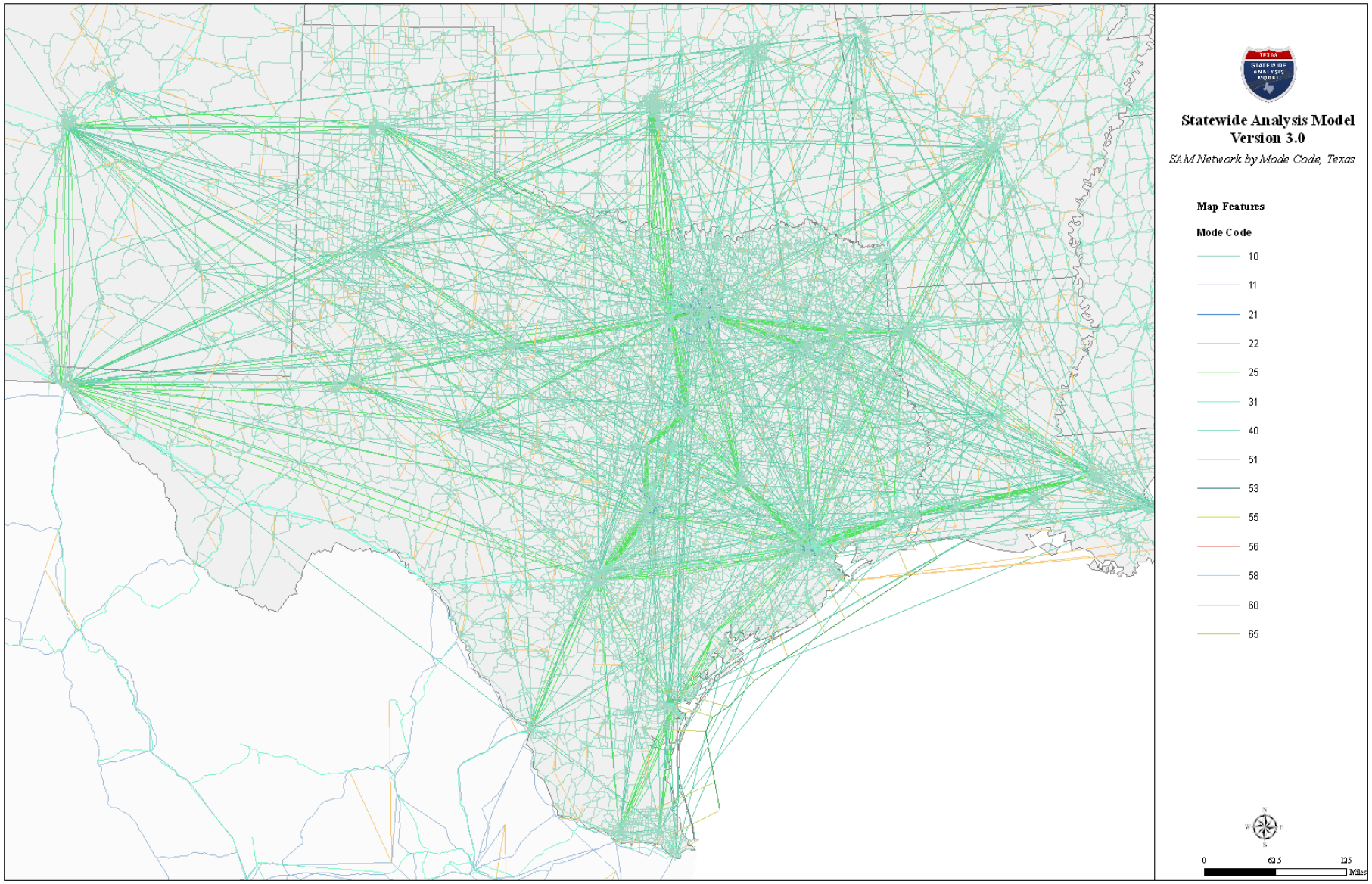
The TAZs are geographical areas that link land uses with the transportation system. The data describing socioeconomic and demographic characteristics of the TAZs are tied to the transportation system using zonal centroids and their associated centroid connectors. The network and zonal densities (granularity) of these two elements should be relatively consistent in order to produce realistic loading of traffic onto the transportation system.

The SAM-V3 uses a multiyear and multimodal network for the analysis of travel demand in the State of Texas. The SAM-V3 multiyear multimodal network is described from three aspects:

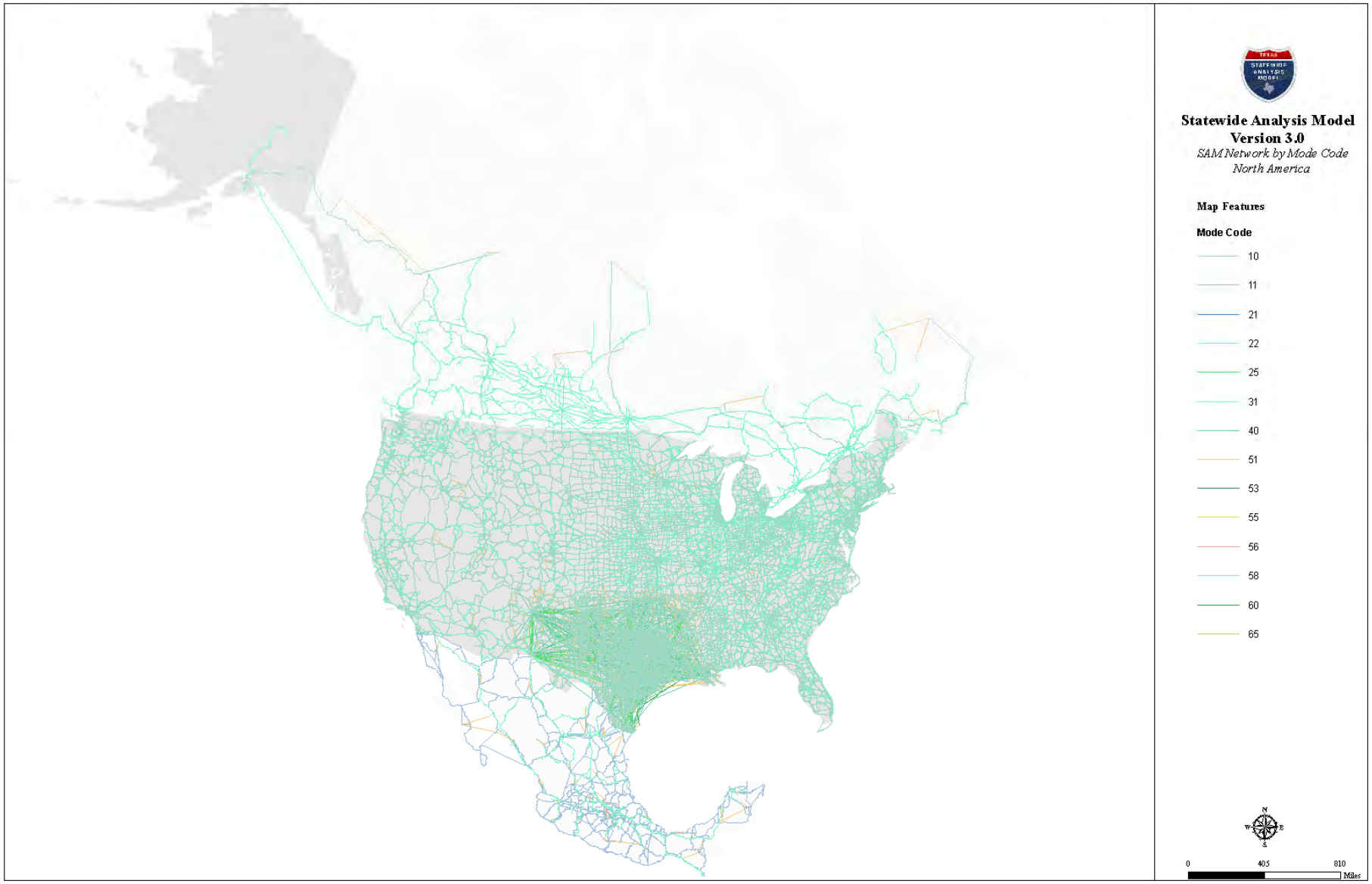
- Network attributes (both road network and other mode networks)
- Network selection criteria
- Methods and procedures for development of some attributes of the network.

**Figure 2** and **Figure 3** show the SAM-V3 multimodal network, by mode, for the State of Texas and for the North American Area.

## Figure 2: SAM-V3 Network by Mode Code (Texas)



## Figure 3: SAM-V3 Network by Mode Code (North America)



The SAM-V3 includes up-to-date network elements for all passenger modes, including:

Roadway Network Attributes

- Future Projects: Major existing and future roadway projects in Texas
- Posted Speed: Recent speed limit changes on Texas interstates
- HOV/HOT Lanes: HOV and HOT lanes from the Houston and Dallas metropolitan areas
- Toll Roads: Toll rates on existing and future roadways

Attributes for other modal networks

- Intercity Passenger Rail
- Urban Passenger Rail
- High Speed Passenger Rail

### 2.4.1 Additional Road Network Attributes

The basic road network attributes include attributes needed for the capacity procedure, as well as the results of the capacity procedure. These attributes contain capacities and travel times for both the 24-hour time period, and for four shorter time periods, representing peak and off-peak travel times. In the following section, attributes related to the future road improvement, specifically HOV lanes and toll road facilities, are explained.

### 2.4.2 Attributes for Other Modal Networks

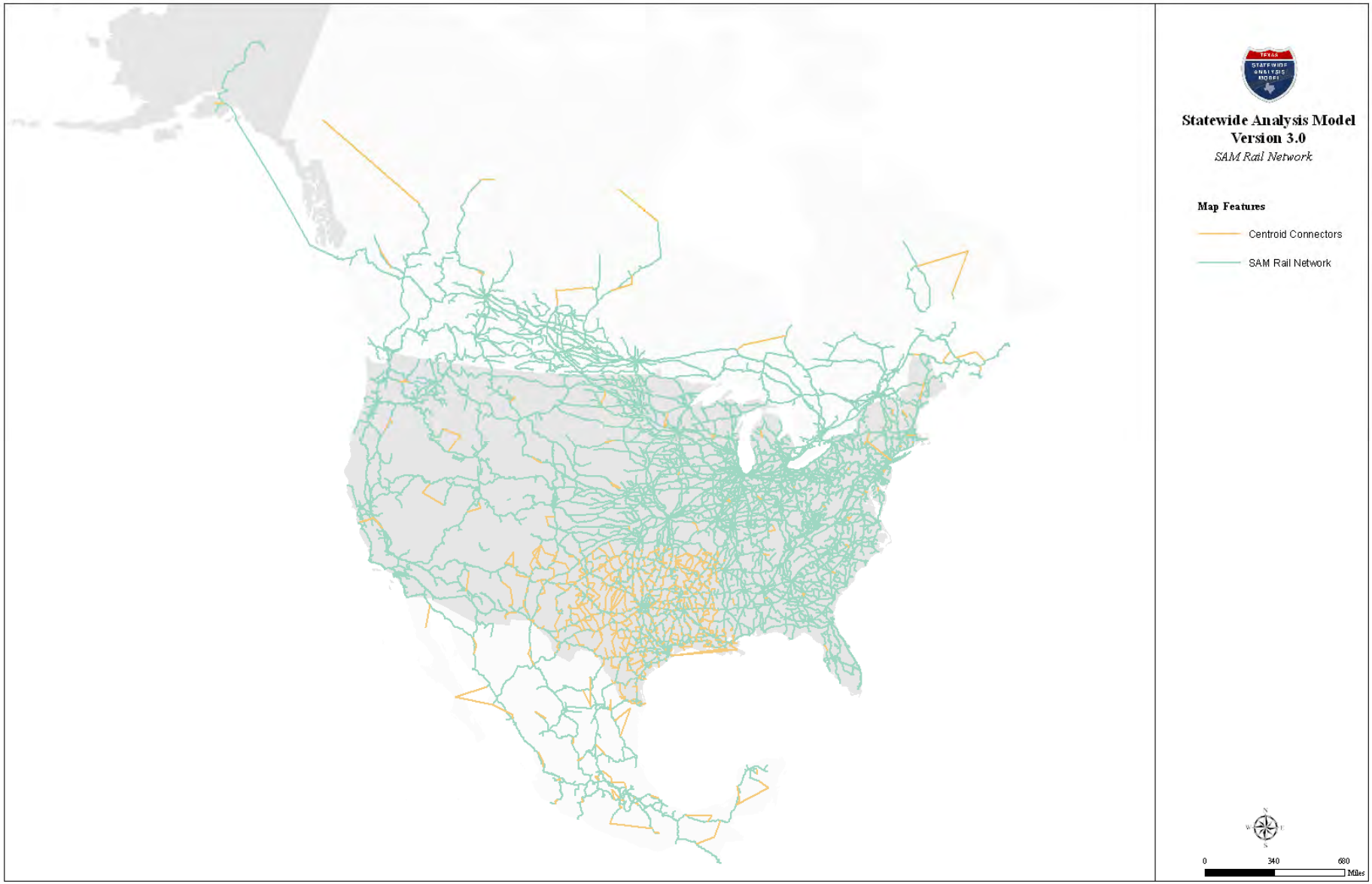
The SAM-V3 multi-modal network also includes a rail network, an air network, and a water network. In this section, attributes for the network components associated with passenger modes other than automobile are discussed.

Rail Network

The SAM-V3 rail network includes freight rail and passenger rail. The SAM-V3 rail network is based on a rail network developed and maintained by the Oak Ridge National Laboratory Center for Transportation Analysis (CTA).

The CTA Railroad Network is a representation of the North American railroad system that contains every railroad route in the US, Canada, and Mexico that has been active since 1993, as shown in **Figure 4**. It is intended for logical network programming, traffic analyses, and mapping applications. Railroad corporate ownership changes frequently. Therefore, corporate structure, a key to the simulation of routing, is explicitly temporal, thus allowing for historical studies and comparisons. Supporting data on interlines and corporate ancestry allows the construction of routable networks for a specific target date. The network is an extension of the Federal Railroad Administration's (FRA) strategic network.

## Figure 4: SAM-V3 Rail Network



The CTA rail network contains the following characteristics:

1. Virtually all active US lines that have 100 meter geographic accuracy
2. Rail subdivision
3. Traffic densities that have been transcribed from the FRA strategic network of 2005 for all US lines above 1 million gross tons/yr. (Classes: 1=below 1M tons, 2=5M, 3=10M, 4=20M, 5=40M, 6=60M, 7=above).

### Passenger Rail

The passenger rail network includes three types of rail: urban rail, intercity rail and high speed rail (HSR). Currently, four metropolitan areas in Texas are serviced by urban rail: Austin, Houston, and Dallas/Fort Worth. A few more urban rail lines are planned for the future, according to the respective Metropolitan Planning Organizations' (MPO) transportation plans. The existing and planned urban rail lines were all coded into the SAM-V3 network as shown in **Figure 5** and are distinguished by their constructed years. The route ID range for urban rail has also been designed to reflect service locations, as shown in **Table 2**.

**Table 2: Urban Rail Route ID Ranges**[1]

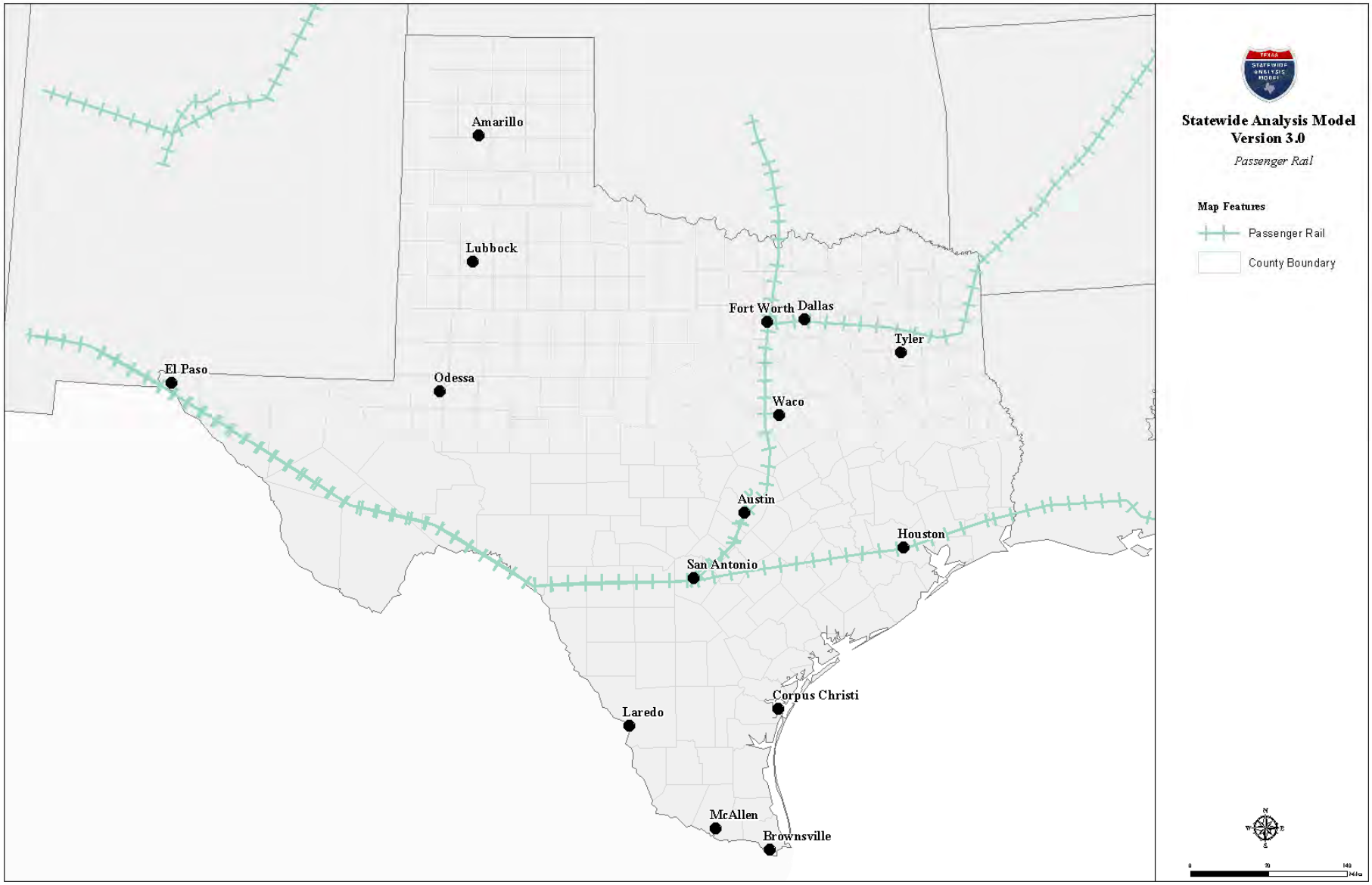
| Route ID Range | Location | MODE_CODE | Number of Routes |
|---|---|---|---|
| 2001-2099 | Dallas Area | 21 | 18 |
| 2101-2199 | Houston Area | 21 | 8 |
| 2201-2299 | Austin Area | 21 | 2 |
| 2301 | LSTAR (between Austin and San Antonio) | 22 | 1 |

The intercity rail network for the SAM-V3 was developed based upon route information from AMTRAK, which was the only long distance passenger rail service operation in Texas in 2010. A review of AMTRAK stops and stations was also conducted, and the rail layer was updated to reflect recent changes to the service. This updating process was done to ensure that the proper connectivity of the passenger rail system was maintained. In 2010 there were three AMTRAK routes that served Texas:

- The Heartland Flyer
- The Texas Eagle
- The Sunset Limited.

[1] It should be noted that although LSTAR commuter rail was categorized as urban rail based on the rail characteristics, it runs between cities, and thus was modeled as intercity rail with mode coded as 22.

## Figure 5: SAM-V3 Passenger Rail



## 3.0 Model Refinement for the Texas Transportation Plan

TxDOT has long been recognized as a national leader in transportation excellence, providing for and maintaining a multimodal transportation system that serves the equally diverse needs of Texans and the state's growing economy. In order to accurately represent the rapidly expanding transportation system in the travel demand model used for the Texas Transportation Plan, the project team refined the SAM-V3 network to include the most up-to-date conditions—as well as future conditions—of the Texas transportation system. This section explains how the project team decided which projects should be included in the refined SAM-V3 network, and how those projects were then coded into the network.

### *3.1 Plan Review*

For urbanized areas with a population greater than 50,000, the planning and coordination of federal highway and transit investments are the responsibility of MPOs. Each of the 25 MPOs in Texas are required to maintain and update a Transportation Improvement Program (TIP) and Metropolitan Transportation Plan (MTP) to provide short- and long-term plans for transportation investments in their respective regions. In refining the SAM-V3 network, the project team thoroughly reviewed all financially committed projects within each MPO's MTP, as well as in the Statewide Transportation Improvement Program (STIP). Table 3 below shows the plans that were reviewed for this task.

**Table 3: Plans Incorporated into the SAM-V3 Network Update**

| MPO | Reference Name | Adoption Date |
|---|---|---|
| Statewide Transportation Improvement Program (STIP) | Statewide Transportation Improvement Program, STIP, by District | August 2012 |
| Abilene MPO | Abilene MPO MTP 2010-2035 | January 12, 2010 |
| Amarillo MPO | Amarillo MTP 2010-2035 | October 20, 2011 (amended) |
| CAMPO (Austin) MPO | CAMPO 2035 RTP | May 24, 2010 |
| Beaumont – Port Arthur MPO | SETRPC-MPO for the JOHRTS Area MTP 2035 | April 19, 2013 |
| Brownsville MPO | 2010-2035 Brownsville MTP | December 9, 2009 |
| Bryan – College Station MPO | BCS MPO 2010-2035 MTP | February 9, 2011 (amended) |
| Corpus Christi MPO | Corpus Christi MTO MTP 2010-2035 | March 3, 2011 (amended) |
| Hidalgo County MPO (Pharr) | 2010-2035 MTP | December 10, 2009 |
| El Paso MPO | Horizon 2040 MTP | October 4, 2013 |
| Houston Galveston MPO | The 2035 RTP Update | January 25, 2011 (approved) |
| Harlingen MPO | 2010-2035 MTP | December 9, 2009 |
| Killeen – Temple MPO | Mobility 35 MTP | October 21, 2009 (amended) |
| Laredo MPO | Laredo MTP 2010-2035 Update | December 11, 2009 |
| Longview MPO | Transportation 2035 Longview MTP | May 15, 2013 (amended) |

**Table 3: Plans Incorporated into the SAM-V3 Network Update**

| MPO | Reference Name | Adoption Date |
|---|---|---|
| Lubbock MPO | Lubbock MTP 2012-2040 | August 21, 2012 |
| Midland Odessa MPO | Midland Odessa 2035 Transportation Plan Update | November 30, 2009 |
| North Central Texas MPO | 2035 Mobility, 2013 Update | June 13, 2013 (amended) |
| San Angelo MPO | San Angelo MTP 2010-2035 | January 2013 (amended) |
| San Antonio – Bexar County MPO | Mobility 2035 MTP | December 7, 2009 |
| Sherman – Denison MPO | Transportation Outlook 2035 | April 25, 2012 (amended) |
| Texarkana MPO | TUTS 2035 MTP | October 1, 2009 |
| Tyler Area MPO | TAMPO MTP 2035 | April 22, 2010 (amended) |
| Victoria MPO | Victoria Urbanized Area MTP 2035 | December 11, 2012 (amended) |
| Waco MPO | Connections 2035 Waco MTP | August 2010 |
| Wichita Falls MPO | Wichita Falls MPO 2010-2035 MTP Update | June 4, 2012 |

Note:
CAMPO = Capitol Area Metropolitan Planning Organization

From these plans the project team identified **regionally significant projects that would affect the capacity of the transportation system**. These projects included new roadways, tollways and HOV lanes; road widening projects, including new turning lanes; conversion of existing lanes to tolled or managed facilities; and other capacity-adding projects. Once these projects were selected, they were then coded into the SAM-V3 network, as is described in more detail in the next section.

### Network Coding

The SAM-V3 network stores information about the current and future characteristics of each facility in the Texas transportation system. This information includes physical attributes such as posted speed limit and number of lanes, as well as changes that are planned in the future, such as road widening projects. To code the projects identified in the MPO plans into the SAM-V3 network, the project team input information about each project into a Microsoft Access database that could be read by SAM-V3 to automatically update the network attributes of the transportation system for a specified model year. The attributes input into the project data are described in **Table 4** below.

The project database method allows facilities that will be affected by multiple projects over time to be updated incrementally. For example, a single roadway segment may have three projects associated with it, each adding additional lanes in separate years. To code this, the three projects are listed separately in the project database with their expected completion dates, and are then read by SAM-V3 to automatically update the attributes of that segment after running the network update procedure. This method also allows modelers to add or remove specific projects from a given scenario for an analysis. For example, one may wish to observe the effect of adding a freeway in 2020 that is not planned to be constructed until 2040.

**Table 4: Project Database Attributes**

| Field Name | Description |
|---|---|
| ID | Automatically generated Microsoft Access ID |
| AddRemove | Flag denoting whether to include or exclude a project from a given scenario |
| ProjectID | Unique identifier for a project. The ProjectID is coded on each link in the network affected by the project. The format of the Project ID is: MPO abbrev. + MPO project ID. |
| ProjectYear | Year project begins operation |
| RemovedYear | Year facility is removed from network |
| OneWay | Controls how the number of lanes is populated on the network line layer. A "ONEWAY" flag in this field tells the interface to divide the value in the field “NumLanes” by two and transfer the value to the network directionally. |
| NumLanes | The total number of lanes associated with the roadway |
| FC | The functional classification of the roadway |
| DIV | Flag denoting if the facility is divided or not |
| Shoulder | Shoulder width if the project includes adding a shoulder |
| Posted_SP | Posted speed for roadway |
| MODE_CODE | Mode code of a link |
| Terrain | Flag denoting the topology of land. Topology affects the capacity of roadways.<br>1 = flat, 2 = rolling, 3= mountainous |
| Parking | Parking value to use for number of parking movements. The presence of on street parking reduces roadway capacity. |
| Lane_Config | Only for links at roadway intersection. Contains a code used to determine the lane group configuration (e.g., “L1LS0T3RS1R1” = # dedicated left, # shared left, # through, # shared right, # dedicated right) |
| ProjectSource | Note documenting the source of the project information |
| CSJ | Note that can be used to document the project CSJ |
| Name | Name of the facility |
| Type | Project types:<br>• Build frontage rd.<br>• Change to Toll<br>• New HOV<br>• New Managed Lanes<br>• New road<br>• Widen<br>• Upgrade to expressway<br>• Upgrade to freeway |
| Note | Optional field for notes |
| Alternative ID | Optional field for other ID for a project |
| MTP version | Optional field for MTP information |
| Toll Notes | Optional field to document the toll way note |

# Texas Transportation Plan

## Tech Memo 4: Freight Methodology

April 10, 2014

## Acknowledgements

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- 4.0 List of Needs from State Freight Plan Team page 5

This memo outlines the methodology for developing freight needs and performance-based outcomes for the Texas Transportation Plan (TTP) and identifies work that will be incorporated from the Texas Freight Mobility Plan (TFMP). This proposed methodology will be more thoroughly defined in Tech Memo 3.8: Freight Methodology. The Task 4 Freight modal profile Tech Memo will include all detailed freight analyses and recommendations to be used in developing the TTP.

# 1.0 Introduction

This section will include the MAP-21 objectives for freight and their importance to the Texas Transportation Plan (TTP). It will also reference the TFMP and its importance to the TTP.

The memo will be organized into two primary sections:

- Section 2: TFMP Overview, including summary/ scope of analysis of the State's first freight plan
- Section 3: TTP Freight Methodology, including a description of the Freight Plan components identified for incorporation into TTP, the sources of freight data and information to be utilized in the TTP, the TTP technical methodology, and recommendations for TTP scenarios/ additional SAMv3 runs

# 2.0 Texas Freight Mobility Plan Overview

This section will summarize the TFMP and summarize key information for TTP development:

## *2.1 Freight Plan Background*

- Scope, timeline for completion, and modes considered (Truck, Rail, Ports and Inland Waterways, Air, and Pipeline)
- Outline of Final Report as presented to the Texas Freight Advisory Committee (TxFAC) February 20, 2014
- Goals, objectives, and performance measures

## *2.2 Freight Plan Data and Development Methodology*

- Methodology for developing primary and secondary freight networks
- Methodology for developing freight needs
- Methodology for identifying freight projects
- Methodology for establishing benefit cost analysis and project prioritization strategies

## *2.3 Freight Plan Recommendation Areas*

- Three categories: Projects and corridor improvement; programs; policies
- Nine proposed topic areas for evaluation: Capacity, operations, safety and security, intermodal and rural connectivity, NAFTA and border challenges, energy and environment, education and public awareness; institutional, industry, and interagency cooperation; funding and finance

## 3.0 TTP Freight Methodology

This section will provide recommendations for incorporating the State Freight Plan into the TTP and will identify additional data to be analyzed to develop multimodal freight needs for the Plan.

### *3.1 Data and Tech Memos*

- SAMv3 forecast, including TRANSEARCH data
- Freight Plan Tech Memos on conditions and needs (list memos)
- Freight Plan and TTP stakeholder and public outreach findings

### *3.2 Methodology*

- Summarize State Freight Plan goals, objectives, and performance measures
- Existing conditions – Incorporate TFMP Tech Memos for:
  a. Facility inventory for all freight modes modes: Truck, Rail, Ports and Inland Waterways, Air, and Pipeline
  b. System conditions
  c. Preliminary system needs (More work will be done to ensure that definition of "needs" for State Freight Plan is consistent with TTP definitions, where needs will be performance-based and not a project-specific wish list.)
- Demand forecasts – Utilize the SAMv3 baseline for the interaction of freight and passenger traffic in all modes, which includes TRANSEARCH data
- Needs analysis – Utilize SAMv3 and TFMP Tech Memos to develop:
  a. Projects and corridor improvement to eliminate bottlenecks and enhance network connectivity
  b. Programs and policies to manage and operate the Freight network and support economic growth
  c. Strategic intermodal projects and other specific modal project needs as identified in the TFMP

### *3.3 Plan Scenarios*

- Describe recommended freight performance measures as defined in the TFMP and their relationship to scenario development
- Consider capacity and strategic projects in an Economic Growth scenario for the TTP, and evaluate the following outcomes and implementation issues/ challenges/ concerns (using SAMv3 and policy evaluation):
  – Operations
  – Safety and Security
  – Intermodal and Rural Connectivity

- NAFTA and Border Challenges
- Energy and Environment
- Educations and Public Awareness
- Institutional, Industry, and Interagency Cooperation
- Funding, finance, additional revenues, and P3 opportunities

## 4.0 List of Needs from State Freight Plan Team

Approved technical memorandum and reports from the following:

- Goals, Objectives, and Performance Measures for all Modes TFMP Task 9
- Inventory and Assesment of the State's Freight Assets TFMP Task 4
- Identified Tiers of Freight Highway Network – Texas Freight Priority Network White Paper
- Analysis of Condition and Performance of the State's Freight Assets TFMP Task 5
- Modal Profiles for All Modes – Highway, Rail, Port and Inland Waterways, Air, and Pipeline
- Freight Forecasting Methodology, Forecasts TFMP Task 7 Technical Memorandum 7.1, 7.2, 7.3
- Identified Needs by Mode and Type – Project, Policy, Program
- Economic Context of Freight, benefit identification TFMP Task 10
- Project Prioritization and Selection Methodology
- Recommended Projects and Improvement Strategies with Benefits by Mode and Type – Project, Policy, Program

It is understood that some documents associated with this list are completed or are in their final drafts while others are just starting. A list of the documents, their status, schedule and location would be helpful and is requested.

# Texas Transportation Plan

## Tech Memo 5: Transportation Snapshot

February 28, 2014

## Acknowledgements


| | |
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# 1.0 Introduction

The Texas Department of Transportation (TxDOT) is committed to providing and maintaining a diverse and multimodal transportation system that serves the diverse needs of Texans and the State's growing economy. As people continue to move to the State, and the economy continues to expand, the transportation system must evolve to accommodate this growth in a manner consistent with the priorities and desires of Texans and Texas industry. Significant and strategic investments are required to operate, maintain, expand, and modernize the multimodal transportation system in order to achieve the level of service that users expect while making efficient use of taxpayer dollars and delivering on TxDOT's commitment to customer service.

As the official statewide long-range transportation plan, the *Texas Transportation Plan (TTP) 2040* will document the needs for the multimodal transportation system over a 25-year horizon and identify funding gaps based on reasonably expected revenues. To make the best use of limited resources, the TTP 2040 will advance performance-based decision-making to link transportation investments with the goals established in the 2013-2017 Strategic Plan as well as those identified as part of TTP development. The TTP 2040 is being developed as a cooperative effort with transportation stakeholders, multimodal owners and operators, and customers of the State transportation system.

As part of the TTP 2040 planning effort, and to better understand the size and complexity of the Texas transportation system and its importance to a variety of users, this document provides a "snapshot" of Texas' multimodal transportation system as it exists today with respect to all passenger and freight travel modes. It also provides a synopsis of current thinking on future trends that will be analyzed in more detail in Plan development.

# 2.0 Transportation Today

## *2.1 Transportation in Texas*

As the largest transportation system in the nation, the Texas transportation system permits users to drive, ride, walk, bike, or fly to get where they need to go and enables freight transport by ship, air, rail, truck and pipeline to facilitate State, national, and global commerce and support industry. Providing for such diversity of travel requires a complex and interconnected network of roads, bridges, airports, railroads, ports, and other elements—all of which must be maintained and expanded in accordance with the demand for use to provide their intended function at a level that users expect. Table 1 provides a high-level overview of the existing multimodal transportation system in Texas.

**Table 1. Texas Transportation at a Glance**

| | |
|---|---|
| People | • 25.1 million Texans (2010)[i]<br>• 237,440 million vehicle miles traveled annually[ii]<br>• 85% of population resides in metro areas[iii]<br>• 10.9% of population aged 65 or older[iv] |
| Pavement | • Over 313,000 total centerline miles of pavement[v]<br>• Over 197,000 lane miles operated and maintained by TXDOT[vi]<br>• Over 15,000 lane miles of interstates[vi]<br>• 88% of pavement lane miles on state-owned roads in good or better condition[vi]<br>• $9,305 million invested in the transportation system annually[vii]<br>• 39% of investment used to expand current system[vii] |
| Bridges | • 52,227 bridges[viii]<br>• 33,513 owned and maintained by TXDOT[viii]<br>• More than 81% of total bridges in good or better condition[viii] |
| Transit and Passenger Rail | • 8 metropolitan, 30 urbanized, and 38 non-urbanized transit systems[ix]<br>• 88 elderly and disability transit programs[ix]<br>• Constitutes 1.55% of work commute trips[ii]<br>• Over 281 million total transit trips in 2011[ix]<br>• Served by the Texas Eagle, Sunset Limited, and Heartland Flyer Amtrak routes[x] |
| Freight | • 11 deep-draft and 10 shallow ocean ports[xi]<br>• 10,384 total miles of freight rail operated by 47 railroad companies[xii]<br>• 73% of Texas-manufactured goods are transported by truck[xii]<br>• By air, freight leaving Texas can reach any North American market in less than 4 hours[xii] |
| International Trade | • 26 international border crossings (264,491 vehicles and 137,687 pedestrians cross daily)[xiii]<br>• Greater than $17 billion of imports and exports processed annually[xiv] |

## *2.2 Passenger Travel*

### 2.2.1 Highway

With 86 percent of the Texas population residing in metropolitan areas,[xv] there is a large demand for urban roadways. In 2012, there were 167,002 million vehicle miles traveled (VMT) in urban areas and 70,834 million VMT in rural areas throughout the State—roughly two and three times the national averages, respectively.[xvi] While rural roadways may carry less than half the traffic volume of urban highways, the rural highway system is essential to the economic vitality of the State. It provides access to jobs and services for the millions of Texans residing in rural areas, facilitates commerce, and supports the activities of many Texas industries including farming, ranching, timber and logging, mineral extraction, and energy.

Houston, Dallas-Fort Worth, and Austin rank among the top-20 most congested cities in the nation in terms of annual person-hours of delay.[xvii] Nearly 75 percent of the top-100 most congested roadways in Texas are located in the Houston and Dallas Fort-Worth metropolitan areas (i.e., in Harris, Dallas, and Tarrant counties combined).[xviii] Congestion in these and other metropolitan areas is expected to worsen significantly between 2010 and 2040 due to high population growth: the population in 35 Texas counties is expected to increase by 50 percent or more, with the highest

percentage increases occurring in the Austin, Dallas, San Antonio, and Houston metropolitan areas.[xi] The 2040 baseline scenario of the Texas Statewide Analysis Model (SAM V3) predicts that VMT will increase approximately 62 percent from 2010 to 2040 as a result of high population and employment growth (**Table 2**).

**Table 2. SAM V3 Baseline Forecast**

| Texas Transportation Demographics | Forecasted Change from 2010 to 2040 |
|---|---|
| Population | + 61% |
| Employment | + 80% |
| Vehicle Miles Traveled | + 62% |
| Vehicle Hours Traveled | + 85% |
| Number of Personal Trips (Total) | + 57% |
| Number of Personal Trips (by Transit) | + 57% |
| Number of Vehicle Trips | + 57% |

Source: Texas Statewide Analysis Model (SAM) V3

Despite high levels of congestion, the majority of work travel in the State's large metropolitan areas still occurs via single occupancy vehicles. As shown in **Table 3**, driving alone accounts for 81 percent of work travel in the Austin metropolitan area; 85 percent in the Dallas metropolitan area; 81 percent in the El Paso metropolitan area; 83 percent in the Houston metropolitan area; and 83 percent in the San Antonio metropolitan area.[xix]

**Table 3. Commuter Mode Choice Profile**

| | Austin | Dallas | El Paso | Houston | San Antonio |
|---|---|---|---|---|---|
| Drive alone | 81% | 85% | 81% | 83% | 83% |
| Carpooled | 12% | 11% | 11% | 11% | 12% |
| Public transportation | 3% | 1% | 2% | 1% | 2% |
| Walked | 2% | 1% | 2% | 1% | 2% |
| Taxicab, motorcycle, bicycle or other | 3% | 2% | 3% | 2% | 1% |

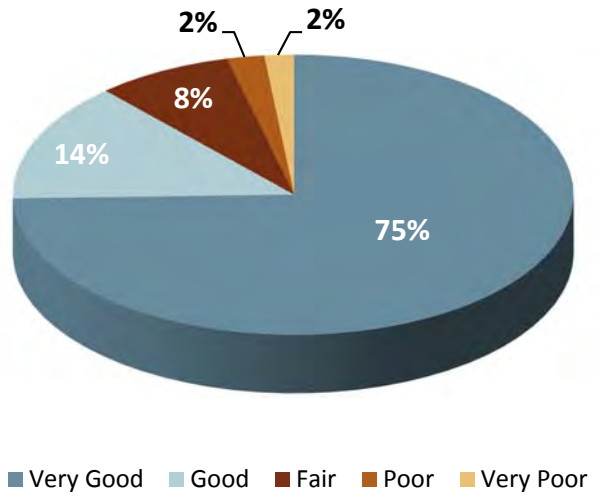
Note:
American Community Survey 2012, 3 year estimate[xix]

In addition to congestion reduction, highway safety and infrastructure preservation are among the top transportation priorities for the State. Continuing and focused efforts to improve highway safety have shown some success thus far: between 2003 and 2013, fatalities from crashes decreased by 11 percent, from 3,822 to 3,399.[xx] Efforts to improve the condition and performance of infrastructure assets are ongoing and include an enhanced focus on developing and implementing proactive and strategic asset management practices and capabilities. Considering the size of the Texas transportation system and the total number of highway assets—pavement segments, bridges, and other ancillary assets—applying least life-cycle cost methods for the selection of preservation,

rehabilitation, or replacement activities has the potential for huge cost savings when applied consistently throughout the State.

There are over 300,000 centerline miles of public roadways in Texas, of which over 80,000 are operated and maintained by TxDOT.[v] As shown in **Figure 1**, 88.3 percent of pavement lane miles statewide were in "good or better" condition in FY 2013. This represents the first overall improvement in pavement condition that occurred in the last four years and the highest percentage of pavement in "good or better" condition since FY 2002 when the Texas Transportation Commission established the goal of 90 percent "good or better" pavement lane miles statewide.[vi]

**Figure 1. Statewide Pavement Condition (by lane miles)**




| Condition Score | State-of-Good-Repair |
|---|---|
| 90-100 | Very Good |
| 70-89 | Good |
| 50-69 | Fair |
| 35-49 | Poor |
| 1-34 | Very Poor |

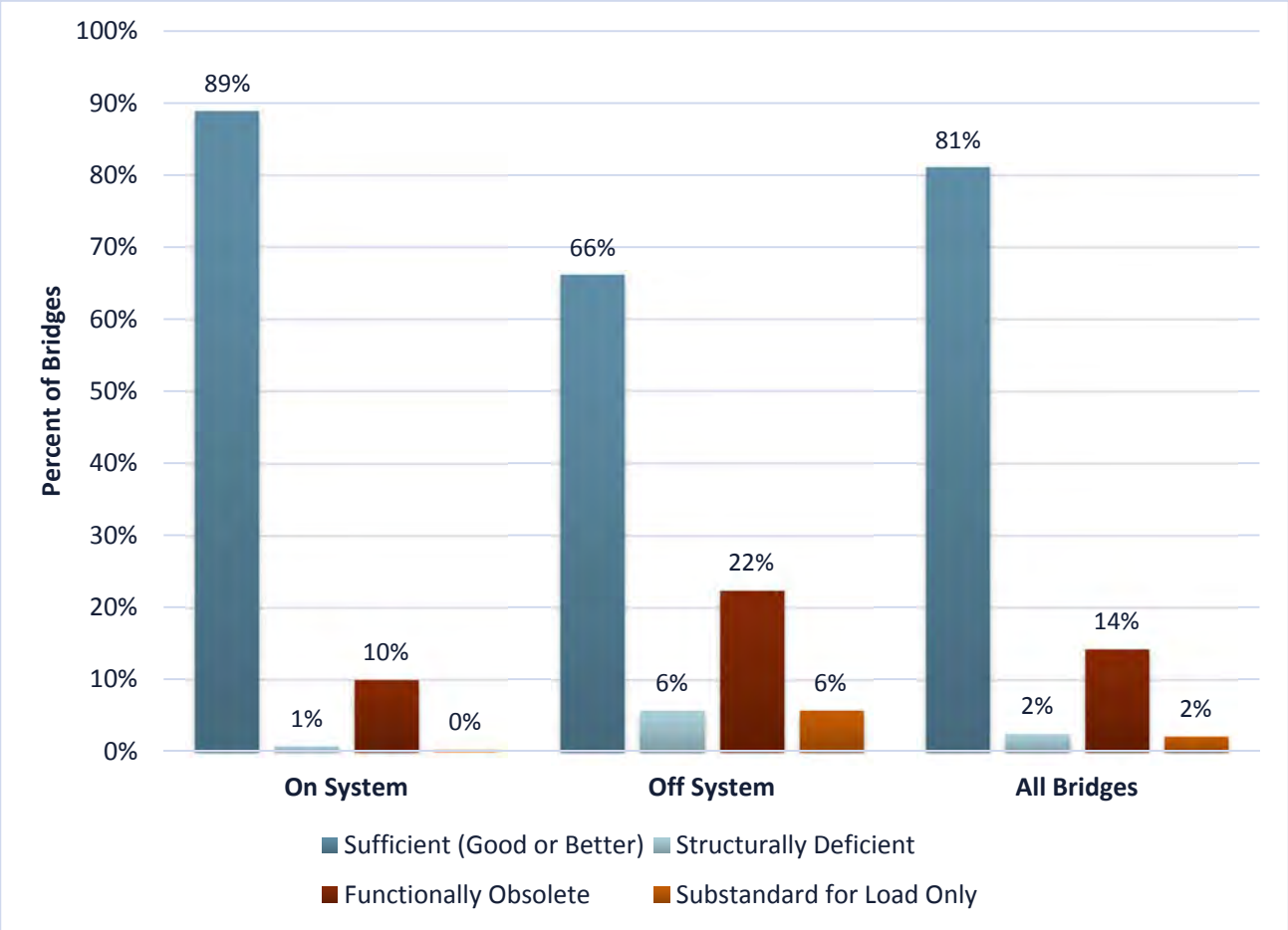
Source: TXDOT PMIS Annual Report 2010-2013

There are 52,000 highway bridges in Texas, constituting 9 percent of the nation's total inventory of bridges. Bridge performance is classified by condition, with deficient structures designated as structurally deficient or functionally obsolete based on FHWA reporting standards[viii] or as substandard-for-load if the carrying capacity is less than the maximum permitted by State law. Bridges in a state-of-good-repair are not deficient in any respect.

Bridge inspection data from September 2012 reveals that at the time of the inspection:

- More than 53 percent of highway bridges in Texas were built after 1970.
- Approximately 88 percent of on-system bridges (those located on the Texas State highway network), 65 percent of off-system bridges, and 80 percent of total bridges were in a state-of-good repair (**Figure 2**).
- Less than 1 percent of on-system bridges were structurally deficient.
- Over 7,000 bridges (13.5 percent) in Texas were functionally obsolete.

**Figure 2. Condition of Texas Bridges by Count in September 2012**

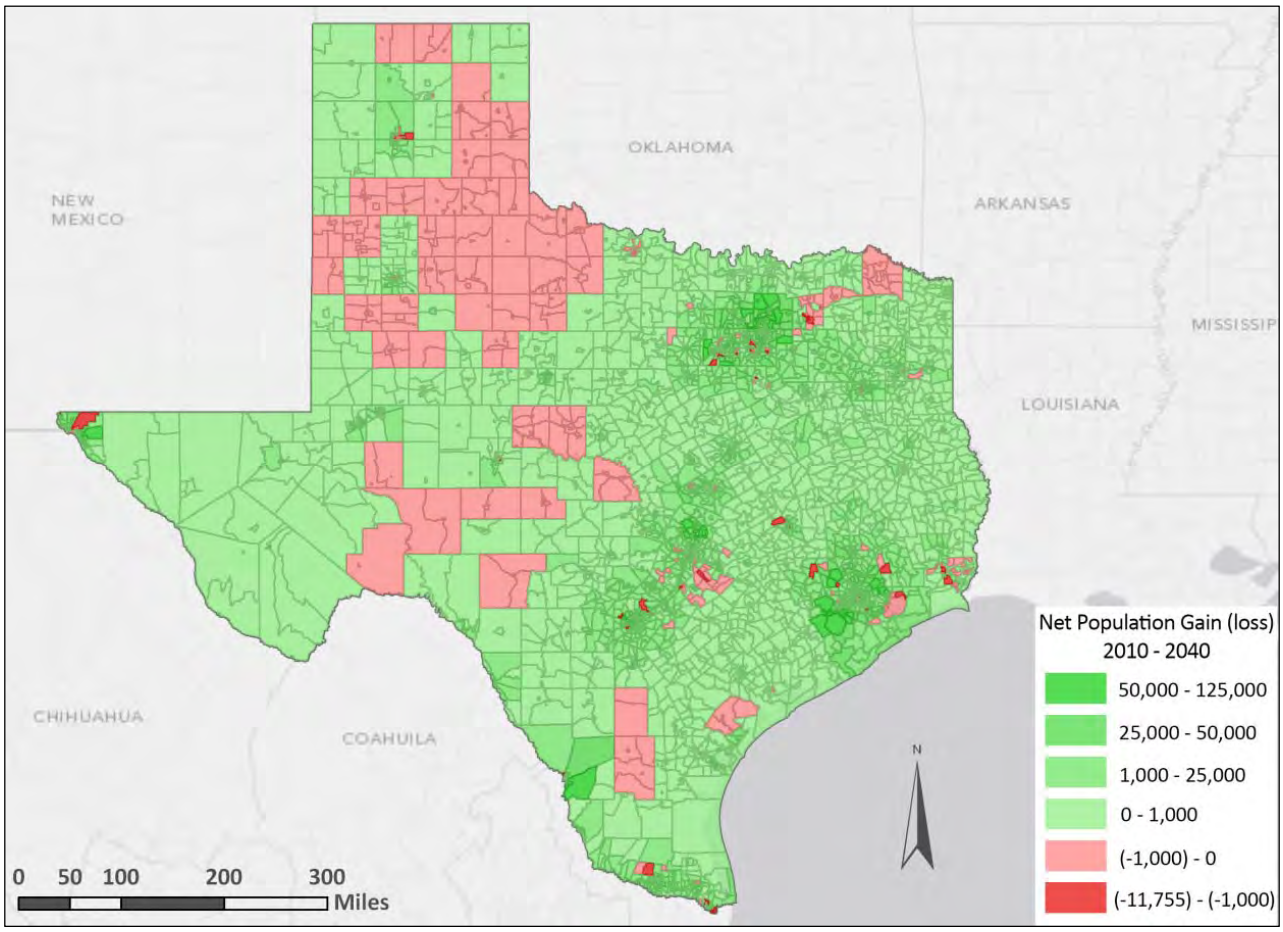



### 2.2.2 Transit

Transit provides a critical transportation option in metropolitan and rural areas alike. In 2011 there were 281 million transit passenger boardings in the State; this reflects an annual 2 percent increase in transit ridership between 2002 and 2012.[ix] Transit services in Texas are primarily focused in the largest urban areas in accordance with the prevalence of use; however, every county has some form of public transportation.

Figure 3 illustrates the population shift projected from rural to urban areas between 2010 and 2040. Continuing urbanization in Texas combined with a high influx of new residents concentrated primarily in metropolitan areas will make transit an even more attractive and essential transportation option for the safe and efficient movement of people. As such, 2040 baseline scenario of SAM V3 predicts that passenger trips by urban rail will more than double between 2010 and 2040 (Table 4).

**Figure 3. Texas Population Change Projected from 2010 to 2040**




Source: Texas Statewide Analysis Model (SAM) V3

**Table 4. Percent Change in Total Trips by Mode from 2010 to 2040**

| Passenger Transportation Mode | Forecasted Change in Total Trips from 2010 to 2040 |
|---|---|
| Drive Alone | + 57% |
| Share Ride (2 persons) | + 57% |
| Share Ride (3+ persons) | + 56% |
| Bus | + 45% |
| Urban Rail | + 201% |
| Long Distance Trip (Air and Intercity Rail) | + 75% |
| Total Trips across All Modes | + 57% |

Source: Texas Statewide Analysis Model (SAM) V3

Rail transit is available in Houston, Dallas, Fort Worth, Austin, and Galveston. Additionally, rail transit provides access between Denton County and the Dallas/ Fort Worth (DFW) metropolitan area. Intercity rail services are available through Amtrak via the *Sunset Limited* route, which runs approximately 2,000 miles between New Orleans, San Antonio, and Los Angeles; the *Texas Eagle*, which travels daily between Chicago and San Antonio; and the *Heartland Flyer*, which connects between Oklahoma City and Fort Worth.[x]

The current condition of transit assets in Texas is provided in **Figure 4** by asset category and in **Figure 5** by travel mode based on the following designations:

- **Excellent:** No visible defects – like new condition
- **Good:** Some (slightly) defective or deteriorated component(s)
- **Adequate:** Moderately defective or deteriorated component(s)
- **Marginal:** Defective or deteriorated component(s) in need of replacement
- **Worn:** Critically damaged component(s) or in need of immediate repair

### 2.2.3 Aviation

Air travel is another significant passenger travel mode and an important contributor to the Texas economy based on its role in promoting tourism, creating jobs, and facilitating commerce. The Texas airport system is the largest in the nation with over 1,600 public and private landing sites, 292 airports, and 2 heliports. Of the total airports in the State, 27 are classified as Commercial Service airports (26 primary and 1 non-primary based on annual passenger enplanements), 24 are classified as Reliever airports, and 241 are classified as General Aviation airports.[xxi] Commercial Service airports and the majority of Reliever airports in Texas are located in large metropolitan areas. General Aviation airports provide access to more remote areas of the State and connect widely dispersed economic activity centers.[xxi]

**Figure 4. Current Condition of Transit Assets by Asset Category**

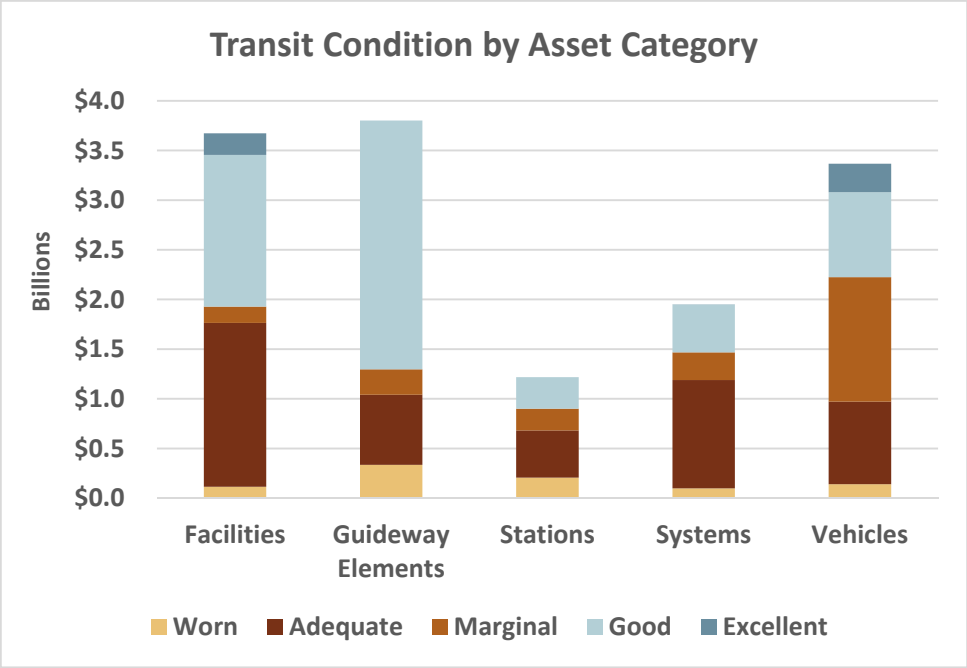
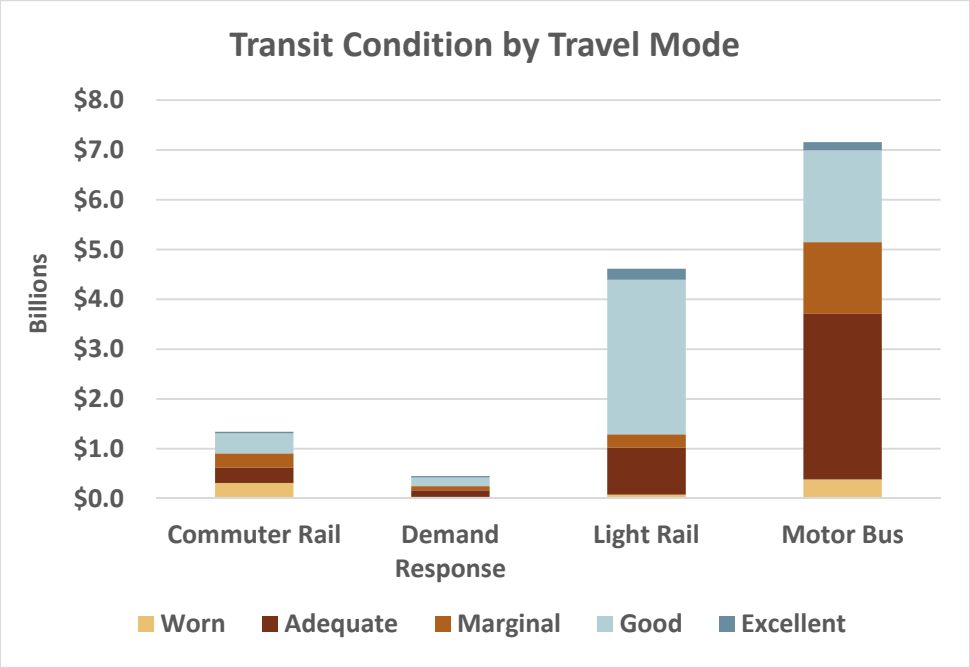



**Figure 5. Current Condition of Transit Assets by Travel Mode**



Dallas/Fort Worth International (DFW) and Houston George Bush Intercontinental (IAH) consistently rank among the nation's busiest: in 2012, DFW ranked 3rd in the U.S. for passenger arrivals and departures and 3rd overall for total departures; IAH ranked 13th in the U.S. for passenger arrivals and departures and 7th overall for total departures.[xxii]

### 2.2.4 Non-Motorized

Providing safe, interconnected, and well-maintained pedestrian and bicycle facilities is essential for creating livable and sustainable communities, for improving residents' quality of life, and for supporting the use of walking and biking as viable travel modes rather than strictly for recreational purposes. While bicycle and pedestrian projects are implemented primarily by local governments, all major construction and reconstruction highway projects in Texas may include provisions for bicycle travel, and local agencies may fund the incorporation of bike lanes on State roads.

Texas ranked 45th in the nation with respect to the combined bike and walk to work share based on results from the 2007-2009 American Community Survey. Austin (#27), Houston (#37), El Paso (#42), San Antonio (#45), Arlington (#46), Dallas (#49) and Fort Worth (#51) all ranked among the top-51 U.S. cities with respect to bike and walk to work share from 2007 to 2009.[xxiii]

Pedestrian and bicycle safety is a top priority for the State. In 2010, Texas averaged 1.37 pedestrian fatalities per 100,000 residents—20th overall among states and slightly lower than the national rate of 1.38 pedestrian fatalities per 100,000 residents.[xxiv] TxDOT is currently working with the FHWA to develop and implement an aggressive plan to reduce pedestrian crashes, fatalities, and injuries.

### 2.2.5 Intelligent Transportation Systems (ITS)

Intelligent Transportation Systems (ITS) serve several purposes in Texas transportation that include traffic management, information dissemination, and border security.[xi] ITS devices provide real-time monitoring of system conditions and can be used to reduce incident response times and provide pertinent and timely information to travelers. The types of devices used in Texas include Digital Message Signs (DMS); Closed Circuit Television Camera (CCTV); Lane Control Signals (LCS); radar detection; detection loops; Highway Advisory Radio (HAR); ramp meters; Automatic Vehicle Identification (AVI); flood warning sensors; and weather sensors.

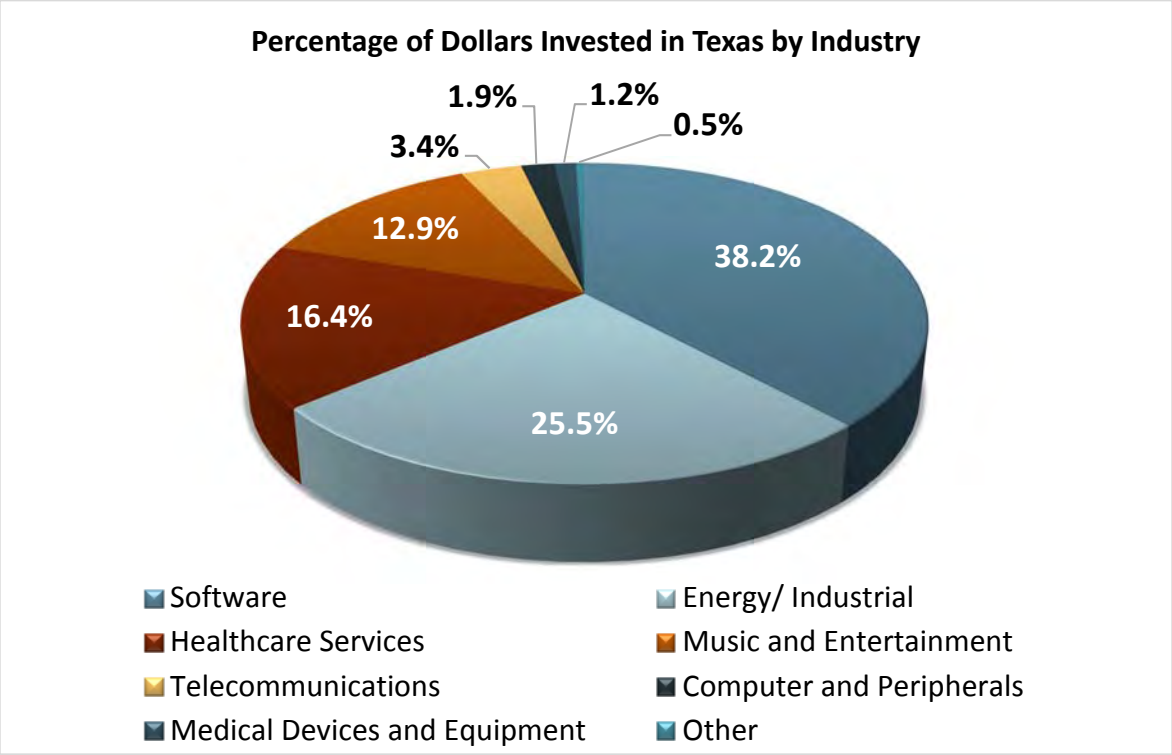
In the future, ITS and transportation operations technologies will continue to be a critical component of system management and congestion reduction as a more cost effective alternative to traditional highway expansion. As technology becomes more robust and more integrated into the day-to-day lives of Texans, it will be critical to consider the changes that enhanced technology may bring about in the Plan horizon. For example, smart phones and electronic media will continue to change the way we travel and in many cases allowing us to not travel at all. In the Plan horizon, the Google driverless car will likely become a reality, further pushing the envelope of technology integration into the transportation network.

## 2.3 *Freight*

Texas has maintained strong economic and job growth despite the nation's economic downturn, and freight has played a key role in the State's economic resilience.[xxv] Industries that are largely fueling the growing Texas economy include software, energy/industrial, and healthcare services as shown in **Figure 6**.[xxvi]

The Texas freight system facilitates commerce and supports industry by transporting goods by ship, air, rail, truck, and pipeline. While some modes such as pipelines transport only goods, others such as the highway system transport both people and goods, and conflicts between freight and passenger movements have significant capacity and safety implications. In the case of the highway system, private automobiles and long-haul truckers mix primarily on the major interstates traversing the State.

**Figure 6. Industries Fueling Texas' Economic Growth**




Source: PricewaterhouseCoopers and National Venture Capital Association's Money Tree Report

### 2.3.1 Trucking

Texas provides a land bridge for freight movements from California to the east coast along I-10 and I-40, and from Mexico to U.S. destinations and Canada along I-35, I-69, and US 59. On average, heavy vehicle traffic constitutes approximately 12 percent of the vehicle miles traveled in Texas annually.[xii]

1.2 billion tons of freight were transported on the Texas highway system in 2011, constituting more than 46 percent of all freight moved in the State that same year; by 2040, truck tonnage is expected to increase by 78 percent and account for 56 percent of all freight moved. Trucking supports the Texas economy by:[xii]

- **Creating jobs:** 1 in 16 Texans are employed by approximately 66,000 trucking companies, including over 185,000 truck drivers.
- **Supporting Texas industry:** 73 percent of goods manufactured in Texas are transported by truck.
- **Facilitating international trade:** 85percent of trade between Texas and Mexico is handled by trucks.

TxDOT is currently developing the State's first State Freight Plan, which will be integrated with the TTP 2040.

### 2.3.2 Ports

There are 11 deep-draft ocean ports and 10 shallow ports in Texas that are connected by the Gulf Intracoastal Waterway, a navigable inland waterway that runs along the State's eastern coastline.[xi] Collectively, Texas ports rank 1st nationally in goods exports and waterborne commerce and account for 19 percent of the total port tonnage in the U.S., handling approximately 564 million tons of foreign and domestic freight annually.[xi]

In 2011, maritime cargo activity at ports generated $277 billion in economic value, representing 25 percent of the State Gross Domestic Product (GDP).[xxx] In addition to increasing GDP, ports support the Texas economy by creating opportunities for employment: approximately 1.5 million jobs are directly or indirectly related to moving cargo via port terminals in the State. Port security is vital for preventing illegal imports/ exports or the mishandling of hazardous imports and – when expanded to include maritime security – the economic losses resulting from piracy and other criminal activities that threaten the security and economic competitiveness of the State.[xi]

### 2.3.3 Railroads

Texas ranks 1st in the nation for the number of rail miles with approximately 10,400 total miles. [xxvii] On average, Texas railroads transport 8.8 million car loads of freight annually – the second highest annual number of car loads in the country.[xxvii] In 2011, over 7 million tons of intermodal rail freight was transported from Texas.[xxvii] Coal and chemicals account for the majority of rail freight originating and terminating in the State.[xxvii]

Freight rail in Texas ranks 1st in the nation for employment.[xxvii] More than 17,000 Texans are employed by 47 freight railroad companies that operate in the State, of which there are three Class I (major) railroad companies: Union Pacific (UP), Burlington Northern Santa Fe (BNSF), and Kansas City Southern (KCS).[xxvii]

Five of seven total rail crossings between the U.S. and Mexico are located in Texas, and these crossings handle 89 percent of the total rail containers transported from Mexico to the U.S. In addition to handling the majority of cross-border freight transported by rail (by volume), Texas is a major hub for national freight rail movements. As one of the busiest and most congested railroad hubs in the country, Tower 55 near Fort Worth provides a critical junction point for the national freight and passenger rail networks alike, with nearly 100 freight and passenger trains moving through the area every day.[xxviii]

### 2.3.4 Air Cargo

Due to the high cost of shipping, goods transported by air are primarily perishable or of high value.[xxix] For this reason, while the weight share of goods shipped by air compared to the total goods transported via freight modes is less than 1 percent, the value share of goods shipped by air is approximately 16 percent of the total value of goods transported via freight modes. Imported goods constitute the majority of air freight handled in Texas.[xxix]

As a growing part of the State economy, air cargo is particularly contributing to the rapid expansion of oil/gas exploration and the local biomedical industry in Houston.[xxix] These industries are helped by the fact that flights leaving any airport in Texas can reach any domestic market in less than 4 hours.[xxix]

International air cargo shipments at Dallas/ Fort Worth airport have more than doubled between 1999 and 2013.[xxix] In 2012, DFW (#10) and IAH (#17) ranked among the top-20 U.S. airports with respect to the gross weight of air cargo handled.[xxix] IAH is the fastest growing air cargo hub in the State.[xxix]

### 2.3.5 Pipeline

Texas has the most extensive pipeline in the U.S., with over 360,000 total miles of pipelines carrying crude oil, natural gas, and other liquids. Oil and natural gas production in Texas comprise 20 percent and 25 percent, respectively, of the total amounts produced domestically.

Over the past decade, the State has experienced a tremendous increase in the exploration and production of energy resources. As an example, shale natural gas production in Texas nearly tripled between 2009 and 2012. This increase in energy-related activity has greatly benefited local and State economies. However, the increase in heavy truck volume to support oil and gas production has accelerated the deterioration of the State's roadways – many of which were not initially designed to support heavy traffic loads.[vi] Determining and addressing energy sector impacts on the condition of Texas roadways will continue to be a priority for the State going forward.

## 2.4 Environmental Concerns

Motor vehicles are a major source of air pollution, including ground-level ozone or smog, particulate matter (PM), carbon monoxide, and air toxins. PM presents one of the greatest air quality challenges in Texas, and motor vehicle exhaust is a major source of fine particulates ($PM_{2.5}$). Coarse particulates ($PM_{10}$) are caused by vehicle exhaust as well as traffic on streets and highways that stirs dust into the air, construction activity on transportation facilities, and travel on unpaved roads. In addition to PM, ozone presents significant air quality challenges in Texas, particularly in major metropolitan areas.

The Environmental Protection Agency (EPA) established national ambient air quality standards under the Clean Air Act that limit the concentrations of air pollutants including transportation emissions. Regions of the country that persistently exceed the maximum concentrations established by the standards are designated as "nonattainment." States with nonattainment areas are required to develop a plan for submittal to the EPA that details the steps they will take to meet and continue to meet national ambient air quality standards. Currently, El Paso County is in nonattainment for $PM_{10}$, and the Dallas-Fort Worth and Houston-Galveston-Brazoria regions are in nonattainment for ozone.

## 2.5 Economic Growth and Transportation Funding

Over the past 10 years, the Texas economy has been among the strongest and most dynamic in the nation. Texas is increasingly interrelated with other geographies and economies domestically and globally. This geographic expansion of trade links has fostered economic growth, but at the same time has placed a significant burden on the Texas transportation system. As shown in **Figure 7**, three major revenue sources comprise approximately 85 percent of the total funding available for improvements and enhancements to State roadways:[xxx]

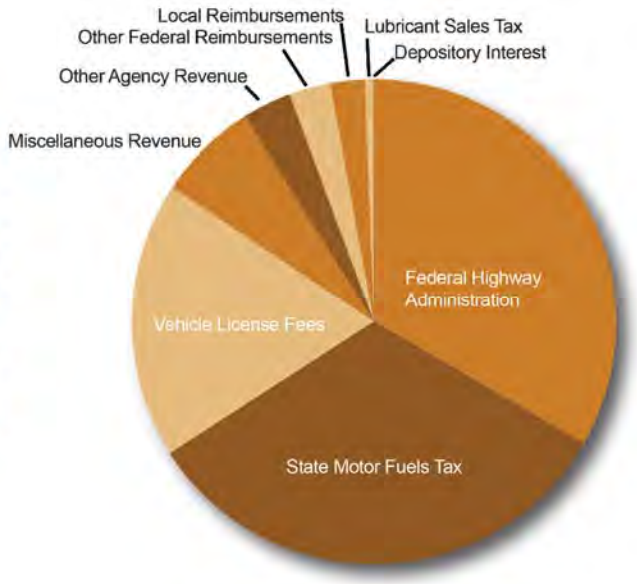
- **State fuel tax:** 20 cents per gallon for gasoline and diesel (last raised in 1991)
- **Federal fuel tax:** 18.4 cents per gallon for gasoline / 24.4 cents per gallon for diesel (last raised in 1993)
- **Vehicle license fees:** $50.75 for personal vehicles annually (some counties add no more than $11.50)

**Figure 7. Sources of Transportation Revenue**

**The Numbers - Sources of Transportation Revenue**

| Source | Amount | Percent |
|---|---|---|
| Federal Highway Administration | $2,428,195,624 | 33% |
| State Motor Fuel Tax | $2,366,071,688 | 33% |
| Vehicle License Fees | $1,347,719,383 | 19% |
| Miscellaneous Revenue | $487,348,436 | 7% |
| Other Agency Revenue | $235,581,073 | 3% |
| Other Federal Reimbursements | $202,466,423 | 3% |
| Local Reimbursements | $165,354,044 | 2% |
| Lubricant Sales Tax | $42,526,000 | 1% |
| Depository Interest | $2,476,501 | 0.03% |
| Total | $7,277,739,173 | 100% |

Actual revenue may differ slightly from the Comptroller's Annual Cash Report in the event the Comptroller makes post-FY adjustments.

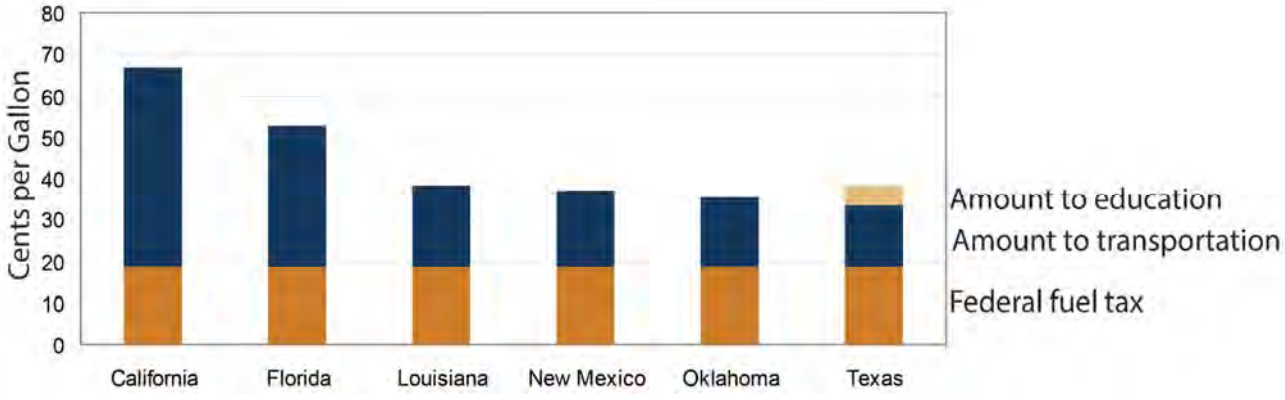



Transportation fees are lower in Texas than in 43 other states including California, Florida, New Mexico, Louisiana, and Oklahoma (**Figure 8**).[xxxi] Specifically, among the 50 states, Texas ranks:

- 18th in vehicle registration fees
- 29th in state gasoline tax rate
- 44th in overall annual cost of vehicle ownership

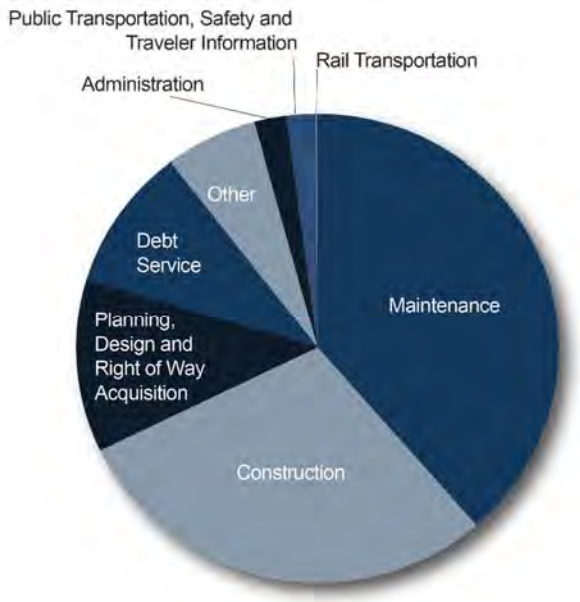
A Texas resident who drives 12,000 miles per year in a vehicle that averages 21 miles per gallon will pay approximately $8.76 in gas taxes to the federal highway fund and $9.52 in taxes to the State roadway fund per month. Currently, most Texas residents pay less than $20.00 per month for transportation infrastructure through fuel taxes.

**Figure 8. State and Federal Fuel Tax Rates**



TxDOT, either directly or through grants, provides maintenance for more than 190,000 lane-miles of highways, 33,500 on-system bridges, 17,000 off-system bridges, 300 airports, and 2,700 rural and small urban public transportation vehicles.[xxxii] As shown in **Figure 9**, maintenance is the largest transportation expenditure in Texas, constituting approximately 40 percent of the annual transportation budget.[7] Together with maintenance expenditures, initial construction, planning, design, and right of way, along with debt service, comprise 90 percent of the total transportation expenditures in Texas. Miscellaneous fees and other disbursements constitute the additional 10 percent of expenditures.

**Figure 9. TxDOT Transportation Expenditures**




**The Numbers - Transportation Expenditures (in millions)**

| Expenditure | Amount | Percentage |
|---|---|---|
| Maintenance | $3,593.0 | 39% |
| Construction | $2,713.5 | 29% |
| Planning, Design and Right of Way Acquistion | $1,111.6 | 12% |
| Debt Service | $919.5 | 10% |
| Other | $578.3 | 6% |
| Administration | $199.0 | 2% |
| Public Transportation, Safety and Travel Information | $182.0 | 2% |
| Rail Transportation | $7.7 | 0.1% |
| **Total** | **$9,304.6** | **100%** |

Source: TxDOT Budget | 2013

As the Texas transportation system ages, there is an imperative need to invest in the existing transportation system to maintain an acceptable level of service for current and future generations. Sound asset management practices that include the timely application of rehabilitation and preventive maintenance activities can be adopted and implemented to extend the life of infrastructure assets and reduce life-cycle costs. However, such investment in system preservation must be balanced against investment in system expansion and other priorities to accommodate growth and achieve the State's overall transportation vision, goals, and objectives.

## 3.0 Looking Ahead

In the next 25 years, the Texas population is expected to grow from 25 million to 38.5 million,[xxxiii] and freight miles traveled are expected to increase at twice the rate of passenger miles traveled. This growth in population and freight traffic is likely to result in increased congestion, decreased multimodal safety and reliability, and the accelerated deterioration of bridge and pavement assets under heavier and more frequent loadings. The Texas transportation system will need to grow to

accommodate the increase in passenger and freight users in a manner that reflects their desires for more reliable, accessible, convenient, safe, and efficient transportation choices while simultaneously considering the disparate needs and priorities of rural, urban, and suburban areas across the State.

With the continuing depletion of the national Highway Trust Fund and predictions of insolvency by as early as 2015,[xxxiv] it is unclear how states and the federal government will meet the growing transportation needs of tomorrow. Procuring sustainable funding presents a significant underlying challenge to maintaining and improving upon the condition and performance of the Texas transportation system today and for years to come.

Other significant challenges for the future Texas transportation system include:

- **Making the system safer**: Improving multimodal safety continues to be TxDOT's number one priority with specific emphasis placed on reducing fatal and serious injury crashes and improving pedestrian and bicycle safety.
- **Managing the agency and the system despite diminishing revenues and higher transportation costs**: Like most other DOTs throughout the country, TxDOT is experiencing declining revenues and increasing demands on the multimodal transportation system. There is an urgent need to invest more in the State transportation system to keep pace with growth and to take care of existing assets. As revenues from traditional sources continue to decline, TxDOT will need to identify and pursue innovative techniques to fill the funding gap in order to prevent the deterioration of multimodal system condition and level of service.
- **Making sure all regions of the State benefit from transportation investments**: Rural areas located outside of metropolitan boundaries are home to millions of Texans with different mobility and accessibility needs than those of urban and suburban residents. Multimodal access for all rural residents with a particular focus on aging, disabled, and disadvantaged populations will continue to be a critical priority for TxDOT. Additionally, rural areas are essential to the Texas economy: the transportation system that serves these areas facilitates State, national, and global commerce and supports the activities of many Texas industries. Specific rural transportation priorities such as those relating to system connectivity and infrastructure viability for freight traffic should be considered and addressed in order to ensure future economic prosperity.

The *TTP 2040* will provide a framework that links investments to the desired future vision for the Texas transportation system while fulfilling both State and federal planning requirements. It will be focused on outcomes that include improving multimodal system condition and safety and expanding transportation choices for Texans in all areas of the State. As a performance-based plan, the TTP will prioritize investments in light of Plan goals and objectives, determine the costs required to achieve the goals, forecast future funding sources/levels, and calculate funding gaps.

## 4.0 Endnotes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# Texas Transportation Plan

## Tech Memo 6: Aviation Modal Profile

August 15, 2014

## Acknowledgements


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# 1.0 Introduction

The 2040 Texas Transportation Plan will guide the State of Texas Transportation System into the future by reviewing existing conditions, conducting demand modeling, establishing future needs, and developing financially-constrained investment scenarios for all transportation modes, including the State's Aviation System. This technical memorandum summarizes the long-term capital improvement project needs of the Texas Aviation System and evaluates how well current levels of State funding support those needs as well as presents the benefit, in terms of the number of projects able to be executed, of increasing projected funding toward satisfying the total Aviation System need.

# 2.0 Overview of Existing Conditions

In conjunction with the Federal Aviation Administration (FAA), the Aviation Division of the Texas Department of Transportation (TxDOT) administers capital improvement grant funding for airports included in the Texas Airport System Plan. Texas is one of the few states that participates in the FAA's State Block Grant Program. This program allows the State to control the allocation of Federal grant funding to lower tier eligible airports that would normally be managed by FAA.

Texas has 292 airports and two heliports in its State Aviation System Plan. In 2012, Texas ranked 3rd in Tower Operations (which includes touch-and-goes and overflights) with a total of 4,674,903 Operations (Source: FAA). As reported in the 2010 Texas Airport System Plan, general aviation operations (takeoffs and landings) are estimated to increase by nearly 20 percent with a 65 percent increase in passenger enplanements between 2010 and 2025.

# 3.0 Unconstrained Needs Determination

## *3.1 Methodology and Assumptions*

The analysis used two primary sources to determine the total unconstrained capital improvement needs of the State's airports. For Primary Commercial airport needs, FAA's 2013–2017 National Plan of Integrated Airports Systems (NPIAS) Report Development Costs was used (Source: FAA). For general aviation (GA), Non-Primary Commercial, and Reliever type airport needs, the TxDOT Aviation Division provided their 20-year project needs database, known as the Texas Airport Data System (TADS). For the remainder of the memorandum, the term "GA" will include GA, Non-Primary Commercial, and Reliever airports.

TxDOT GA needs assessments have been traditionally developed through the Texas Airport Data System (TADS). The TADS provides a 20-year outlook of identified airport improvements throughout the state. For each improvement item, the TADS maintains a database including a description, airport location, FAA Priority Score (including individual scoring components), and estimated construction cost. Multiple improvements will be grouped into a larger project when they are constructed. However, for the purposes of this Technical Memo, the term "project" will refer to an individual improvement item.

TxDOT does not provide any funding for Primary Commercial Service airports. Those airports receive their funding directly from the FAA. TxDOT does, however, provide funding for GA airports. The revenue to fund these airports comes from State and Federal Resources. For this study, TxDOT recently met with the FAA and agreed the best way to determine the needs for Primary Commercial Airports was to use the FAA published NPIAS Report. This report describes the Total Development Cost over the next 5 years for each airport listed.

The total unconstrained Aviation System needs for the state are the average annual capital project cost needs for Primary Commercial and GA airports from the above sources extrapolated over the planning period to the year 2040 as is summarized in the next section.

### *3.2 Unconstrained Needs to 2040*

As described above, the TxDOT TADS database provided the GA capital project cost needs for the next 20 years to 2032. Again, the FAA NPIAS Report provided the Primary Commercial capital project cost needs over a 5-year period from 2013 to 2017. On average, this equates to $626M of need for Primary Commercial airports and $105M of need for GA airports (in current day dollars) annually. Assuming the average annual need remains constant over the planning period to the year 2040, the total Primary Commercial need is calculated to be $18.2B. Likewise, a total GA need of $2.9B is calculated over the planning period to the year 2040. Combined, the total need of $21.1B (in current day dollars) represents the cost to implement capital improvement projects over the planning period that address Aviation System deficiencies that focus on enhancing safety/security, FAA's statutory emphasis projects, reconstruction/rehabilitation, environment, planning, capacity, standards, and other local projects.

## 4.0 Anticipated Revenues

TxDOT aviation estimates that on average they receive $51M annually in Federal Block Grant Funds and $15M annually in state funds to support GA airports. Many states have an aviation fuel tax that is used to fund an aviation account; however, Texas receives its aviation funding from the Highway Trust Fund which is supported by a state motor fuel tax.

Texas Primary Commercial airports are primarily funded by Airport Improvement Program (AIP) grants from the FAA. In 2013, the FAA awarded Texas Primary Commercial airports with almost $169M in the form of AIP grants (Source: FAA).

## 5.0 Fiscally-Constrained Analysis and Funding Gap

The Transportation Plan is focused on the financial gap in the State of Texas. As stated in Section 3.1 of this memo, Primary Commercial Service airports are funded solely by the FAA. Since the commercial service airports do not have an impact on the TXDOT aviation fiscal budget, they were excluded from this analysis.

The Fiscally Constrained Analysis uses only projects at GA airports identified in TxDOT's TADS database. For the purposes of this study it was assumed that all projects listed in the database were eligible for State and/or Federal Funding. In addition, it was assumed that each airport could also fund their required share of the project cost.

In order to receive FAA funding, there are certain eligibility requirements for the airport. The airport must be a public use airport and included in the NPIAS. The NPIAS identifies all existing and proposed airports that are significant to national air transportation.

The FAA also has requirements on what types of projects are eligible for funding. Projects that are related to enhancing airport safety, capacity, security, and environmental concerns are typically funded where projects related to revenue-generating are typically not. See Table 5-1 for examples of eligible and ineligible projects from the FAA website; the table does not cover all airport projects.

**Table 5-1. Examples of Eligible versus Ineligible AIP Projects**

| Eligible Projects | Ineligible Projects |
|---|---|
| Runway construction/rehabilitation | Maintenance equipment and vehicles |
| Taxiway construction/rehabilitation | Office and office equipment |
| Apron construction/rehabilitation | Fuel farms* |
| Airfield lighting | Landscaping |
| Airfield signage | Artworks |
| Airfield drainage | Aircraft hangars* |
| Land acquisition | Industrial park development |
| Weather observation stations (AWOS) | Marketing plans |
| Navigational Aids such as REILs and PAPIs | Training |
| Planning studies | Improvements for commercial enterprises |
| Environmental studies | Maintenance or repairs of buildings |
| Safety area improvements | |
| Airport layout plans (ALPs) | |
| Access roads only located on airport property | |
| Removing, lowering, moving, marking, and lighting hazards | |
| Glycol Recovery Trucks/Glycol Vacuum Trucks** (11/29/2007) | |

Notes:
*May be eligible. Contact the Airport District of Regional Office for more information
**To be eligible, the vehicles must be owned and operated by the Airport and meet the Buy American Preference specified in the AIP grant.
Source: www.FAA.gov/airports/aip/overview

The State's eligibility requirements are much simpler. All the projects within the TADS database are eligible for state funding with the exception of the projects from four FAA designated Reliever Airports (Pearland Regional, West Houston, David Wayne Hooks, and Houston SW Airports). These airports are only eligible for federal funding.

In addition to State and Federal Funding, the projects are never funded without a local share of the funding. This share is at least 10 percent of the total project cost. To meet this requirement, the analysis removes 10 percent from the total cost of each individual project listed in the TADS.

## *5.1 Project Prioritization*

Using the project FAA priority score (developed from FAA methodologies for AIP funding) and project cost found in the TADS, a Score-to-Cost Ratio is created for each project. Rather than the project priority score alone, this Score-to-Cost Ratio is used as the prioritization method for determining which projects are funded with the allocated annual budget available. If a project is not funded during a specific year, it is added to the pool of projects for the next year's budget until the year 2040. Using this method, the analysis maximizes the amount of projects programmed per dollar available during the planning period. The cost of all remaining unfunded projects comprise the State's funding gap.

## *5.2 Fiscally-Constrained and Tradeoff Analysis*

Similar to the determination of unconstrained needs, the fiscally-constrained analysis extends the current 20-year TADS database compiled of 9,283 total projects and a total cost of $2.1B to estimate the Aviation System funding gap in 2040.

The projects within the TADS database are separated into two different funding categories: NPIAS and Non-NPIAS. Again, NPIAS projects are eligible for both State and Federal funding whereas Non-NPIAS are only eligible for State funding. The groups of projects are analyzed separately with their current respective Federal and State budget allocations available. Additionally, the analysis includes results for a range of budget and allocation scenarios. For example, if the State chose to assign its entire annual state budget of $15M to Non-NPIAS airports, only Federal money would be available to fund NPIAS airport projects that year. If in the next year it decided to allocate $6M of the State money to Non-NPAIS, it would have the Federal budget along with the remainder of the State budget (the $9M left over from the $15M annual State budget) to fund NPIAS airport projects.

Table 5-2 presents a range of possible State funding for Non-NPIAS airports and estimates of the resulting funding gap. The highlighted row is the current available annual state aviation funding received from the Highway Trust Fund. If all $15M of the Annual State Budget is used every year to fund the 20-year TADS need of $211M, the entire Non-NPIAS system would be completely funded. This however, is an unlikely scenario as it would not leave any additional funding for NPIAS airports.

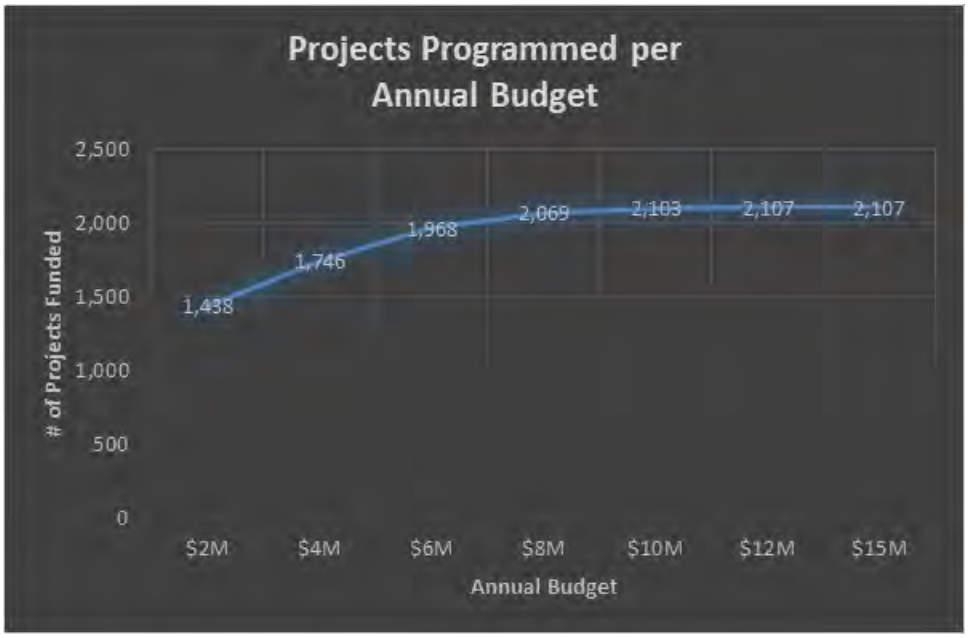
**Table 5-2. Non-NPIAS Annual Budget Scenarios**

| Annual State Budget ($M) | 20-year TADS Capital Project Cost Need ($M) | No. of 20-year TADS Projects Completed | 20-year TADS Value of Projects Completed ($M) | 20-year TADS Funding Gap ($M) | Estimated 2040 Funding Gap ($M) |
|---|---|---|---|---|---|
| $2M | $211M | 1,438 | $40M | $171M | $239M |
| $4M | $211M | 1,746 | $80M | $131M | $183M |
| $6M | $211M | 1,968 | $120M | $91M | $127M |
| $8M | $211M | 2,069 | $160M | $51M | $71M |
| $10M | $211M | 2,103 | $200M | $11M | $15M |
| $12M | $211M | 2,107 | $235M | $0M | $0M |
| $15M | $211M | 2,107 | $235M | $0M | $0M |

Note:
*Highlighted row denotes State Funding Budget

While the TADS database does not provide project-level detail to the year 2040, **Figure 5-1** illustrates the number of Non-NPIAS projects that can be funded within the 20-year framework of the TADS based on varying State budget funding scenarios ranging from $2M annually to $15M annually when all 20-year projects can be completed. It is expected this level of annual funding would continue to be required to meet State Aviation System needs. As is discussed above, the analysis prioritizes the project list and funds as many of the projects with the budget available.

**Figure 5-1. Non-NPIAS Projects Programmed per Annual Budget**



From Figure 5-1, it is observed that after the State's annual funding increases to $8M the number of funded projects levels out as higher cost and lower priority projects remain. This suggests that $7M of the total $15M annual State allocation may be better spent to support NPIAS airport projects. At a budget of $8M annually, there is an estimated Non-NPIAS funding gap of $71M in the year 2040.

Under that funding scenario, the current total annual budget of $58M ($51M [Federal] + $7M [State]) would be available to fund NPIAS airport projects. This equates to a funding gap of $672M by the year 2040. Note, the constraints of the NPIAS analysis did not allow for the extraction of the four NPIAS airports ineligible for State Funding (Pearland Regional, West Houston, David Wayne Hooks, and Houston SW). However, the State's contribution toward a total project value of $66.3M is expected to be approximately 10 percent and is determined not to be significant to the results of the analysis.

Like the Non-NPIAS analysis, **Table 5-3** presents a range of possible funding scenarios for NPIAS airports and estimates of the resulting funding gap. The highlighted row is the current available annual Federal aviation funding received from the FAA.

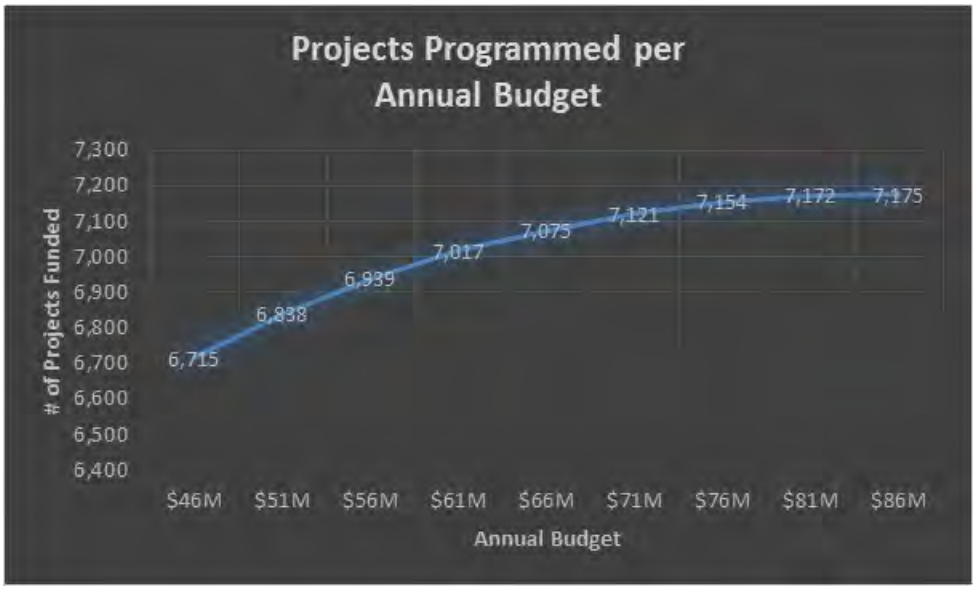
**Table 5-3. NPIAS Annual Budget Scenarios**

| Annual Federal Budget ($M) | 20-year TADS Capital Project Cost Need ($M) | No. of 20-year TADS Projects Completed | 20-year TADS Value of Projects Completed ($M) | 20-year TADS Funding Gap ($M) | Estimated 2040 Funding Gap ($M) |
|---|---|---|---|---|---|
| $46M | $1640M | 6,715 | $920M | $720M | $1,008M |
| $51M | $1640M | 6,838 | $1,020M | $620M | $868M |
| $56M | $1640M | 6,939 | $1,120M | $520M | $728M |
| $61M | $1640M | 7,017 | $1,220M | $420M | $588M |
| $66M | $1640M | 7,075 | $1,320M | $320M | $448M |
| $71M | $1640M | 7,121 | $1,420M | $220M | $308M |
| $76M | $1640M | 7,154 | $1,520M | $120M | $168M |
| $81M | $1640M | 7,172 | $1,620M | $20M | $28M |
| $86M | $1640M | 7,175 | $1,720M | $0M | $0M |

Notes:
Highlighted Row denotes Federal Funding Budget
This includes the four NPIAS Airports ineligible for State funding.

Again, while the TADS database does not provide project-level detail to the year 2040, **Figure 5-2** illustrates the number of NPIAS projects that can be funded within the 20-year framework of the TADS based on varying Federal and State budget funding scenarios ranging from $46M annually to $86M annually when all 20-year projects can be completed. It is expected this level of annual funding would continue to be required to meet Aviation System needs.

**Figure 5-2. NPIAS Projects Programmed per Annual Budget**




With Non-NPIAS and NPIAS combined, the analysis estimates a total Aviation System funding gap of almost $800M ($105M [Non-NPIAS] + $672M [NPIAS]) by the year 2040 and is approximately one-quarter of the total $2.9B worth of the State's unconstrained need. As determined earlier, the amount of annual funding needed to fund the entire system is $86M for NPIAS projects and $12M for Non-NPIAS projects for a total of $98M needed annually. This is $32M per year more than the $66M per year that is currently provided by Federal and State sources. While some increase in Federal funding may occur over time, the State will likely need to support the majority of the budget shortfall.

# Texas Transportation Plan

## Tech Memo 6: Bicycle-Pedestrian Modal Profile

August 14, 2014

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## 1.0 Introduction

As the State's long-range transportation plan, the Texas Transportation Plan 2040 (TTP 2040) will document the size and scope of the Texas transportation system with respect to existing conditions, current and future demand, funding needs by mode, and fiscally-constrained investment scenarios and probable outcomes. The bicycle and pedestrian modes are included in the TTP 2040; however, these modes have been historically under-represented at the statewide planning level in Texas and the nation. As described in *Technical Memorandum #3, Bicycle-Pedestrian Methodology*, bicycle and pedestrian planning generally occurs at the local level and typically lacks the data and tools needed to analyze usage and performance, and forecast future needs. This lack of data provides a challenge when attempting to document bicycle and pedestrian needs, particularly as compared to other modes.

The following sections present an attempt to document fiscally-constrained and unconstrained bicycle and pedestrian needs within the State of Texas. As described in the following sections, this methodology is generally an accounting of Metropolitan Planning Organization (MPO)-reported needs, which tend to vary widely in their respective methodologies. As such, this needs analysis should be considered as a baseline or starting point when discussing bicycle and pedestrian needs in Texas. This is particularly true given the rapidly growing population of the state and the increasing interest of Texans to utilize these modes for transportation.

## 2.0 Overview of Existing Conditions

Unlike other modes of transportation identified within the TTP 2040, the bicycle and pedestrian modes include facilities constructed and maintained at all levels of government, not just accommodations on TxDOT's State Highway System (SHS). As such, the pedestrian/bike needs reported in the following sections include bicycle and pedestrian facilities on the TxDOT system, as well as facilities owned by county and city governments.

The bicycle and pedestrian modes are served by a variety of facility types, which include both on-road and off-road facilities. The most common types of bicycle and pedestrian facilities include the following:

- Sidewalk – pathway separate from but adjacent to roadway. Typically used by pedestrians; bicycle use varies by jurisdiction.
- Signed Shared Roadway – A roadway that is open to both bicycle and motor vehicle travel (AASHTO, 2012). A roadway that is officially designated and marked as a bicycle route, but which is open to motor vehicle travel and upon which no bicycle lane is designated (TxDOT, 2011). A Signed Shared Roadway shall include posted bike route signs and may include pavement markings.
- Signed Shoulder Bike Route – The portion of roadway contiguous with the travel way that accommodates stopped vehicles, emergency use, and lateral support for sub base, base, and

surface course. Shoulders where paved are often used by bicyclists (AASHTO, 2012). A Signed Shoulder shall include posted bike route signs and may include pavement markings.

- **Bike or Bicycle Lane** – A portion of a roadway that has been designated for preferential or exclusive use by bicyclists by pavement markings and, if used, signs (AASHTO, 2012; TxDOT, 2011). It is intended for one-way travel, usually in the same direction as the adjacent traffic lane, unless designated as a contra-flow lane (AASHTO, 2012).
- **Shared Use Path** – A bikeway outside the traveled way and physically separated from motor vehicle traffic by an open space or barrier and either within the highway right-of-way or within an independent right-of-way or within an independent alignment (AASHTO, 2012; TxDOT, 2011). Shared use paths may also be used by pedestrians (including skaters, users of manual and motorized wheelchairs, joggers) and other authorized motorized and non-motorized users. Most shared use paths are designed for two-way travel (AASHTO, 2012).
- **Cycle Track** – A Cycle Track is an exclusive bicycle facility that has elements of a separated path and on-road bike lane. A Cycle Track, while still within the roadway, is physically separated from motor traffic and is distinct from the sidewalk.

Facilities specifically designated for bicycles and pedestrians are more commonly located in urban and suburban areas, while rural areas are typically under-represented. Rural bicyclists and pedestrians may use sidewalks where available, but often utilize the existing roadway network, which is often less accommodating.

MPOs and cities vary in their interest and commitment to the bicycle and pedestrian modes. Larger metropolitan areas in Texas and smaller communities associated with colleges and universities tend to place additional emphasis on bicycle and pedestrian planning and investment. For example, the North Central Texas Council of Governments (NCTCOG) in the Dallas-Fort Worth area continues to develop a Regional Veloweb, which is a network of off-street shared-use paths. The Veloweb is intended to serve as a regional expressway for bicycles, and also serves other non-motorized transportation. As of the 2013 update to their 2035 Metropolitan Transportation Plan (MTP), the Regional Veloweb contains 318 miles of existing facilities, with 1,377 miles planned. In addition, this latest MTP update identifies approximately $1.5 billion of potential funding for “active” transportation improvements through 2035. This high level of planning and financial support that includes the bicycle and pedestrian modes is not typical as compared to other regions of Texas, and serves to illustrate the wide variety of commitments and funding, as well as the local nature of bicycle and pedestrian planning.

## 2.1 Bicycle – Pedestrian System Performance

Unfortunately, significant data gaps exist for bicycle and pedestrian performance metrics. In general, current usage data and forecasting tools are not available. In fact, many cities and regions do not have a complete inventory of their existing bicycle and pedestrian networks. As one would expect, performance of the bicycle and pedestrian network in Texas, as in all states, is highly variable by location. Bicycle and pedestrian planning and investment is generally focused at the local and regional levels, and, as described previously, cities and regions provide varying levels of commitment to these modes, resulting in differences in network size and quality.

### 2.1.1 Usage

On a statewide level, national bicycle and pedestrian advocacy groups such as the League of American Bicyclists and the Alliance for Biking and Walking provide some insight into how Texans are utilizing bicycle and pedestrian accommodations for transportation versus other states. In their report "*Where we Ride – Analysis of Bicycling in American Cities*", the League of American Bicyclists compiled American Community Survey data for 2012. In this report, Texas is ranked #40 of 50 states in regard to percentage of bicycle commuters. Texas' 2012 bike commuting rate was 0.28%, which represented a 19.5% increase from the 2005 rate of 0.23%. In 2012 Oregon ranked #1 in bicycle commuting with a rate of 2.5%. The League also ranked the top 70 largest cities in the U.S. with regard to percentage of bicycle commuters. Texas cities included in the list, along with their national rank and 2012 percentage of bike commuters can be seen in Table 1 below.

**Table 1. Top 70 Largest Cities with Highest Share of Bicycle Commuters (2012)**

| City | Rank | % of Bike Commuters | Population | % Growth 1990-2012 | % Growth 2000-2012 |
|---|---|---|---|---|---|
| Portland, OR | 1 | 6.1% | 603,650 | 430.3% | 248.6% |
| Austin, TX | 16 | 1.6% | 842,595 | 100.1% | 67.6% |
| Houston, TX | 52 | 0.4% | 2,161,686 | 7.1% | -17.9% |
| Corpus Christi, TX | 53 | 0.4% | 312,192 | 50.4% | 44.2% |
| Arlington, TX | 59 | 0.3% | 375,598 | 56.4% | 48.9% |
| Fort Worth, TX | 60 | 0.2% | 782,027 | 26.3% | 83.7% |
| Dallas, TX | 65 | 0.2% | 1,241,108 | 31.8% | 51.6% |
| San Antonio, TX | 67 | 0.2% | 1,383,194 | 17.2% | 9.7% |
| El Paso, TX | 69 | 0.1% | 672,534 | -71.9% | -20.4% |
| Plano, TX | 70 | 0.1% | 270,816 | -69.8% | -40.9% |

Source: League of American Bicyclists, Where we Ride – Analysis of Bicycling in American Cities, 2013

### 2.1.2 Safety

The Alliance for Biking and Walking's *Bicycling and Walking in the United States – 2014 Benchmarking Report* ranks all 50 states in regard to biking and walking safety. The report utilizes National Highway Traffic Safety Administration (NHTSA) Fatality Analysis Reporting System (FARS) and American Community Survey data. Of the 50 states, Texas is ranked #39 in regard to bicyclist fatality rates, and #41 in regard to pedestrian fatality rates. In addition, of the 52 largest cities in the U.S., Arlington is Texas' top bicycle and pedestrian performer, ranked #1 (lowest fatality rate) in regard to bicyclist fatality rates and #24 in regard to pedestrian fatality rates.

Utilizing raw numbers, the NHTSA's *Traffic Safety Facts* also provides data regarding bicycle and pedestrian safety in Texas and the nation. Table 2 provides a snapshot of fatality rates for biking and walking in the years 2012 and 2007. As can be seen, rates in Texas have increased over the 5-year period.

**Table 2. Pedalcyclist and Pedestrian Fatalities, Texas and U.S. Totals**

| Location | Year | Pedalcyclist Fatalities | Pedalcyclist % of Total Traffic Fatalities | Pedalcyclist Fatalities per Million Population | Pedestrian Fatalities | Pedestrian % of Total Traffic Fatalities | Pedestrian Fatalities per 100,000 Population |
|---|---|---|---|---|---|---|---|
| Texas | 2012 | 56 | 1.6% | 2.15 | 478 | 14.1% | 1.83 |
| Texas | 2007 | 48 | 1.4% | 2.01 | 387 | 11.5% | 1.62 |
| U.S. Total | 2012 | 726 | 2.2% | 2.31 | 4,743 | 14.1% | 1.51 |
| U.S. Total | 2007 | 698 | 1.7% | 2.31 | 4,654 | 11.3% | 1.54 |

Source: NHTSA Traffic Safety Facts (2012 and 2007 Data) – Bicyclists and Other Cyclists; Pedestrians

### 2.1.3 Funding

In addition to safety and other factors, The Alliance for Biking and Walking's *Bicycling and Walking in the United States – 2014 Benchmarking Report* also ranks the 50 states based on percentage of federal transportation dollars applied to bicycling and walking. Utilizing FHWA's Fiscal Management Information System (FMIS) 2009–2012 data, the Alliance ranks Texas #29 of the 50 states, spending 1.6% of federal transportation dollars on bike/ped. The highest ranked state, Delaware, spends 3.7% on bike/pedestrian facilities.

## *2.2 Bicycle – Pedestrian System Deficiencies*

As previously discussed, the data necessary to analyze bicycle and pedestrian usage and system performance and condition is lacking, particularly at a statewide level. Emphasis on these modes is variable among cities and MPOs, which results in having varying levels of network information. An important first step in understanding the statewide bicycle and pedestrian network is a complete inventory and mapping of the city, county, and state maintained networks. Only after a full inventory of the networks can system deficiencies be identified. A top-down coordinated approach to system

inventorying and mapping, beginning with the state (TxDOT) and proceeding to MPOs and cities would seem ideal. Agencies responsible for roadway planning, design, construction, and maintenance should take inventory of bicycle and pedestrian accommodations by type, surface material, and width. It is recommended that local, regional, and state transportation agencies inventory bicycle and pedestrian accommodations annually and provide annual Geographic Information System (GIS) updates to local planning organizations for regional mapping.

TxDOT has in fact begun such an inventory of bicycle and pedestrian facilities on the State Highway System. TxDOT's Statewide Bicycle and Pedestrian Coordinator has begun a pilot project starting with the Tyler District to map bikeways on state maintained roadways. The map and associated database will be compiled from current TxDOT databases, maintained by TxDOT's Transportation Planning and Programming Section, as well as statewide pavement condition photos taken by TxDOT's Materials and Pavement Section. The map and database will be developed as an interactive tool to provide a variety of roadway information in conjunction with the identification of existing bike routes. Information will include signed bike routes by type (shared roadway, shoulder, bike lane, cycle tracks, and off-road shared use paths) with roadway information such as shoulder widths, pavement type, posted speed limit, annual average daily traffic, etc. The ultimate goal of the project will be to have a complete GIS inventory of bikeways on the State Highway System with information useful to bicyclists and pedestrians. Eventual availability of the data as a mobile phone application will be considered in project development.

Following a thorough inventory of a jurisdiction's bicycle and pedestrian network, local, regional, and state planners and engineers will have the opportunity to identify system deficiencies. Based on a jurisdiction's priorities, future projects can then be programmed to fill in connectivity gaps, improve conditions of the existing system, or address other priorities.

## 3.0 Needs Determination

The following sections provide a summary of the TTP 2040 bicycle and pedestrian needs determination methodology as well as results of the fiscally-constrained and unconstrained needs analysis to 2040.

### *3.1 Methodology and Assumptions*

The previous *Technical Memorandum #3, Bicycle-Pedestrian Methodology* described the methodology proposed for assessing the bicycle and pedestrian modes within the TTP 2040. The modal overview reviewed the roles of governmental agencies and departments involved with bicycle and pedestrian planning in Texas such as the U.S. Department of Transportation, TxDOT, Texas Parks & Wildlife Department, Texas Historical Commission, Metropolitan Planning Organizations, and cities. In addition, the roles of other organizations and advocacy groups were reviewed such as the American Association of State Highway and Transportation Officials (AASHTO), League of American Bicyclists, Alliance for Biking and Walking, BikeTexas, and the Rails-to-Trails Conservancy.

A review of data sources revealed that MPOs and cities continue to be the primary sources of bicycle and pedestrian information within Texas. As described in *Technical Memorandum #3, Bicycle-Pedestrian Methodology*, all 25 MPOs within Texas were surveyed for bicycle/pedestrian modal information within their respective Metropolitan Transportation Plans and/or stand-alone bicycle/pedestrian plans. In addition, where present, city bicycle plans were reviewed for the larger cities within the 25 Texas metro areas served by MPOs.

Following a review of available data, significant data gaps were found to exist for the bicycle and pedestrian modes. Data gaps included a lack of usage and performance data, lack of statewide inventories, lack of local inventories in some locations, and lack of rural area information. Where information was available from MPOs and cities, a significant constraint was the variable level of reporting, detail, and assumptions made by the reporting jurisdictions.

### 3.1.1 Defining "Needs"

As described above, due to a lack of bicycle and pedestrian information at the statewide level, needs were assessed by reviewing the 25 Texas MPOs for bicycle and pedestrian modal information within their Metropolitan Transportation Plans and/or stand-alone bicycle/pedestrian plans. Additionally, where present, city bicycle plans were also reviewed for the larger cities within the 25 Texas metro areas. Following a review of these MPO and city plans, future bicycle and pedestrian programs and projects, and their associated costs (where available), were compiled.

While the MPO and city-identified programs and projects were found to represent the bulk of the available bicycle and pedestrian needs information, additional methodologies were proposed in *Technical Memorandum #3, Bicycle-Pedestrian Methodology.* These methods were described as follows:

- Where projects are not identified within urban areas, identify high-level connectivity and safety issues (where discussed) which could benefit from future construction. Maintenance and accessibility needs would likely be more difficult to identify, and would not be included. Following identification, apply high-level estimated costs to identify project costs.
- Integrate priority needs identified in Outreach Round 1.

Upon further review of the available bicycle and pedestrian data, identification of additional high-level connectivity and safety issues was found to be too time-consuming and project-specific for analysis at the statewide level. However, priority needs were identified in Outreach Round 1, particularly from BikeTexas, which is a statewide advocacy, safety, and education non-profit organization focused on biking and walking. BikeTexas' comments address TxDOT and infrastructure policy, funding, and performance standards, and can be found in the Public Involvement Technical Memorandum. In addition, while rural area bicycle/pedestrian information was generally unavailable, bicycle and pedestrian needs of rural areas were included and are described in Section 3.2 below.

## 3.2 Fiscally-Constrained Needs to 2040

Table 4 presents the results of a review of the 25 most recent Texas MTPs as well as available stand-alone bicycle/pedestrian plans from MPOs and larger Texas cities. As can be seen, the reported information was highly variable among the MPOs and cities. Some MPOs reported extensive lists of bicycle and pedestrian programs and projects with associated costs, while others reported very little. Per federal requirements, most MPOs reported some level of fiscally-constrained financial need for the bicycle and pedestrian modes. Variability and potential shortcomings within the reported bicycle and pedestrian data were common, and included the following:

- Financial needs do not include planned projects with known bicycle and pedestrian components where these component costs were not broken out. This will result in underestimating bike/pedestrain needs.
- Financial needs include all reported Transportation Enhancement projects in 9 of the 25 MPOs. While Transportation Enhancement Program funds are often used for bicycle and pedestrian projects, they are not required to be, and this may overestimate bike/pedestrian needs.
- Some bicycle and pedestrian projects were listed in MTPs, but had no corresponding cost information. This will result in underestimating bike/pedestrian needs.

Rural needs were also assessed and included, as shown in Tables 3 and 4. Per population statistics shown in **Table 3**, rural needs were calculated as 12% of reported Metro area needs.

**Table 3. Texas Population, 2012 Projections**

| Location | Population | Percentage of Total |
|---|---|---|
| Texas | 26,146,548 | 100% |
| Metropolitan (MSA) | 23,077,613 | 88% |
| Non-metropolitan | 3,068,935 | 12% |

Source: Texas Department of State Health Services (http://www.dshs.state.tx.us/chs/popdat/st2012.shtm)

While imperfect due to data gaps and variability, fiscally-constrained needs through 2040 for the bicycle and pedestrian modes were calculated and estimated to be approximately $3 billion, as shown in **Table 4**. Due to its limitations, this fiscally-constrained needs analysis should be considered as a baseline or starting point when discussing bicycle and pedestrian needs in Texas. This is particularly true given the rapidly growing population of the state and the increasing interest of Texans to utilize these modes for transportation.

**Table 4. MTP and/or Stand-alone Bicycle/Pedestrian Plan Fiscally-Constrained and Unconstrained Needs**

| MPO | Financial Need from MTP and/or Stand-alone Bike/Pedestrian Plan | Fiscally-Constrained Needs | Unconstrained Additional Needs |
|---|---|---|---|
| Abilene | MTP lists bike/ped needs under traditional and enhanced funding scenarios. Not all needs are accounted for, such as Safe Routes to School (SRTS) and Transportation Enhancements. Cost figures are presented for ADA ramps, sidewalks, bikeways, etc. | $17,319,000 | |
| Amarillo | MTP Lists four Safe Routes to School projects they would like funded and will compete for, three of which include cost estimates. Also lists one Trans. Enhancement project they will compete for that is bike/ped - Rails to Trails Phase 2, $4,000,000. | $4,800,000 | |
| CAMPO-Austin | Many roadway projects will include bike/ped components, which are not broken out. Stand-alone bike/ped projects and programs are grouped together on constrained list and cost $444,000,000 (regionally funded - fed, state, or local). Other priority locally-only funded projects are listed for roadways and include bike/ped without breaking out. The City of Austin, in their 2009 Bicycle Plan, projects a cost of $254,000,000 for complete build-out of the bicycle network. The Transportation Policy Board has determined to "Allocate at least 15 percent of available CAMPO discretionary federal funding (STP-MM) to bicycle and pedestrian projects through the CAMPO TIP process, using the Priority Pedestrian Districts Map and Priority Regional Bicycle Corridors Map in the project evaluation," (Policy 4). No CAMPO "Bike Plan". | $444,000,000 | $254,000,000 |
| SETRPC-Beaumont | This region is under a conformity lapse and therefore only exempt projects are listed, however, bike/ped projects are exempt. Bike/ped constrained projects total $5,629,849. They also list other generic grouped bike/ped projects with no estimated costs, as well as a placeholder for transportation enhancements of $14,821,214. | $20,451,063 | |
| Brownsville | From 2010 MPO Bike & Ped Needs Assessment Study. They need 400 miles of sidewalks, which would cost $44,292,000. City of Los Fresnos compiled some Safe Routes to School Needs, totaling $745,393. MTP does not provide bike/ped cost estimates. | $745,393 | $44,292,000 |
| BCSMPO-Bryan/College Station | The MTP lists 3 bike/ped projects with funding identified, $11,170,000. Ped facilities are listed with other projects, but ped. costs are not broken out. One additional sidewalk project in Bryan is listed but not funded, Texas Ave., $6,000,000. The City of College Station, in its 2010 Bike/Ped Plan has proposed approximately $85,000,000 in short-long term needs for bike/ped. No MPO bike plan. | $11,170,000 | $91,000,000 |
| CRP-Corpus Christi | July, 2013 amendment to MTP added $1,036,698 for bike/ped projects. The MTP lists bike/ped projects totaling $2,900,000. | $3,936,698 | |
| El Paso | Horizon 2040 MTP lists the following total project costs: Bike $4,602,600; Bike & Ped $21,289,233; Pedestrian $18,129,798; for a total of $44,021,631. No MPO or city Bike Plan. | $44,021,631 | |

**Table 4. MTP and/or Stand-alone Bicycle/Pedestrian Plan Fiscally-Constrained and Unconstrained Needs**

| MPO | Financial Need from MTP and/or Stand-alone Bike/Pedestrian Plan | Fiscally-Constrained Needs | Unconstrained Additional Needs |
|---|---|---|---|
| HSBMPO-Harlingen | MTP lists financially constrained trans. enhancements as $7,994,168. | $7,994,168 | |
| H-GAC-Houston | From 2035 Regional Bikeway Plan (2007), grand total of bike/ped projects in RTP is $280,367,511. 2035 RTP Update lowered funding expectations, but didn't break-out bike/ped. No City of Houston bike plan. Contacted H-GAC in June, 2014. They have some draft new constrained needs $, but are not yet ready to present to the public. City of Sugar Land Bike/Ped Plan lists a projected cost for high priority recommendations of $36-45 million ($40,500,000 average), with no funding secured. | $280,367,511 | $40,500,000 |
| HCMPO - Hidalgo County | MTP list available funding for trans. Enhancements at $36,504,000. Bike/ped projects total $9,758,857. | $46,262,857 | |
| K-TUTS Killeen/ Temple | Detailed tables of recommended bike and ped. facilities in Appendix C of KTMPO 2011 Regional Thoroughfare and Pedestrian/Bicycle Plan. Belton $12.79m, Copperas Cove $5.95m, Harker Heights $6.31m, Kempner $236.1k, Killeen $24.66m, Little River/Academy $474.5k, Morgan's Point Resort $56.4k, Nolanville $1.76m, Temple $28.25m, Salado $3.24m, Bell County $37.35m, Coryell County $4.85m, Lampasas County $3.98m, Fort Hood $7.45m, USACE $4.91m. MTP lists a maintenance placeholder for trans. enhancements of $22,701,310. Short range trans. enhancement projects at various locations $6,544,565. Long range trans. enhancement projects at various locations $16,156,745. Unfunded regionally significant bike/ped projects - sidewalk project $1,000,000; pedestrian bridge $1,193,536. | $45,402,620 | $142,267,000 |
| Laredo | The MTP lists one large project as feasible under their constrained analysis - the Manadas Creek Hike and Bike Trail - $27,239,455. | $27,239,455 | |
| Longview | Projected needs match projected revenue for bike/ped. One specific trail listed as well as other general trails and enhancements. | $21,724,532 | |
| Lubbock | From the Lubbock MPO Comprehensive Bicycle Plan, 3 phases are proposed for expanding the bikeway system, with a total cost of $1,513,137. | $1,513,137 | |
| MOTOR-Midland/ Odessa | Five constrained projects were listed, totaling $8,848,002 year of expenditure cost. The projected amount available for Transportation Enhancements (bike/ped) 2010-2035 is $11,218,824. | $11,218,824 | |

**Table 4. MTP and/or Stand-alone Bicycle/Pedestrian Plan Fiscally-Constrained and Unconstrained Needs**

| MPO | Financial Need from MTP and/or Stand-alone Bike/Pedestrian Plan | Fiscally-Constrained Needs | Unconstrained Additional Needs |
|---|---|---|---|
| NCTCOG-DFW | A "Regional Veloweb" is recommended as an off-street network of shared-use paths. Costs are estimated at $800,000/mile. Total funding required to complete all veloweb projects is $1.12 billion. The latest MTP update identifies approx. $1.5 billion of potential funding for "active" trans. improvements between now and 2035. Specific projects include Spot Improvement Program $66,468,000; Safe Routes to School - accounted for through the more than $237,248,000 identified for active transportation in the region; Trans Enhancement Program - same; Local Air Quality - same; Sustainability and Livability - same; Complete Streets - same; Access to Rail - same; Pedestrian Facilities - same; Safety countermeasures - same; On-street bike facility initiative - same; Congestion Mit/Air Quality - same; Regional Veloweb $1,190,724,000. Mobility 2035-2013 Update Bike/Ped revenue & expenditures = $1,495,700,000. No separate MPO bike/ped plan. 2011 Dallas Bike Plan does not contain $ estimates. Bike Ft. Worth 2009 includes $159,897,000 (Planning level construction costs, no maintenance). | $1,495,700,000 | $159,897,000 |
| San Angelo | Funded project list: Safe Routes to School 2007 $899,999; Lone Wolf Bridge Ped project $1,400,000; N. Chadbourne Corridor Ped/Transit Access $337,613; Safe Routes to School 2009 $499,999; Red Arroyo Shared Use Path $3,999,140. Unfunded project list: CBD Bike/Ped Improvements $1,200,000. MTP Appendix B, Prioritization of Future bike/ped projects, 2 pages of projects with total of $33,670,500. | $7,136,751 | $34,870,500 |
| SABC MPO-<br>San Antonio | Amount funded: Stand Alone Ped $25M; Stand Alone Bike $25M; Trans Enhancement Program Cat. 9 $3M/year for a total of $76.3M through 2035. No separate MPO bike plan. San Antonio Bike Plan 2011: An order-of-magnitude cost projection for complete build out of the entire bicycle network is estimated to cost approximately $250 million to $275 million ($262.5 million average). | $126,300,000 | $262,500,000 |
| SD MPO-Sherman/<br>Denison | Transportation Enhancements historic average annually $96,393. Enhancement projects various locations $497,338. MPO bike plan was from 1998 and contained no $ estimates. | $497,338 | |
| Texarkana | Arkansas constrained project list 2010 to 2035 $850,799; Texas $4,362,590 | $5,213,389 | |
| Tyler | Projected Cat.9 Trans. Enhancement Funding: $1,625,000, MTP says this category is typically bike/ped. MTP lists other priority projects & costs that include a bike component, but do not break out the bike/ped costs. | $1,625,000 | |
| Victoria | MTP lists one unconstrained needs project that includes bike/ped: Airline Rd. extension with 10' multipurpose path. Total cost is $12,000,000 with no break-out of bike/ped cost. | | $0 |

**Table 4. MTP and/or Stand-alone Bicycle/Pedestrian Plan Fiscally-Constrained and Unconstrained Needs**

| MPO | Financial Need from MTP and/or Stand-alone Bike/Pedestrian Plan | Fiscally-Constrained Needs | Unconstrained Additional Needs |
|---|---|---|---|
| WUTS-Waco | MTP identifies bike/ped priority projects: Sidewalk program $2,660,000; Brazos riverwalk $800,000; $2,750,000; $5,500,000; Sidewalk program long-term $9,340,000; 4th and 5th Streets $270,000; Austin Ave. $20,000; East Herring Ave. $55,000; Herring/Lyle Aves. $200,000; Univ. Parks Dr. $205,000; Clifton/Elm/Washington Ave. $130,000; Priority Projects 12-21 $3,885,000. | $25,815,000 | |
| WFS MPO-Wichita Falls | MTP lists un-funded bike/ped needs. 9 projects are listed, 7 of which have an estimated cost totaling $9,925,000. | | $9,925,000 |
| **Rural Texas** | **Per population statistics in Table 3, calculated as 12% of Metro area needs.** | **$318,054,524** | **$124,710,180** |
| **Total** | | **$2,968,508,891*** | **$1,163,961,680*** |

Note:
*Year of Expenditure Dollars

### *3.3 Unconstrained Needs to 2040*

**Table 4** also presents the results of a similar review of bicycle and pedestrian unconstrained needs to 2040. As can be seen, the reported unconstrained needs information was also highly variable among the MPOs. In general, unconstrained needs were underreported, with only nine of 25 MPOs reporting financial information. Review of the various MTPs and stand-alone plans revealed that many jurisdictions were hesitant to report unconstrained "wish lists" of bicycle and pedestrian projects during the last economic recession, when many of the MTPs were written. Additionally, some of the jurisdictions likely did not have enough network data or bicycle/pedestrian planning in place to create an unconstrained needs project list. This lack of reported unconstrained needs obviously underestimates the unconstrained needs of the Texas bicycle and pedestrian system.

While also imperfect due to data gaps and variability, unconstrained needs through 2040 for the bicycle and pedestrian modes were calculated and estimated to be approximately $1.2 billion, as shown in **Table 4**. Due to its limitations, this unconstrained needs analysis should also be considered as a baseline or starting point when discussing bicycle and pedestrian needs in Texas. This is particularly true given the rapidly growing population of the state and the increasing interest of Texans to utilize these modes for transportation.

## 4.0 Anticipated Revenues and Funding

Funding for the bicycle and pedestrian modes is provided through a variety of federal, state, local, and private sources. While some funding programs are specifically dedicated to bicycle and pedestrian projects, other programs require bicycle and pedestrian projects to compete with other transportation project types for funding. In addition, funding programs change over time, particularly when new federal surface transportation laws are implemented. The most recent long-term federal authorization, MAP-21 (Moving Ahead for Progress in the 21st Century) provides states and local jurisdictions more flexibility and local control in the use of federal transportation funds. Unfortunately, MAP-21 also consolidated some bicycle and pedestrian-specific programs and reduced total funding for these modes. A non-exhaustive list of some bicycle and pedestrian funding programs at various levels of government includes the following:

- Transportation Alternatives Program (TAP) – Transportation Enhancement Activities
- Surface Transportation Program (STP)
- Congestion Mitigation and Air Quality Improvement (CMAQ) Program
- Highway Safety Improvement Program (HSIP)
- National Highway Performance Program (NHPP)
- Federal Transit Administration Capital Funds
- Associated Transit Improvement (ATI)
- Section 402 – State and Community Highway Safety Grant Program
- Federal Lands Highway Program
- Texas Parks and Wildlife Department Recreational Trail Grants
- Local Bonds
- Private Funds

While a variety of funding programs exist for bicycle and pedestrian projects, only a small percentage of federal transportation dollars are spent on these modes. Using FHWA FMIS data (2009-2012), the Alliance for Biking and Walking's *Bicycling and Walking in the United States – 2014 Benchmarking Report* reveals only 2.1% of federal transportation dollars are spent on bicycle and pedestrian projects.

In Texas, past state-reported spending on bicycle and pedestrian facilities and programs in the last 10 years is depicted in **Table 5**. As can be seen, bicycle and pedestrian spending in Texas has fluctuated quite a bit over the last decade.

As described previously, the current trend of federal funding for the bicycle and pedestrian modes is to provide states and local jurisdictions more flexibility and local control in the use of federal transportation funds. In addition, due to increasing congestion in urban areas and demographic trends, participation in bicycling and walking is likely to continue to increase in Texas and the nation. Only through increased data collection and planning will states and local jurisdictions be able to understand bicycle and pedestrian system deficiencies and needs. With the future of funding for bicycle and pedestrian accommodations uncertain, an increased understanding of bike/pedestrian deficiencies should allow for more equitable planning and funding for these modes, and the resulting transportation, economic, social, and health benefits bicycling and walking provide.

**Table 5. Federal-Aid Highway Program Texas-Reported Bicycle and Pedestrian Spending, FY 2004-2013**

| State | 2013 $ | 2012 $ | 2011 $ | 2010 $ | 2009 $ | 2008 $ | 2007 $ | 2006 $ | 2005 $ | 2004 $ |
|---|---|---|---|---|---|---|---|---|---|---|
| Texas | 51,046,087 | 56,770,715 | 34,702,839 | 55,362,819 | 73,533,819 | 23,504,849 | 38,845,360 | 20,241,366 | 18,604,604 | 16,191,200 |

Source: http://www.fhwa.dot.gov/environment/bicycle_pedestrian/funding/bipedfund.cfm

# Texas Transportation Plan

## Tech Memo 6: Bridge/Culvert Modal Profile

August 14, 2014

## Acknowledgements

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## 1.0 Introduction

With over 35,000 structures on the state-maintained system, TxDOT is responsible for providing safe and reliable bridges and culverts for infrastructure users. This memorandum details the current and forecasted future conditions of on-system bridges/culverts for the state of Texas through the year 2040.

In applying the methodology detailed in Technical Memo #3, it was found that TxDOT would need – in $2013 – over $42B ($1.6 B/yr) to eliminate structural deficiencies, reduce functional obsolescence, and minimize life-cycle costs on the state-network through 2040. With an anticipated $0.5 B/yr available in revenue, this represents a gap of over one billion dollars each year throughout the 2014 to 2040 analysis period. As a result, initial forecasts suggest structural deficiency by deck area will reach the 10% federal mandate by 2030 if no additional investment is applied.

A full summary of results for the state-owned bridge/culvert system in Texas is provided herein, as well as recommendations for next steps.

## 2.0 Overview of Existing Conditions

In breaking down the on-system inventory, it was found that all bridges/culverts across the state are on average 36 years old and 2% structurally deficient by deck area (**Table 1**).

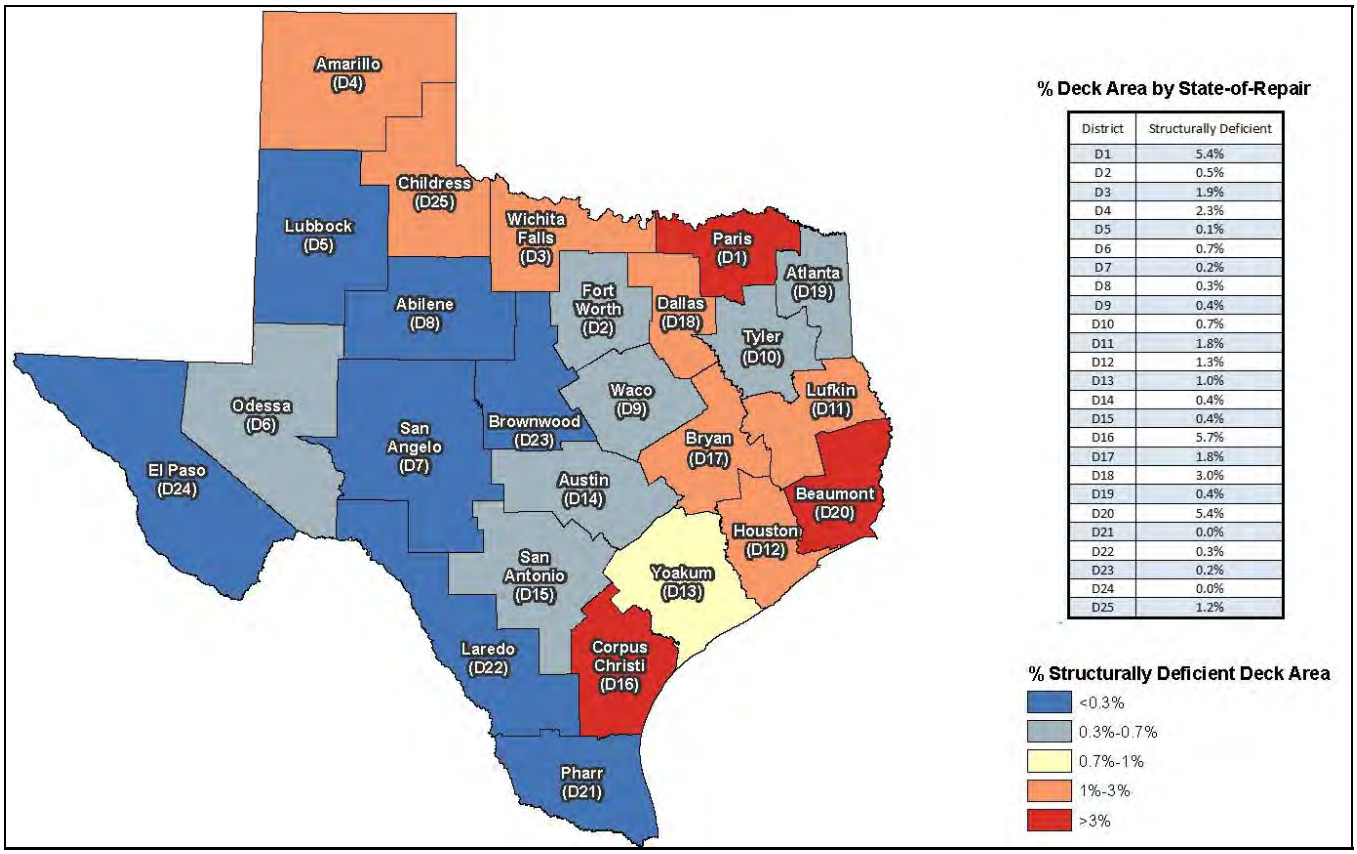
**Table 1: Existing Conditions by Bridge/Culvert Network**

| Network | Inventory Count | Average Age | Percent Structurally Deficient Deck Area |
|---|---|---|---|
| NHS | 18,384 | 32 years | 1.5% |
| Non-NHS | 16,808 | 41 years | 2.0% |
| On Freight System* | 7,797 | 32 years | 3.4% |
| Off Freight System* | 27,463 | 37 years | 1.4% |
| **Statewide** | **35,260** | **36 years** | **1.6%** |

"Freight System refers to the NBI field "Designated National Truck Route"

**Figure 1** illustrates percentage of structurally deficient deck area by district as currently exists. From a geographic perspective, structural conditions by district (**Figure 2**) show that no districts currently have structurally deficient (a four or lower NBI condition rating) deck areas exceeding the federally mandated 10% on the NHS. In terms of the current backlog of corrective repairs/replacements, Districts 1, 16, and 20 currently have just over 5% structurally deficient deck area; 0.2% of the system have an NBI rating of 3 or less indicating a higher structural risk – of these District 20 has nearly half of the higher risk deck areas while District 4 has the most number of higher risk structures (**Figure 3**).

## Figure 1: Existing Bridge Conditions – Percent Structurally Deficient Deck Area by District




**% Deck Area by State-of-Repair**

| District | Structurally Deficient |
|---|---|
| D1 | 5.4% |
| D2 | 0.5% |
| D3 | 1.9% |
| D4 | 2.3% |
| D5 | 0.1% |
| D6 | 0.7% |
| D7 | 0.2% |
| D8 | 0.3% |
| D9 | 0.4% |
| D10 | 0.7% |
| D11 | 1.8% |
| D12 | 1.3% |
| D13 | 1.0% |
| D14 | 0.4% |
| D15 | 0.4% |
| D16 | 5.7% |
| D17 | 1.8% |
| D18 | 3.0% |
| D19 | 0.4% |
| D20 | 5.4% |
| D21 | 0.0% |
| D22 | 0.3% |
| D23 | 0.2% |
| D24 | 0.0% |
| D25 | 1.2% |

## Figure 2: Percent Deck Area by State-of-Repair for Each District

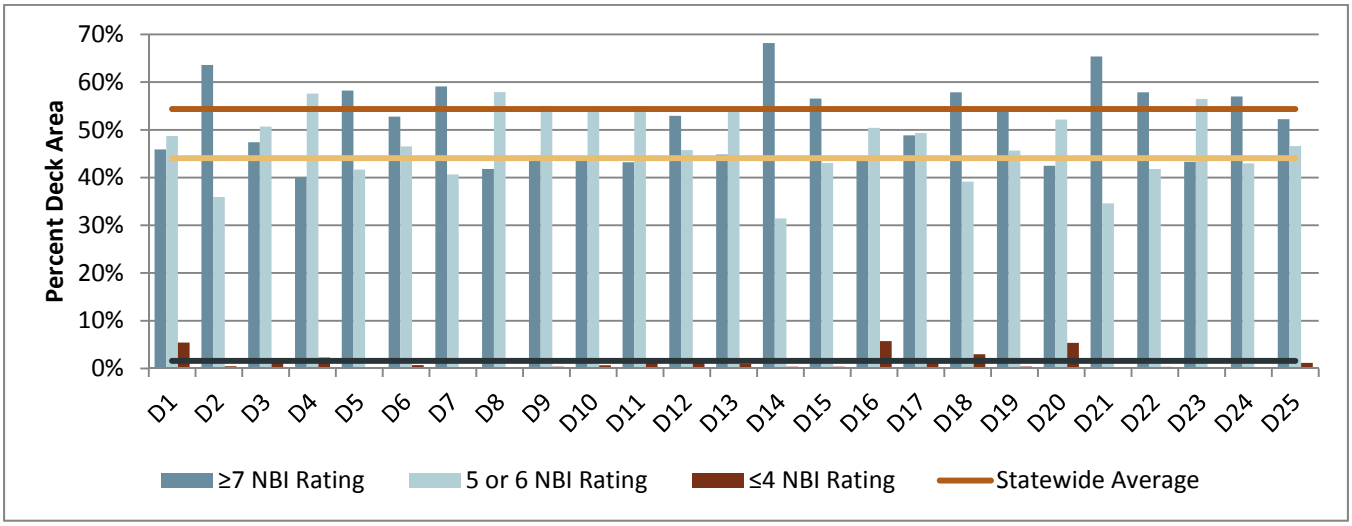
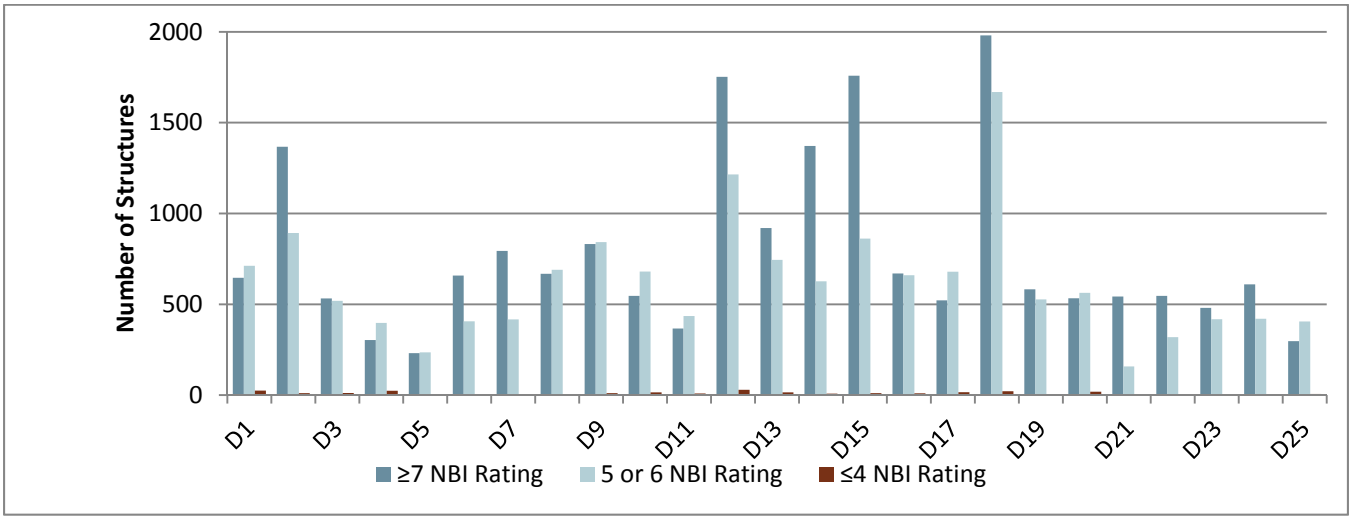


**Figure 3: Structure Count by State-of-Repair for Each District**




To further improve upon these conditions and to prevent further assets from reaching a structurally deficient state, an unconstrained analysis was conducted to quantify the total amount of money required to eliminate structural deficiencies statewide for TxDOT maintained bridge/culvert assets.

# 3.0 Unconstrained Needs Determination

## *3.1 Methodology and Assumptions*

### 3.1.1 Defining "Needs" and State-of-Good Repair

As defined by TxDOT, bridge/culverts are considered to be in a state-of-good-repair when not structurally deficient, functionally obsolete, or sub-standard for load. Therefore, when defining "needs" within this document, the financial total refers routine and preventive maintenance cyclical costs and the capital cost to 1) prevent/eliminate structural deficiency and strengthen sub-standard structures for load and 2) correct for functional obsolescence at the time of a cost-effective replacement activity determined by structural deficiency correction. This performance-based needs assessment has been found to be a best practice across state DOTs and is further called for in the MAP-21 legislation. In using the methodology, the TxDOT performance measures described in Table 2 were able to be quantified.

**Table 2: TxDOT Bridge Performance Measures and Descriptions**

| Measure(s) | Description |
|---|---|
| Percent Structurally Deficient Deck Area on NHS and non-NHS | Percent of system deck area that have structures deemed Structurally Deficient |
| Count of Bridges and Percent Deck Area with Cyclic Maintenance Needs | Number of structures and deck area of structures with a deck/superstructure/substructure/or culvert rating of 7 or higher |
| Count of Bridges and Percent Deck Area with Preventative Maintenance Needs | Number of structures and deck area of structures with a deck/superstructure/substructure/or culvert rating of 5 or 6 |
| Count of Bridges and Percent Deck Area with Rehabilitation or Replacement Needs | Number of structures and deck area of structures with a deck/superstructure/substructure/or culvert rating of 4 or less |

From provided file "TxDOT Bridge Performance Measure Determination"

### 3.1.2 Predicting Future Performance and Selecting Investments

Performance predictions were determined using CH2M HILL's Bridge TAM Tool. This tool, similar to the upcoming version of PONTIS, uses probabilistic models (calibrated based on historical data) to forecast the most likely deterioration for each component given the age and most recent condition inspection data. Separate models were calibrated for existing/new construction, predominantly steel/concrete superstructure material, wet non-freeze/dry non-freeze climate zone, and NHS Interstate/NHS Non-Interstate/Non-NHS functional class.

The predicted condition states, using the NBI 0 (worst) to 9 (best) scale, were utilized to identify feasible activities including cyclic/preventive maintenance and rehabilitation/replacement per TxDOT definition.

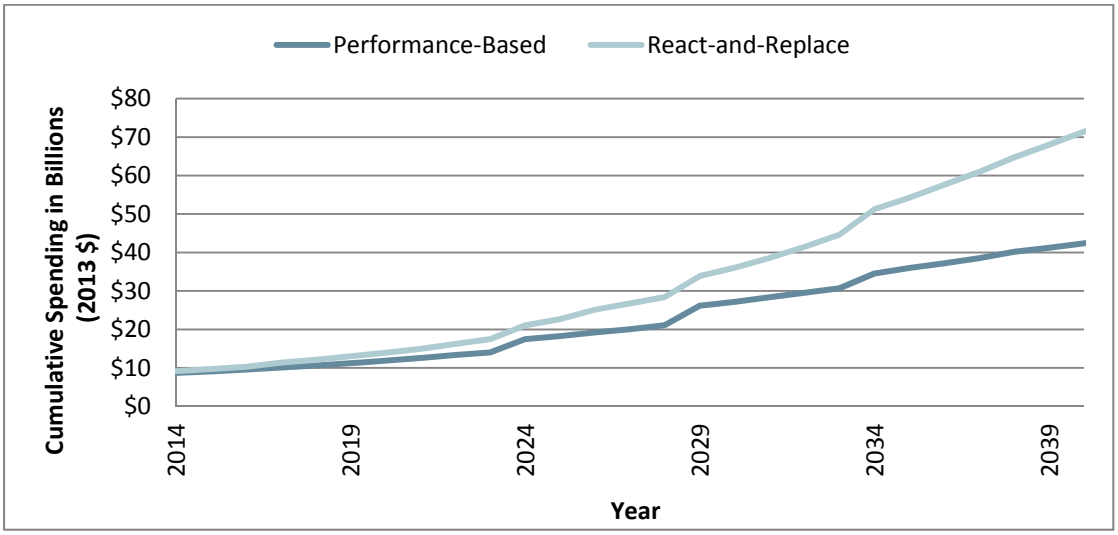
To determine the most cost effective activity, life-cycle-cost analysis was conducted. The activity profile yielding the lowest equivalent annual cost was carried forward for each bridge/culvert asset on the state system. These costs were aggregated over the 2040 planning horizon to reflect the unconstrained needs detailed in the following section.

## *3.2 Unconstrained Needs to 2040*

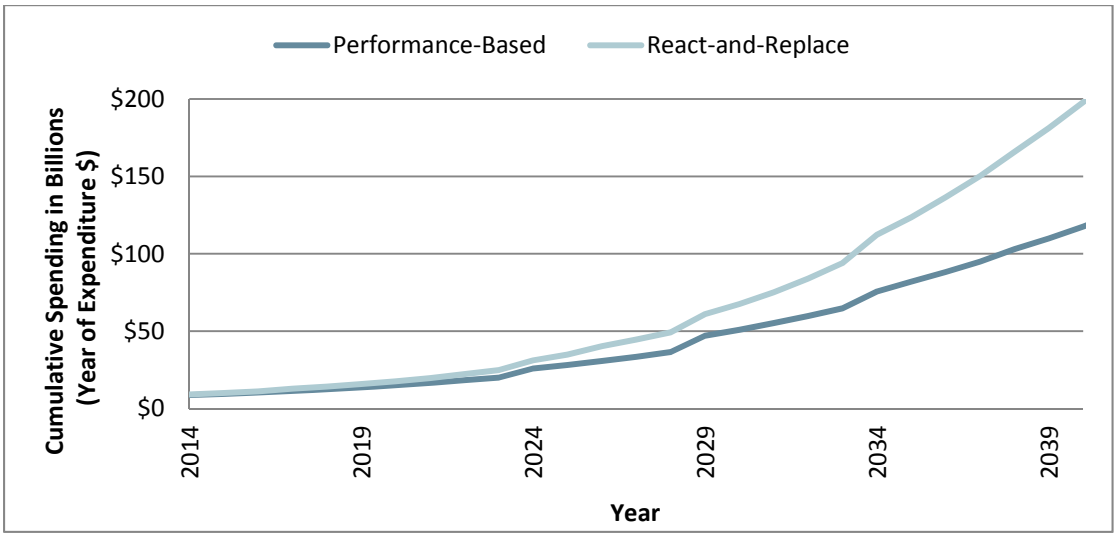
In using the described methodology, it was found that TxDOT would need – in 2013$ – over $42B ($1.6B/yr) to eliminate structural deficiencies, reduce functional obsolescence, and minimize life-cycle costs on the state-network through 2040. This strategy is termed the "performance-based" scenario. Alternatively, if TxDOT preferred to streamline the replacement of older structures at the time of predicted structural deficiency – termed the "react-and-replace" scenario, costs would be predicted to reach – in 2013$ – over $71B ($2.8 B/yr) to eliminate structural deficiencies and reduce functional obsolescence. Through a preservation-focused strategy, nearly $30B worth of savings – in 2013$ – may be realized (**Figure 4**).

Based on the predicted timings to structural deficiency, and considering that groupings of assets are often constructed around the same time, peaks in activity timings are expected to occur throughout the planning horizon. Three peaks in particular have been identified, with multiple higher cost activities anticipated to be required around 2025, 2030, and 2035 (**Figure 5**); **Figure 6** shows the corresponding count of activities expected over the planning horizon.

**Figure 4: Forecasted Cumulative Expenditures in an Unconstrained Scenario**

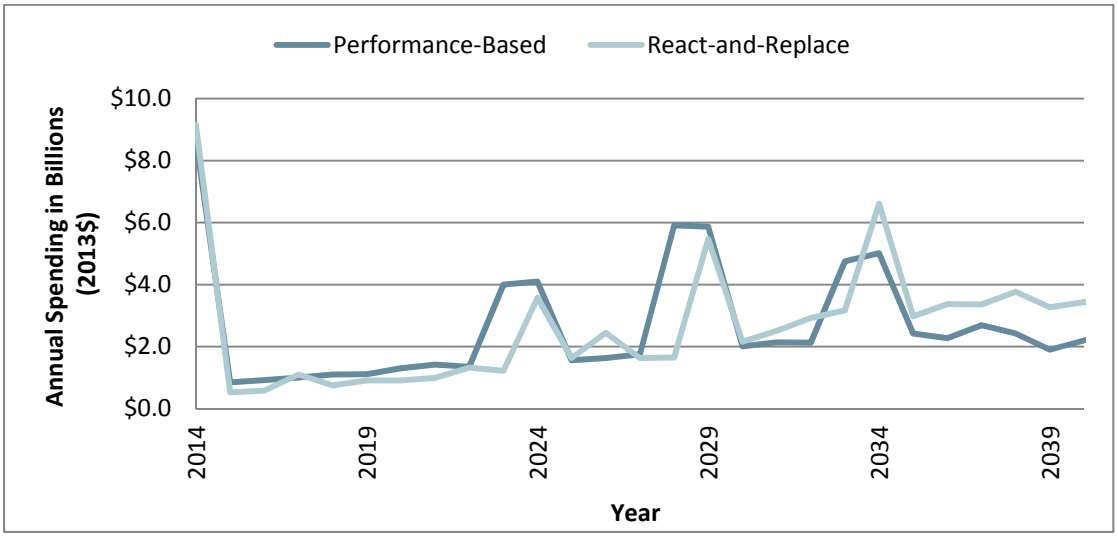



(a) 2013 Dollars

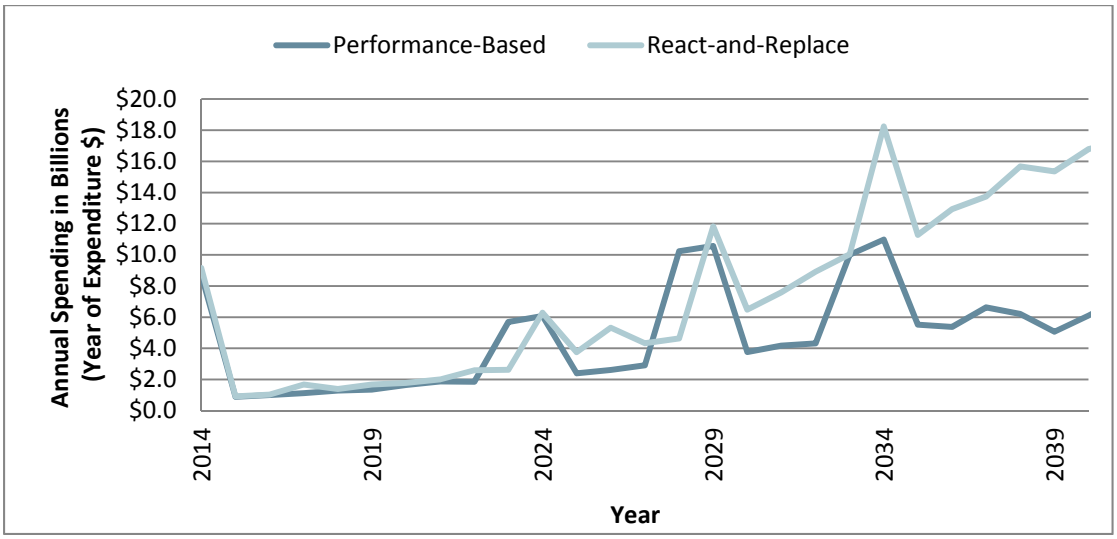



(b) Year of Expenditure (Inflation-Adjusted) Dollars

**Figure 5: Forecasted Annual Expenditures in an Unconstrained Scenario**

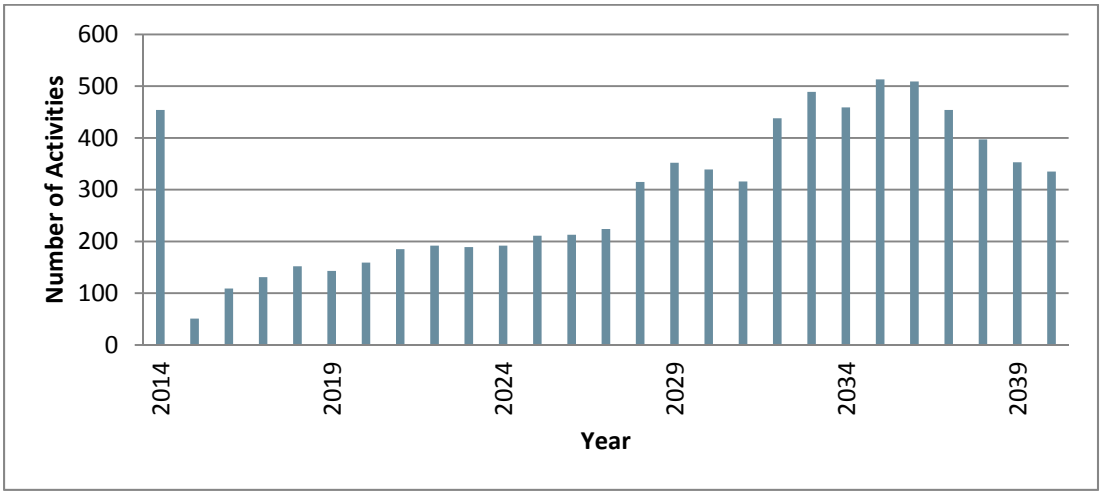



(a) 2013 Dollars




(b) Year of Expenditure (Inflation-Adjusted) Dollars

**Figure 6: Forecasted Capital Rehabilitation/Replacement Activities in an Unconstrained Scenario**




The bulk of needs, nearly 80%, are anticipated to be required on the NHS due to higher truck volumes, corresponding improvement costs, and a higher inventory of structures; roughly half of this cost is expected to be split between the Interstate and non-Interstate systems. In terms of freight needs, given the large number of inventory not on the designated national truck route, a slightly higher (60/40) split in needs is projected (**Table 3**).

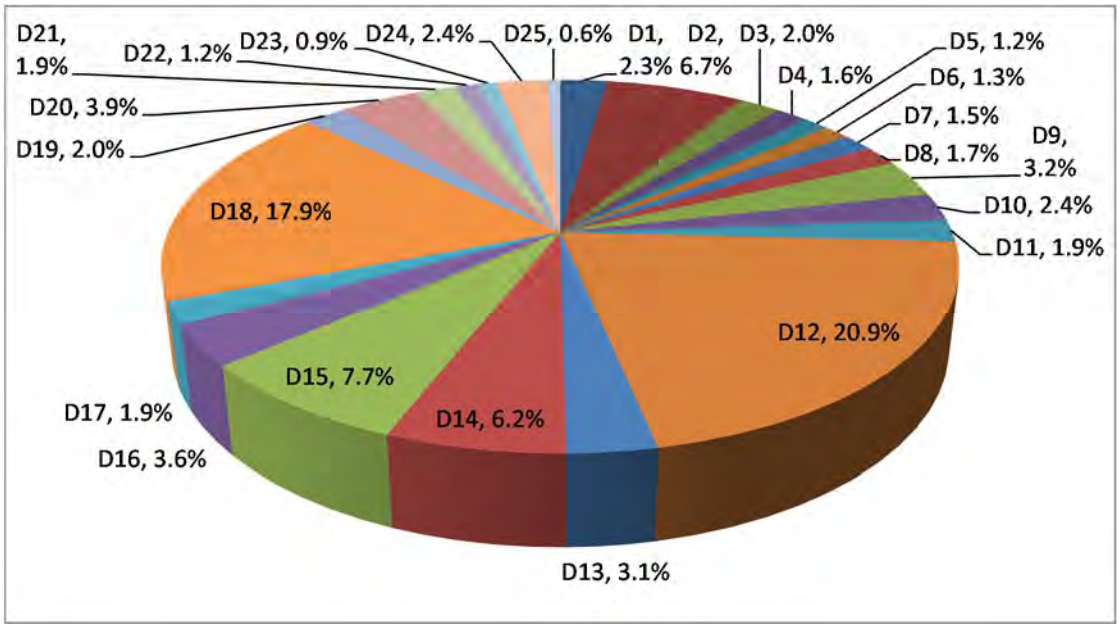
**Table 3: 2040 Bridge/Culvert Needs by On-System Network**

| Network | Needs in 2013$ |
|---|---|
| NHS Interstate | $16.03 B |
| NHS Non-Interstate | $17.29 B |
| Non-NHS | $9.09 B |
| On Freight System* | $17.16 B |
| Off Freight System* | $25.26 B |
| **Statewide** | **$42.41 B** |

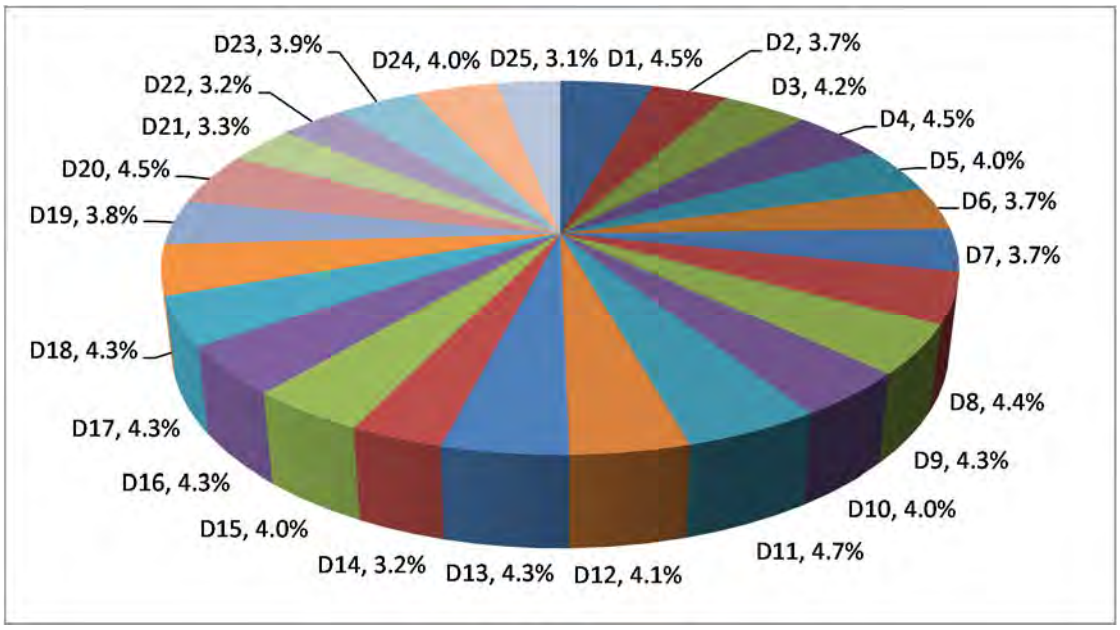
"Freight System refers to the NBI field "Designated National Truck Route"

When viewed from a district perspective (**Figure 7**), the majority of needs – in terms of magnitude – are expected around major cities which have the largest concentration of structures and higher unit costs: Houston (D12), Dallas (D18), San Antonio (D15), Fort Worth (D2), and Austin (D14), respectively. However, when considered from a dollar per square foot vantage point, far more equity across the state can be visualized; in fact the top five districts on a per unit of deck area basis are as follows: Beaumont (D20), Amarillo (D4), Corpus Christi (D16), Paris (D1), and Abilene (D8). **Figure 8** illustrates forecasted 2040 bridge needs by district.

**Figure 7: Percent Total Needs through 2040 by District**

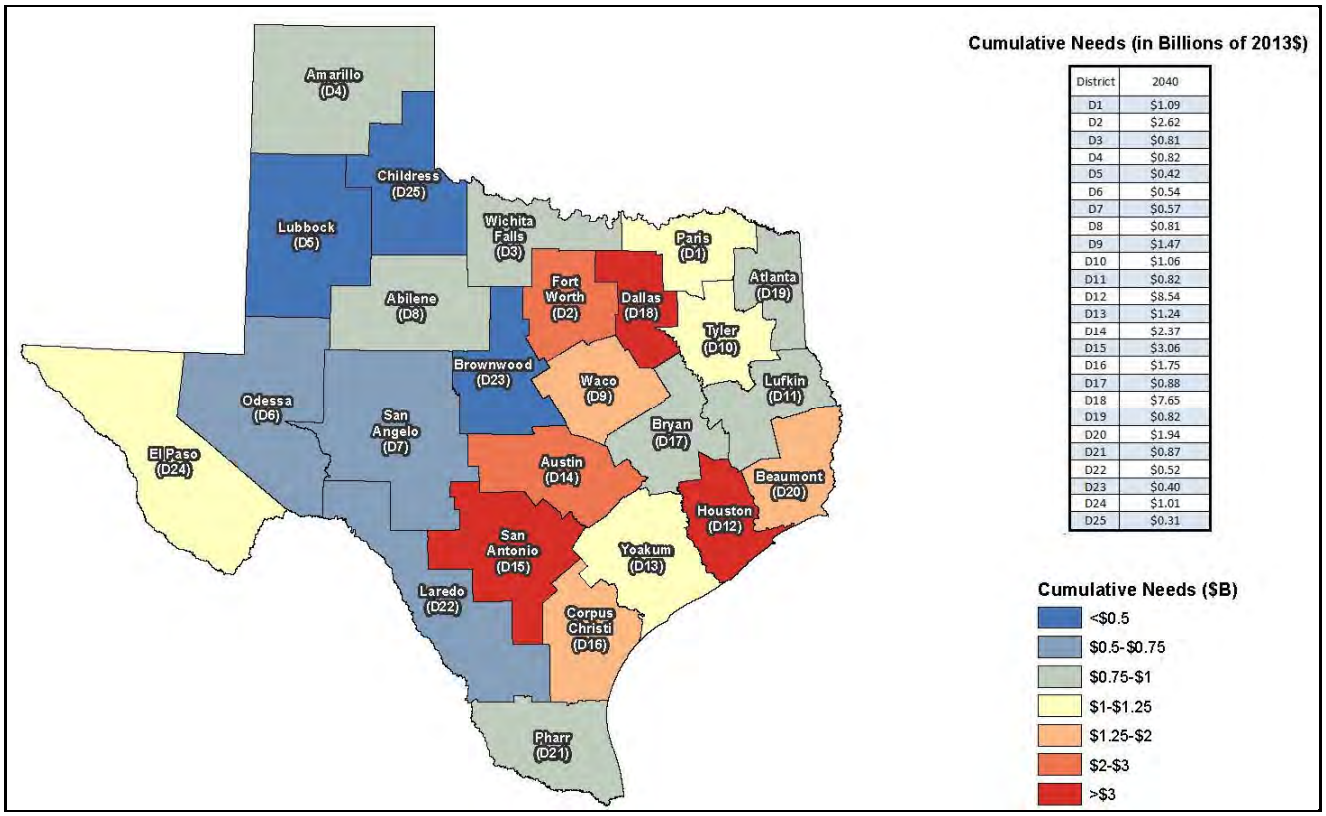



(a) Total Needs by Magnitude




(b) Total Needs per Square Foot

**Figure 8: Forecasted 2040 Bridge Needs by District**




**Cumulative Needs (in Billions of 2013$)**

| District | 2040 |
|---|---|
| D1 | $1.09 |
| D2 | $2.62 |
| D3 | $0.81 |
| D4 | $0.82 |
| D5 | $0.42 |
| D6 | $0.54 |
| D7 | $0.57 |
| D8 | $0.81 |
| D9 | $1.47 |
| D10 | $1.06 |
| D11 | $0.82 |
| D12 | $8.54 |
| D13 | $1.24 |
| D14 | $2.37 |
| D15 | $3.06 |
| D16 | $1.75 |
| D17 | $0.88 |
| D18 | $7.65 |
| D19 | $0.82 |
| D20 | $1.94 |
| D21 | $0.87 |
| D22 | $0.52 |
| D23 | $0.40 |
| D24 | $1.01 |
| D25 | $0.31 |

In the 2030 Committee Report, TxDOT estimated needing a cumulative total of $25B (2013$) from 2010 through 2030; in using the CH2M HILL TAM Tool, this estimate is $27B (from 2014 through 2030). Relative to the previous TxDOT SLRTP, on-system bridge needs were approximated to be $27B (2013$) from 2010 through 2035; in using the CH2M HILL TAM Tool, this estimate is $36B from 2014 through 2035 — the main difference in these estimates being that a lower assumption for replacement cost per square foot was used in past publications (~$200/SF instead of $300/SF) and varying definitions of "needs" (for example, the 2030 Committee Report looked at continuing 2010 conditions). As such, the provided results herein are considered in line with past publications.

# 4.0 Fiscally-Constrained Analysis

## *4.1 Project Prioritization*

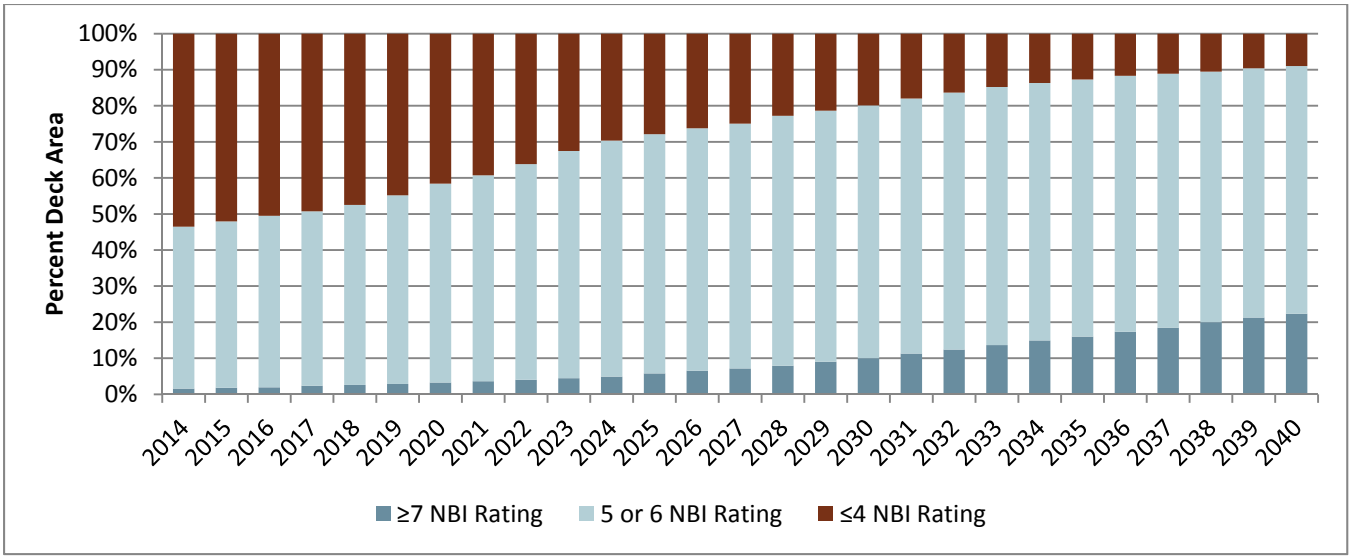
A “bottom-up” (project-level) approach was utilized to establish the linkage between system performance and investment level. As such for each activity identified by the CH2M HILL Bridge TAM Tool, a priority score was assigned weighing the benefit of the activity in reducing structural risk (worst-first based on condition ratings) and life-cycle costs (opportunity-based given potential savings from effectively timed activities). These two components were weighed on a 50/50 basis and updated for each year throughout the 2040 planning horizon with the tool conducting an optimization to maximize the program score relative to the annual budget – currently expected at $500M. The performance with and without implementation of each project was used to aggregate results.

## *4.2 Fiscally-Constrained and Tradeoff Analysis*

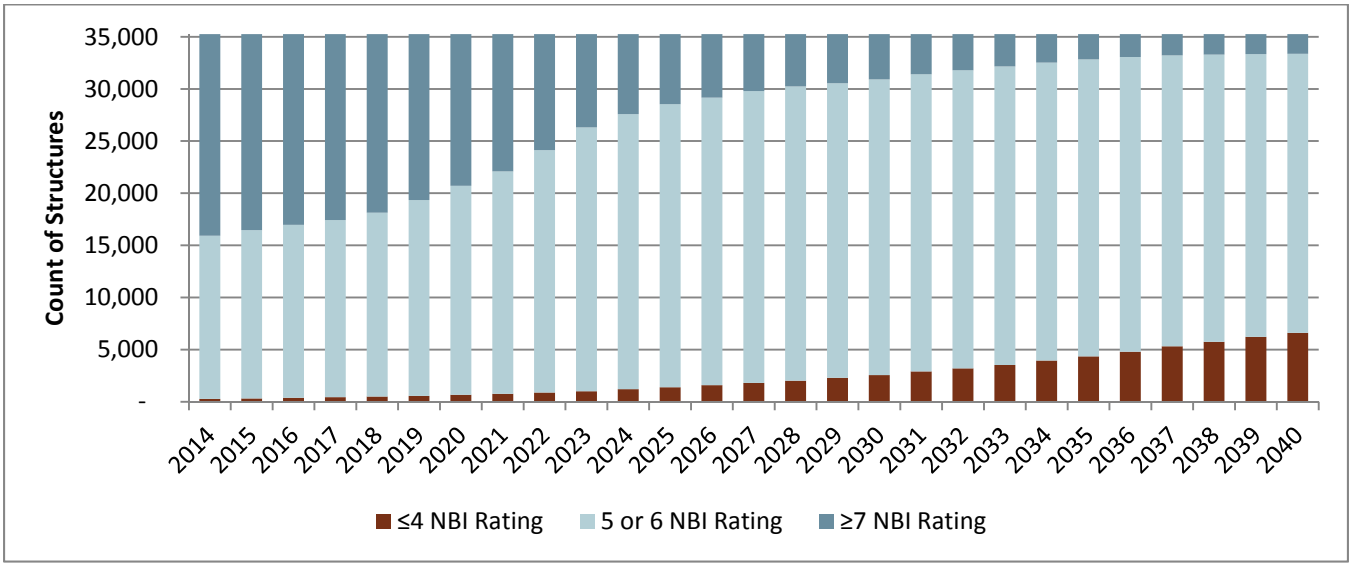
As a result of an annual, inflation adjusted $500M budget, structural condition is predicted to be relatively stable through 2020 but not sufficient to meet state goals throughout the 2040 planning horizon. At this funding level, structural deficiency is forecasted to exceed 10% by deck area on the NHS (part of MAP-21 rulemaking) by 2030 and ultimately reach 22% overall by 2040.

With most bridge/culvert assets across the system reaching their design life (50 years in age) in 2030, more extensive repair requirements will create a challenge for the agency to keep pace (**Figure 9**). It is forecasted that roughly twice the expected budget is needed to sufficiently address TxDOT on-system bridge needs; a comparison of performance at this increased funding level is provided in **Table 5**.

**Figure 9: Financially-Constrained Forecast for Bridge/Culvert State-of-Repair at $500M Annual Investment Level**




(a) By Deck Area




(b) By Count

**Table 5: 2040 Bridge/Culvert Forecasted State-of-Repair by Annual Investment Level**

| TxDOT Needs Classification | Percent Deck Area ($500M/yr) | Count of Structures ($500M/yr) | Percent Deck Area ($1,000M/yr) | Count of Structures ($1,000M/yr) |
|---|---|---|---|---|
| Cyclic Maintenance (≥7 NBI Rating) | 9.0% | 1,893 | 11.7% | 2,157 |
| Preventive Maintenance (5 or 6 NBI Rating) | 68.7% | 26,757 | 77.2% | 17,218 |
| Rehabilitation or Replacement (≤4 NBI Rating) | 22.3% | 6,610 | 11.1% | 15,885 |

By system, it was forecasted that the structures on the NHS will reach 21.6% (11.4% if double investment) structural deficiency by deck area and structures on the freight highway system will reach 23.7% (13.2% if double investment) (**Table 6a**). Should this occur, to meet federal requirements on the NHS, a tradeoff will be needed to improve NHS conditions at expense of the non-NHS.

If the annual $500M were allocated to TxDOT districts based on the percent total needs (**Table 6b**), TxDOT is predicted to be able to mitigate only 7% (64% at $1,000M/yr) of predicted structural deficiencies by count and 2% (approximately half at $1,000M/yr) by deck area, on top of cyclical/preventive maintenance.

**Table 6: 2040 Bridge/Culvert Forecasted Structural Deficiency at $1B/yr**

**(a) by Network**

| Network | % SD Deck Area ($500M/yr) | Count of SD Structures ($500M/yr) | % SD Deck Area ($1,000M/yr) | Count of SD Structures ($1,000M/yr) |
|---|---|---|---|---|
| NHS | 21.6% | 3,919 | 11.4% | 1,570 |
| Non-NHS | 24.8% | 2,691 | 10.3% | 1,022 |
| On Freight System* | 23.7% | 1,977 | 13.2% | 798 |
| Off Freight System* | 21.5% | 4,633 | 9.9% | 1,794 |
| **Statewide** | **22.3%** | **6,610** | **11.1%** | **2,592** |

**Table 6: 2040 Bridge/Culvert Forecasted Structural Deficiency at $1B/yr**

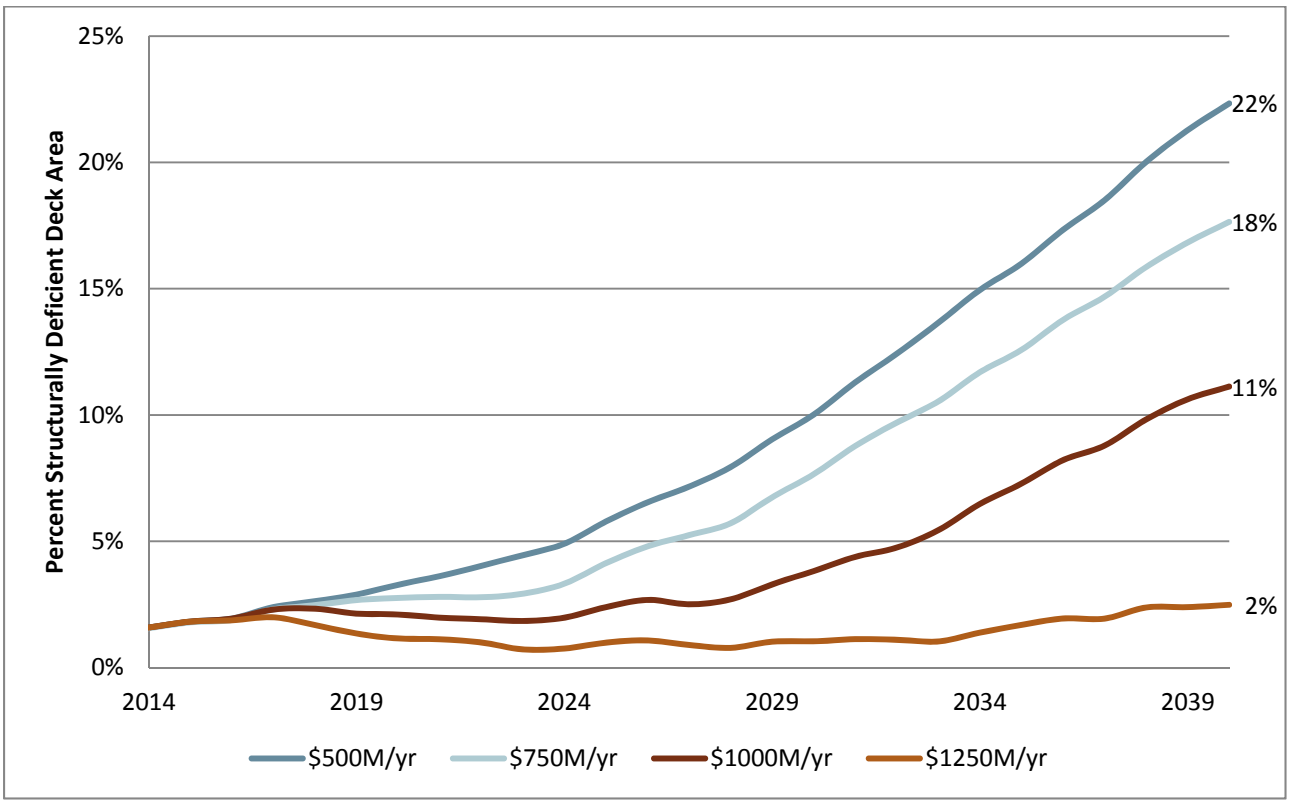
**(b) by District**

| District | Assumed Annual Budget Allocation* | % SD Deck Area ($500M/yr) | Count of SD Structures ($500M/yr) | % SD Deck Area ($1000M/yr) | Count of SD Structures ($1000M/yr) |
|---|---|---|---|---|---|
| 1 – Paris | 2.6% | 34.8% | 344 | 20.7% | 217 |
| 2 – Fort Worth | 6.2% | 14.1% | 397 | 8.0% | 177 |
| 3 – Wichita Falls | 1.9% | 21.4% | 205 | 9.2% | 60 |
| 4 – Amarillo | 1.9% | 33.3% | 186 | 19.6% | 91 |
| 5 – Lubbock | 1.0% | 11.5% | 50 | 2.8% | 10 |
| 6 – Odessa | 1.3% | 22.7% | 137 | 4.6% | 27 |
| 7 – San Angelo | 1.3% | 18.3% | 127 | 4.8% | 17 |
| 8 – Abilene | 1.9% | 33.8% | 318 | 19.9% | 181 |
| 9 – Waco | 3.5% | 40.7% | 409 | 20.5% | 122 |
| 10 – Tyler | 2.5% | 32.2% | 269 | 17.2% | 114 |
| 11 – Lufkin | 1.9% | 39.6% | 223 | 25.4% | 120 |
| 12 – Houston | 20.1% | 16.7% | 483 | 4.9% | 29 |
| 13 – Yoakum | 2.9% | 37.7% | 361 | 14..4% | 92 |
| 14 – Austin | 5.6% | 10.9% | 227 | 7.4% | 138 |
| 15 – San Antonio | 7.2% | 17.7% | 375 | 6.2% | 54 |
| 16 – Corpus Christi | 4.1% | 28.2% | 220 | 15.4% | 133 |
| 17 – Bryan | 2.1% | 32.9% | 332 | 17.8% | 148 |
| 18 – Dallas | 18.0% | 24.4% | 883 | 16.7% | 577 |
| 19 – Atlanta | 1.9% | 28.0% | 195 | 11.6% | 38 |
| 20 – Beaumont | 4.6% | 32.0% | 274 | 18.6% | 132 |
| 21 – Pharr | 2.0% | 18.0% | 50 | 12.6% | 27 |
| 22 – Laredo | 1.2% | 16.9% | 85 | 4.1% | 3 |
| 23 – Brownwood | 0.9% | 32.4% | 145 | 10.0% | 20 |
| 24 – El Paso | 2.4% | 22.3% | 200 | 8.2% | 39 |
| 25 – Childress | 0.7% | 24.0% | 115 | 10.7% | 26 |
| **Statewide** | **100%** | **22.3%** | **6,610** | **11.1%** | **2,592** |

*Budget allocations are based on % of relative needs and not any indication of TxDOT policy

Given uncertainties in future revenue and the potential for an infusion of resources, tradeoff analyses were conducted around the performance bought at different investment levels. For instance, if funds are increased by $25M/yr then structural deficiencies in 2040 would be expected to decrease by 4% of deck area; for another $25M/yr on top of that, structural deficiencies by deck area could be cut in half (**Figure 10**).

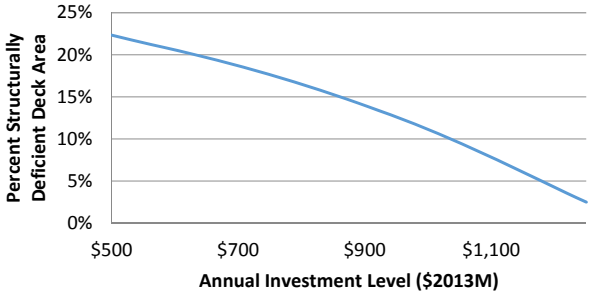
**Figure 10: Forecasted Performance over Planning Horizon Relative to Investment Level**



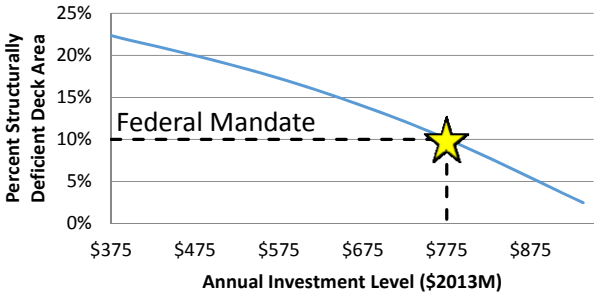

In order to meet federal mandates on structurally deficient deck area through 2040, an annual investment of $775M/yr is predicted to be required; this value currently exceeds the total on-system budget without consideration of the non-NHS. The tradeoff curves in **Figure 11** can be used to inform the setting of long-range performance targets and identifying early what performance trajectory can be expected at current budgets.

Given the age of the system, it is recommended that TxDOT seek new revenues, particularly by 2020, to mitigate future structural deficiencies. Particular focus will be needed to meet federal requirements on the NHS. To help align these bridge needs with other modes, a performance-based resource allocation approach is recommended amongst the modes. For instance, if pavement targets are allowed to slip slightly, the improvement in bridge targets may more than make up for the change in performance. Agency preferences will be critical to make the difficult decisions surrounding possible future performance outcomes.

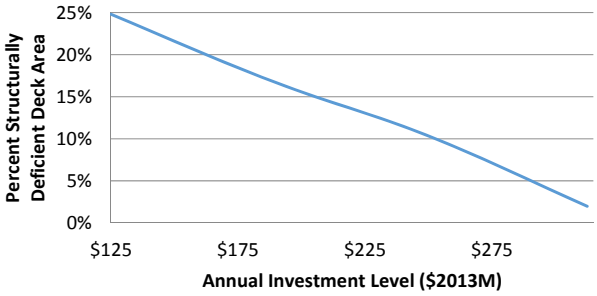
**Figure 11: Forecasted 2040 Performance by Network Relative to Investment Level**



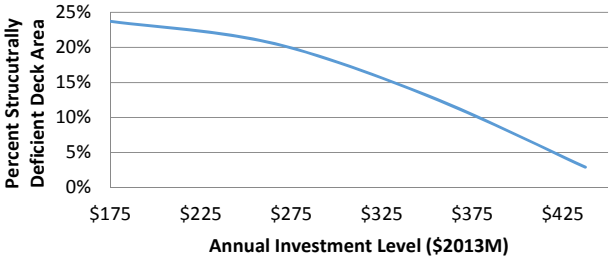

(a) Overall 2040 Conditions



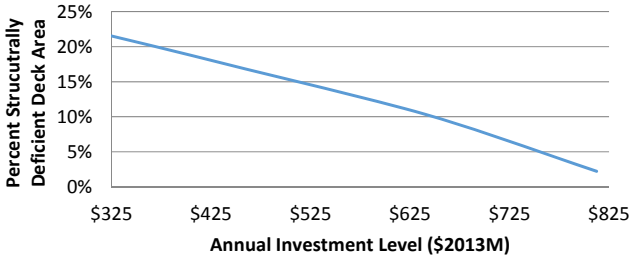

(b) 2040 Conditions on the NHS




(c) 2040 Conditions on the Non-NHS




(d) 2040 Conditions On-Freight Network




(e) 2040 Conditions Off-Freight Network

# Texas Transportation Plan

## Tech Memo 6: Expansion Modal Profile

August 15, 2014

## Acknowledgements

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## 1.0 Introduction

As part of the development of the Texas Transportation Plan (TTP), the project team set out to identify highway capacity needs. To accomplish this, a methodology was developed to define deficient roadways by identifying roadways operating below a specific level of service (LOS). The amount of extra capacity needed to allow a given roadway to operate above the deficient level was then calculated and the cost of the improvement estimated.

The Texas Statewide Analysis Model version (SAM-V3) provided the network and traffic data use for this analysis, while the Texas Transportation Planning (TPP) highway expansion unit cost was utilized to calculate potential capacity improvement costs. This analysis was conducted for both the base year (2010) and baseline horizon year (2040), as well as for three future network scenarios: the Connectivity and Freight Mobility Scenario, the Urban Mobility Scenario, and the System Preservation Scenario. This technical memorandum describes the methodology used to identify highway capacity deficiencies and presents the results of analysis for 2010 and 2040.

## 2.0 Identification of Highway Deficiencies

The first step in the process was to define deficiencies in terms of roadway network performance. The highway LOS measure, which is used in *The Highway Capacity Manual* and *AASHTO Geometric Design of Highway and Streets,* was utilized to evaluate roadway network performance. This measure allows for flexibility in qualitatively defining an acceptable level of congestion. LOS A represents free flow traffic and LOS F represents a complete breakdown of flow. Below is a brief description of each LOS category.

A. **Free flow.** Traffic flows at or above the posted speed limit and motorists have complete mobility between lanes. The effects of incidents or point breakdowns are easily absorbed. LOS A occurs late at night in urban areas, frequently in rural areas.

B. **Reasonably free flow.** LOS A speeds are maintained, maneuverability within the traffic stream is slightly restricted.

C. **Stable flow, at or near free flow.** Most experienced drivers are comfortable, roads remain safely below but efficiently close to capacity, and posted speed is maintained. Minor incidents may still have no effect but localized service will have noticeable effects and traffic delays will form behind the incident. This is the target LOS for some urban and most rural highways.

D. **Approaching unstable flow.** Speeds slightly decrease as traffic volume slightly increases. Minor incidents are expected to create delays. Examples are a busy shopping corridor in the middle of a weekday, or a functional urban highway during commuting hours. It is a common goal for urban streets during peak hours, as attaining LOS C would require prohibitive cost and societal impact in bypass roads and lane additions.

E. **Unstable flow, operating at capacity.** Flow becomes irregular and speed varies rapidly because there are virtually no usable gaps to maneuver in the traffic stream and speeds rarely reach the

posted limit. Speeds are still at or above 50 mph. Any disruption to traffic flow, such as merging ramp traffic or lane changes, will create a shock wave affecting traffic upstream. Any incident will create serious delays. This is a common standard in larger urban areas, where some roadway congestion is inevitable.

F. **Forced or breakdown flow.** Every vehicle moves in lockstep with the vehicle in front of it, with frequent slowing required. Travel time cannot be predicted, with generally more demand than capacity. A road in a constant traffic jam is at this LOS.

The specific ranges of free flow speed, and passenger car density used to define the LOS and identify deficiencies are presented in Appendix C.

## 3.0 Baseline Deficiencies

The evaluation of deficient roadways and the calculation of the cost of adding the additional capacity necessary to mitigate these deficiencies is described in this section. Roadway deficiencies are reported using the following measures:

- Total delay, in vehicle-hours
  - by functional classification of the roadway
  - by area type (Rural or Urban)
  - by time period (AM Peak, Mid-day, PM Peak, Overnight)
- Percent of system congested
  - by time period (AM Peak, Mid-day, PM Peak, Overnight)
  - by functional classification of the roadway
- Congestion Severity Index (CSI)

These measures are described in more detail in this section.

### *3.1 Total Delay*

Total delay (in vehicle-hours) measures the total time loss due to congestion for all vehicles using roadways included in the Texas Statewide Model (SAM-V3). This measure can be used to prioritize highly travelled sections above those that are less heavily travelled. Changes in total delay between different scenarios can show which improvements affect the state's roadway system or a particular corridor. Annual statewide delay, by functional class, is presented in Table 1 for the 2010 and 2040 baseline scenarios.

$$TotalDelay = (Congested\ Time - Free\ Flow\ Time) * Volume$$

**Table 1: Statewide Annual Delay by Functional Class (in vehicle-hours)**

| FC | FC Description | 2010 Delay | 2040 Delay |
|---|---|---|---|
| 1 | Rural Interstate | 12,600,376 | 108,646,815 |
| 2 | Rural Principal Arterial | 14,576,528 | 152,820,139 |
| 6 | Rural Minor Arterial | 31,528,891 | 113,361,094 |
| 7 | Rural Major Collector | 32,366,955 | 135,373,176 |
| 8 | Rural Minor Collector | 5,161,232 | 24,700,580 |
| 9 | Rural Local | 4,487,119 | 13,813,428 |
| 11 | Urban Interstate | 62,424,772 | 213,886,436 |
| 12 | Urban Freeway & Expressway | 52,059,142 | 222,893,523 |
| 14 | Other Urban Principal Arterial | 220,268,744 | 549,352,393 |
| 16 | Urban Minor Arterial | 49,658,127 | 134,681,670 |
| 17 | Urban Collector | 9,885,620 | 29,697,173 |
| 19 | Urban Local | 1,073,456 | 2,702,983 |
| 111 | HOV and HOT lanes | 10,869,800 | 46,182,073 |
| Total | | 506,960,761 | 1,748,111,486 |

**Table 2: Statewide Annual Delay by Area Type (vehicle-hours)**

| Area | 2010 Delay | 2040 Delay |
|---|---|---|
| Rural | 100,721,100 | 548,715,234 |
| Urban | 406,239,661 | 1,199,396,252 |

## *3.2 Percent of System Congested*

The Percent of System Congested measure describes the extent of congestion on the highway system. This measure is calculated by dividing the number of congested lane miles by the total lane miles for all roadway links in the system. Roadways that are at or below LOS D are assumed to be in congestion. Table 3 below shows the Percent of System Congested by Time Period for the 2010 and 2040 baseline scenarios.

**Table 3: Percent of System Congested (LOS D or worse) by Time Period**

| Period | 2010 % Congested | 2040 % Congested |
|---|---|---|
| AM | 3.7% | 8.4% |
| MD | 0.6% | 2.3% |
| PM | 3.2% | 7.5% |
| NT | 0.0% | 0.0% |

Table 4 presents the Percent of System Congested by Functional Classification for both 2010 and 2040.These numbers show that 2040 system-wide congestion is significantly higher than 2010 system-wide congestion for each of the functional classes.

**Table 4: Percent of System Congested (LOS D or worse) by Functional Class**

| FC | FC Description | 2010 % Congested | 2040 % Congested |
|---|---|---|---|
| 1 | Rural Interstate | 0.4% | 5.9% |
| 2 | Rural Principal Arterial | 1.1% | 5.3% |
| 6 | Rural Minor Arterial | 1.1% | 2.8% |
| 7 | Rural Major Collector | 0.8% | 2.2% |
| 8 | Rural Minor Collector | 0.4% | 1.2% |
| 9 | Rural Local | 0.2% | 0.8% |
| 11 | Urban Interstate | 19.3% | 31.1% |
| 12 | Urban Freeway & Expressway | 13.9% | 18.1% |
| 14 | Other Urban Principal Arterial | 2.4% | 6.4% |
| 16 | Urban Minor Arterial | 2.0% | 5.3% |
| 17 | Urban Collector | 1.7% | 5.1% |
| 19 | Urban Local | 2.6% | 7.7% |
| 111 | HOV and HOT lanes | 49.4% | 22.7% |
| Percent of System Congested – Statewide | | **2.4%** | **5.7%** |

## *3.3 Congestion Severity Index (CSI)*

The Congestion Severity Index (CSI) describes congestion severity by calculating system wide freeway and arterial delay by the amount of vehicle miles traveled. The statewide CSI, which is computed for an average 24-hour day, is shown for the 2010 and 2040 baseline conditions in Table 5 below.

**Table 5: Congestion Severity Index (Freeway Delay per Million Miles of Travel)**

| Congestion Severity Index | 2010 | 2040 |
|---|---|---|
| Statewide | 4,924 | 10,655 |

The following measures, while not summarized in this memo, have been calculated and included along with the above measures in Excel format.

- Daily Freight Congestion Cost
  - The daily freight congestion cost is computed as the delay experienced by truck volumes multiplied by truck value of time.
- Total delay per mile
  - This measure is computed as the total delay divided by the roadway length. This measure can indicate the congestion levels without the difference in roadway length affecting the ranking. This measure was computed for the SAM-V3 highway network, and can be used to identify most congested sections.
- Texas Congestion Index (TCI)
  - The TCI is the ratio of actual travel time to the free flow travel time, which measures the amount of extra time for any trip. The TCI is calculated for the SAM-V3 highway network.
- Commuter Stress Index
  - The commuter stress index measures the amount of extra time for traveling in the peak direction during both peak periods, which reflects most commuters' stress level and is an indicator for people's general perception of congestion. This measure is calculated for the SAM-V3 highway network.

## 4.0 Scenarios Testing Mitigation of 2040 Deficiencies

Once deficient roadway links were identified, the project team determined the additional lane miles needed to keep 2040 congestion levels at a desired level of service. For this analysis, three scenarios were tested, each defined by different target levels of service. These three scenarios included:

- **The Connectivity and Freight Mobility Scenario,** with a target Rural LOS C and Urban LOS D for the 2040 horizon year;
- **The Urban Mobility Scenario,** with a target Rural LOS D and Urban LOS D for the 2040 horizon year;
- **The System Preservation Scenario,** with the target Rural LOS and Urban LOS remaining the same as the LOS from the 2040 baseline scenario (that is, the LOS resulting from projects included in MTPs and STIP).

For each of the three scenarios, the minimum improvement needed to address the identified deficiencies in both peak periods was calculated. If the AM peak warranted one additional lane to address deficiencies but the PM peak warranted two additional lanes, the two additional lanes for the PM peak was selected as the amount of capacity needed. The additional lane-miles required by functional class are shown in **Table 6** below. **Table 7** shows required lane-miles by area type. Note that the System Preservation scenario does not require any additional lanes as it is the same as the baseline 2040 scenario.

**Table 6: Additional Lane Miles Needed by Functional Class**

| FC | FC Description | Connectivity & Freight Mobility | Urban Mobility | System Preservation |
|---|---|---|---|---|
| 1 | Rural Interstate | 0 | 513 | - |
| 2 | Rural Principal Arterial | 1,480 | 1,921 | - |
| 6 | Rural Minor Arterial | 2,926 | 1,264 | - |
| 7 | Rural Major Collector | 3,238 | 1,650 | - |
| 8 | Rural Minor Collector | 4,722 | 397 | - |
| 9 | Rural Local | 1,016 | 185 | - |
| 11 | Urban Interstate | 435 | 3,299 | - |
| 12 | Urban Freeway & Expressway | 4,041 | 3,505 | - |
| 14 | Other Urban Principal Arterial | 3,737 | 2,645 | - |
| 16 | Urban Minor Arterial | 2,691 | 903 | - |
| 17 | Urban Collector | 904 | 243 | - |
| 19 | Urban Local | 243 | 17 | - |
| 111 | HOV and HOT lanes | 677 | 677 | - |
| **Statewide Additional Lane Miles** | | **26,127** | **17,219** | **-** |

**Table 7: Additional Lane-Miles Needed by Area Type**

| Area Type | Connectivity & Freight Mobility | Urban Mobility | System Preservation |
|---|---|---|---|
| Rural | 13,816 | 5,930 | - |
| Urban | 12,310 | 11,289 | - |

## *4.1 Cost Estimates*

The project team next developed cost estimates for the extra capacity needed to address roadway deficiencies in 2040. The draft methodology and assumptions used for the cost estimates are included in Appendix A for reference. The costs associated with addressing roadway deficiencies for the three scenarios (by facility type) are presented in **Table 8**.

**Table 8: Estimated Cost for Improvements, by Facility Type (in thousands of 2014 dollars)[1]**

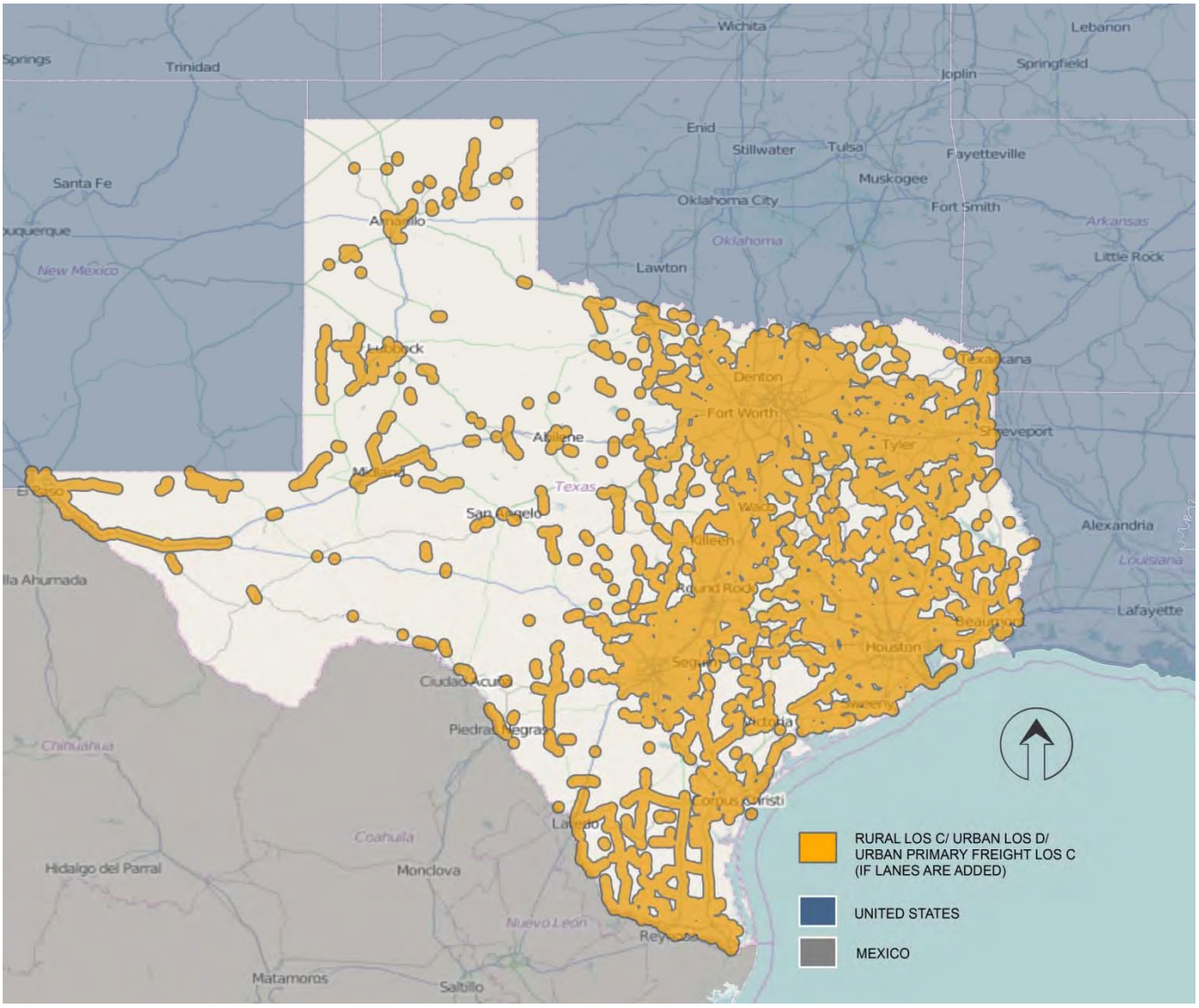
| FC | FC Description | Connectivity & Freight Mobility | Urban Mobility | System Preservation |
|---|---|---|---|---|
| 1 | Rural Interstate | 2,660,878.55 | 923,246.57 | - |
| 2 | Rural Principal Arterial | 4,293,677.08 | 2,819,353.49 | - |
| 6 | Rural Minor Arterial | 4,268,689.26 | 1,666,471.32 | - |
| 7 | Rural Major Collector | 5,377,889.34 | 1,879,243.78 | - |
| 8 | Rural Minor Collector | 1,157,298.70 | 451,733.16 | - |
| 9 | Rural Local | 495,916.11 | 210,149.64 | - |
| 11 | Urban Interstate | 100,015,462.69 | 82,128,578.50 | - |
| 12 | Urban Freeway & Expressway | 89,605,839.69 | 84,703,577.63 | - |
| 14 | Other Urban Principal Arterial | 19,584,705.87 | 19,250,574.68 | - |
| 16 | Urban Minor Arterial | 4,402,930.01 | 4,395,181.00 | - |
| 17 | Urban Collector | 1,066,947.11 | 1,066,947.11 | - |
| 19 | Urban Local | 87,672.48 | 87,672.48 | - |
| 111 | HOV and HOT lanes | 17,637,675.16 | 17,637,675.16 | - |
| Statewide Estimated Cost | | 250,655,582 | 217,220,405 | |

Note:

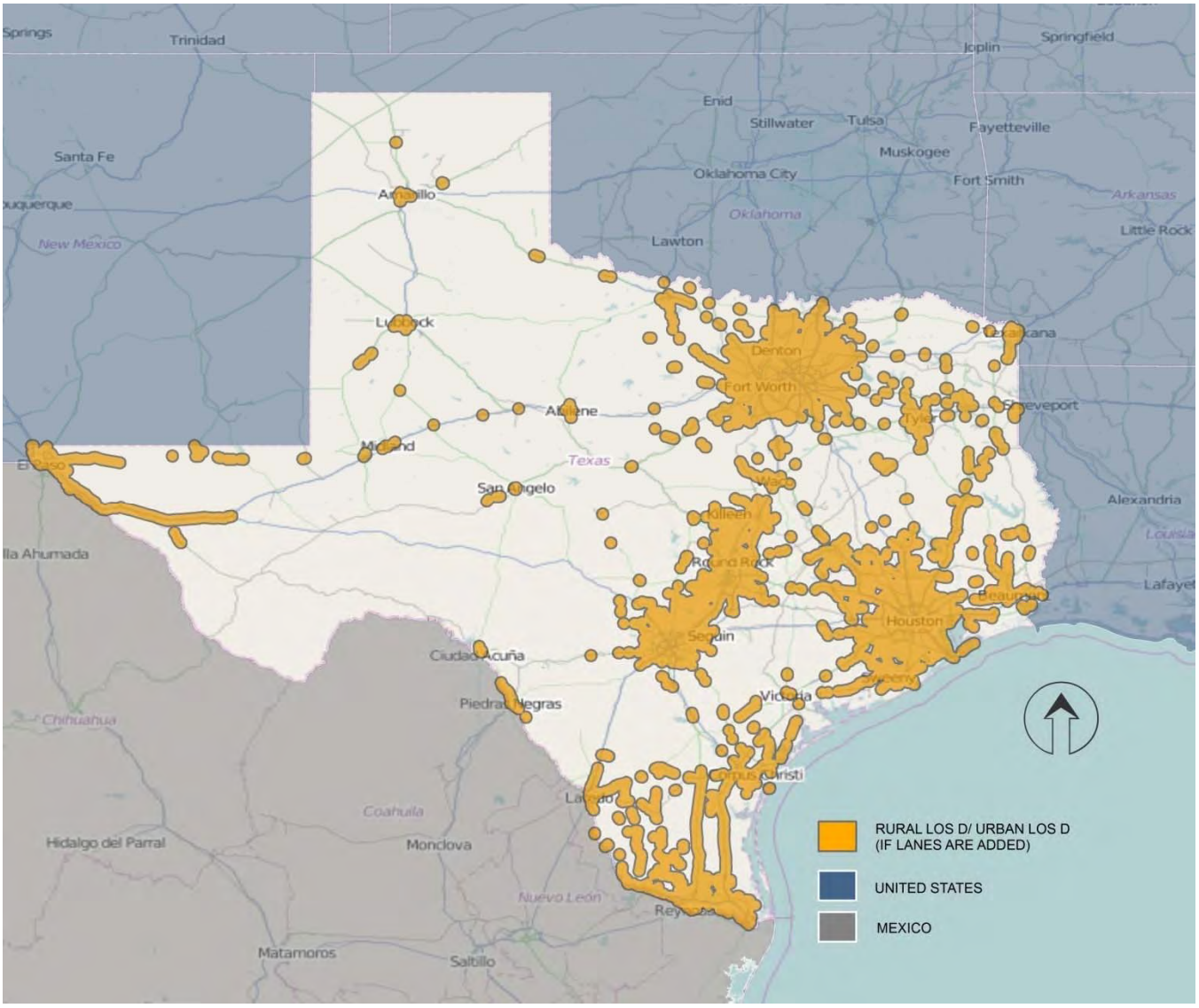
[1] The estimated cost is the average of the normal cost and high cost estimated based on the unit expansion cost.

Mapping the results of this analysis provides a general idea of the areas in the state where capacity improvements may be warranted in order to have a functioning highway system. Note that the maps on the following pages are produced as examples for internal use only, and should not be distributed. Figure 1 through Figure 3 below depict areas of the state in which roadway links have been classified as being deficient (not at target LOS) for the three scenarios presented in this memorandum. Figure 1 and Figure 2 depict where lanes need to be added to achieve the target LOS. Figure 3 depicts areas that are below LOS C if no improvements are made.

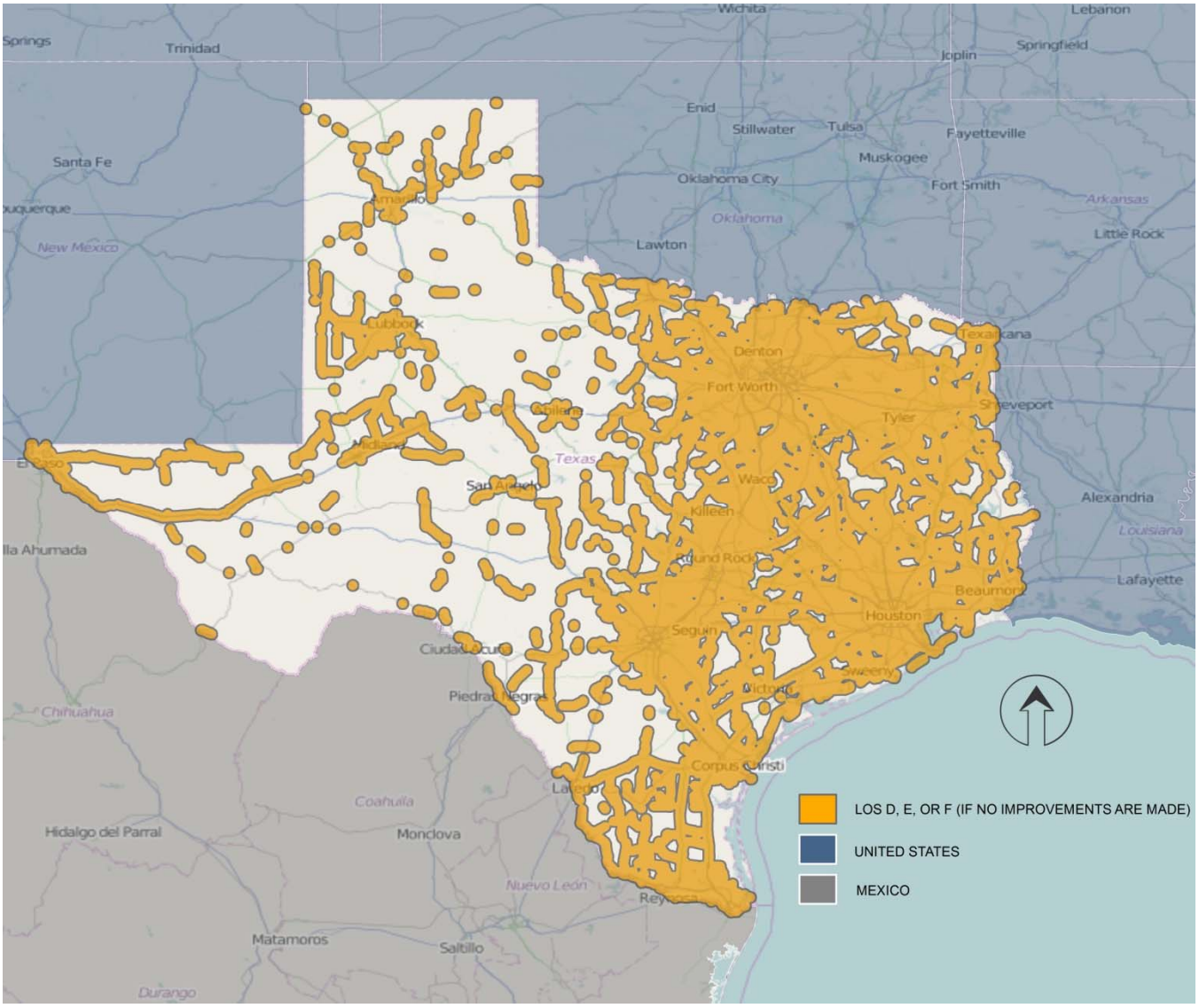
**Figure 1: 2040 Connectivity and Freight Mobility Scenario**



## Figure 2: 2040 Urban Mobility Scenario



## Figure 3: 2040 System Preservation Scenario



## 5.0 Impacts of Improvements on System Performance

Future congestion levels were next assessed with the identified needs (that is, additional lanes of capacity) included in each of the three network scenarios. The same congestion measures presented for the unimproved system were calculated for the improved systems. The results of this analysis are presented in this section.

### *5.1 Total Delay*

As shown in Table 9 below, the unconstrained improvements enhanced system performance by decreasing annual delay (in vehicle-hours) in both the Connectivity & Freight Mobility and Urban Mobility scenarios, as compared with the 2040 baseline scenario.

**Table 9: Statewide Annual Delay by Functional Class (in vehicle-hours)**

| FC | FC Description | 2040 Baseline Delay | Connectivity & Freight Mobility | Urban Mobility | System Preservation |
|---|---|---|---|---|---|
| 1 | Rural Interstate | 108,646,815 | 45,447,371 | 63,243,165 | 108,646,815 |
| 2 | Rural Principal Arterial | 152,820,139 | 56,315,073 | 64,110,870 | 152,820,139 |
| 6 | Rural Minor Arterial | 113,361,094 | 49,991,569 | 61,838,926 | 113,361,094 |
| 7 | Rural Major Collector | 135,373,176 | 60,826,471 | 74,817,643 | 135,373,176 |
| 8 | Rural Minor Collector | 24,700,580 | 10,167,798 | 12,794,542 | 24,700,580 |
| 9 | Rural Local | 13,813,428 | 7,377,252 | 8,949,837 | 13,813,428 |
| 11 | Urban Interstate | 213,886,436 | 28,108,405 | 33,538,657 | 213,886,436 |
| 12 | Urban Freeway & Expressway | 222,893,523 | 27,870,218 | 29,364,497 | 222,893,523 |
| 14 | Other Urban Principal Arterial | 549,352,393 | 269,087,071 | 270,609,739 | 549,352,393 |
| 16 | Urban Minor Arterial | 134,681,670 | 56,531,470 | 56,567,024 | 134,681,670 |
| 17 | Urban Collector | 29,697,173 | 13,883,491 | 13,883,491 | 29,697,173 |
| 19 | Urban Local | 2,702,983 | 1,516,200 | 1,516,200 | 2,702,983 |
| 111 | HOV and HOT lanes | 46,182,073 | 9,378,655 | 9,378,655 | 46,182,073 |
| Total Statewide Delay | | 1,748,111,486 | 636,501,043 | 700,613,246 | 1,748,111,486 |

As shown in Table 10, the unconstrained improvements enhanced system performance by significantly decreasing annual delay (in vehicle-hours) in both the Connectivity & Freight Mobility and Urban Mobility scenarios, as compared with the 2040 baseline scenario.

**Table 10: Statewide Annual Delay by Area Type (in vehicle-hours)**

| Area | 2040 Baseline Delay | Connectivity & Freight Mobility | Urban Mobility | System Preservation |
|---|---|---|---|---|
| Rural | 548,715,234 | 230,125,534 | 285,754,983 | 548,715,234 |
| Urban | 1,199,396,252 | 406,375,510 | 414,858,263 | 1,199,396,252 |

## 5.2 *Percent of System Congested*

**Table 11** below shows the improvement in percent of the system that is congested between the 2040 baseline scenario and the three scenarios for each of the four time periods.

**Table 11: Percent of System Congested (LOS D or Worse) with Improvements by Time Period**

| Period | 2040 Baseline % Congested | Connectivity & Freight Mobility | Urban Mobility | System Preservation |
|---|---|---|---|---|
| AM | 8.4% | 2.1% | 4.2% | 8.4% |
| MD | 2.3% | 0.2% | 0.3% | 2.3% |
| PM | 7.5% | 1.4% | 3.2% | 7.5% |
| NT | 0.0% | 0.0% | 0.0% | 0.0% |

The improvement in percent of the system that is congested between the 2040 baseline scenario and the three scenarios, by functional class, is presented in **Table 12** below.

**Table 12: Percent of System Congested (LOS D or worse) by Functional Class**

| FC | FC Description | 2040 Baseline % Congested | Connectivity & Freight Mobility | Urban Mobility | System Preservation |
|---|---|---|---|---|---|
| 1 | Rural Interstate | 5.9% | 0.0% | 1.4% | 5.9% |
| 2 | Rural Principal Arterial | 5.3% | 0.5% | 1.4% | 5.3% |
| 6 | Rural Minor Arterial | 2.8% | 0.2% | 1.7% | 2.8% |
| 7 | Rural Major Collector | 2.2% | 0.1% | 1.5% | 2.2% |
| 8 | Rural Minor Collector | 1.2% | 0.0% | 0.8% | 1.2% |
| 9 | Rural Local | 0.8% | 0.0% | 0.4% | 0.8% |
| 11 | Urban Interstate | 31.1% | 4.5% | 10.0% | 31.1% |
| 12 | Urban Freeway & Expressway | 18.1% | 9.4% | 11.2% | 18.1% |
| 14 | Other Urban Principal Arterial | 6.4% | 0.7% | 0.7% | 6.4% |
| 16 | Urban Minor Arterial | 5.3% | 0.5% | 0.5% | 5.3% |
| 17 | Urban Collector | 5.1% | 1.7% | 1.7% | 5.1% |
| 19 | Urban Local | 7.7% | 1.3% | 1.3% | 7.7% |
| 111 | HOV and HOT lanes | 22.7% | 5.9% | 5.9% | 22.7% |
| Percent of System Congested – Statewide | | 5.7% | 1.1% | 2.4% | 5.7% |

## 5.3 Congestion Severity Index (CSI)

Finally, the change in the statewide Congestion Severity Index (CSI) between the 2040 baseline scenario and the three scenarios is shown in Table 13.

**Table 13: Congestion Severity Index**

| | 2040 Baseline | Connectivity & Freight Mobility | Urban Mobility | System Preservation |
|---|---|---|---|---|
| Statewide | 10,655 | 3,863 | 4,173 | 10,655 |

# Texas Transportation Plan

## Tech Memo 6: Intelligent Transportation Systems Modal Profile

August 15, 2014

## Acknowledgements

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# 1.0 Introduction

As the State's long-range transportation plan, the Texas Transportation Plan 2040 (TTP 2040) will document the size and scope of the Texas transportation system with respect to existing conditions, current and future demand, funding needs by mode, and fiscally-constrained investment scenarios and probable outcomes. This memo will document the existing conditions, current and future demand, funding needs, and fiscally-constrained investment scenarios for the Intelligent Transportation System (ITS) devices.

# 2.0 Overview of Existing Conditions

The inventory of ITS devices located within the state of Texas were collected by TxDOT as described in the Technical Memorandum #3 and include only devices that are maintained by TxDOT. At the time of inventory there were approximately 9000 different ITS devices located through the entire state. The inventory included the following devices:

- Closed Captioned Television Cameras (CCTV)
- Dynamic Message Signs (DMS)
- Lane Control Signals (LCS)
- Radar Detection
- Loop Detection
- Highway Advisory Radio (HAR)
- Ramp Meters
- Automatic Vehicle Identification (AVI)
- Flood Warning
- Weather Sensors

At this time, the inventory did not include other items such as traffic signals, illumination, signing, and pavement markings. The age of the ITS devices are unknown, but each device is assumed to be in working order and maintained by TxDOT on a TxDOT facility. All other devices are assumed to be maintained by a local agency.

# 3.0 Unconstrained Needs Determination

The following section provides a summary of the TTP 2040 ITS needs determination methodology as well as a fiscally-constrained and unconstrained needs analysis to 2040.

## *3.1 Methods and Assumptions*

The previous Technical Memorandum #3, Intelligence Transportation System Methodology, described the methodology proposed for assessing the ITS devices inventory within the TTP 2040. The memorandum reviewed the stakeholder involvement and types of investment, regional transportation plans and programs, the existing inventory data collection, the proposed capital projects, and historical maintenance and operations costs.

Existing ITS devices are assumed to remain in place and functional through 2040. This includes the necessary maintenance and replacement of devices on a planned schedule. New ITS devices are added to the yearly inventory based on the ITS deployment plans developed for each district or MPO. The costs to maintain the new ITS devices is incorporated into the yearly maintenance costs. It was assumed that the costs for maintenance and capital projects would be evenly distributed yearly based on current dollar values.

The ITS deployment plans developed for each district contained estimated costs for each proposed project including local and state projects. The majority of the deployment plans were developed over ten years ago, so the accuracy as to what projects have been implemented is questionable. As a result, it was assumed that only the long-range plans are yet to be implemented. MPOs have developed plans that may be more recent, but did not identify specific ITS projects. It appears that most MPOs are including future ITS devices as part of major rehabilitations to existing facilities. In addition, nearly all MPOs do not provide specific ITS costs. Based on this data, ITS needs were based on the ITS deployment plans with the accumulated costs distributed equally year over year.

## *3.2 Unconstrained Needs to 2040*

In using the described methodology, it was found that TxDOT would need approximately $30 million each year (2014 dollars) just to maintain the existing ITS system. By 2040, TxDOT will have spent $1 billion to maintain the existing network. This assumes that all devices in place will be maintained on a regular schedule and replaced as needed. It also assumes a 6 percent contingency to cover unforeseen expenditures. **Figure 1** displays the necessary expenditures to maintain the existing ITS system.

In addition to maintaining the existing system, new projects are planned. These new projects will require initial funding as well as the yearly maintenance. It is projected the new projects would require an annual funding of over $300 million (2014 dollars) to cover the initial capital costs and anticipated yearly maintenance. A contingency amount of 6% is also included to cover any unforeseen costs. Through 2040 the total needs for the ITS capital projects would exceed $8 billion (2014 dollars). The results are displayed below in **Figure 2**.

**Figure 1: Maintain Existing ITS Devices (YOE)**

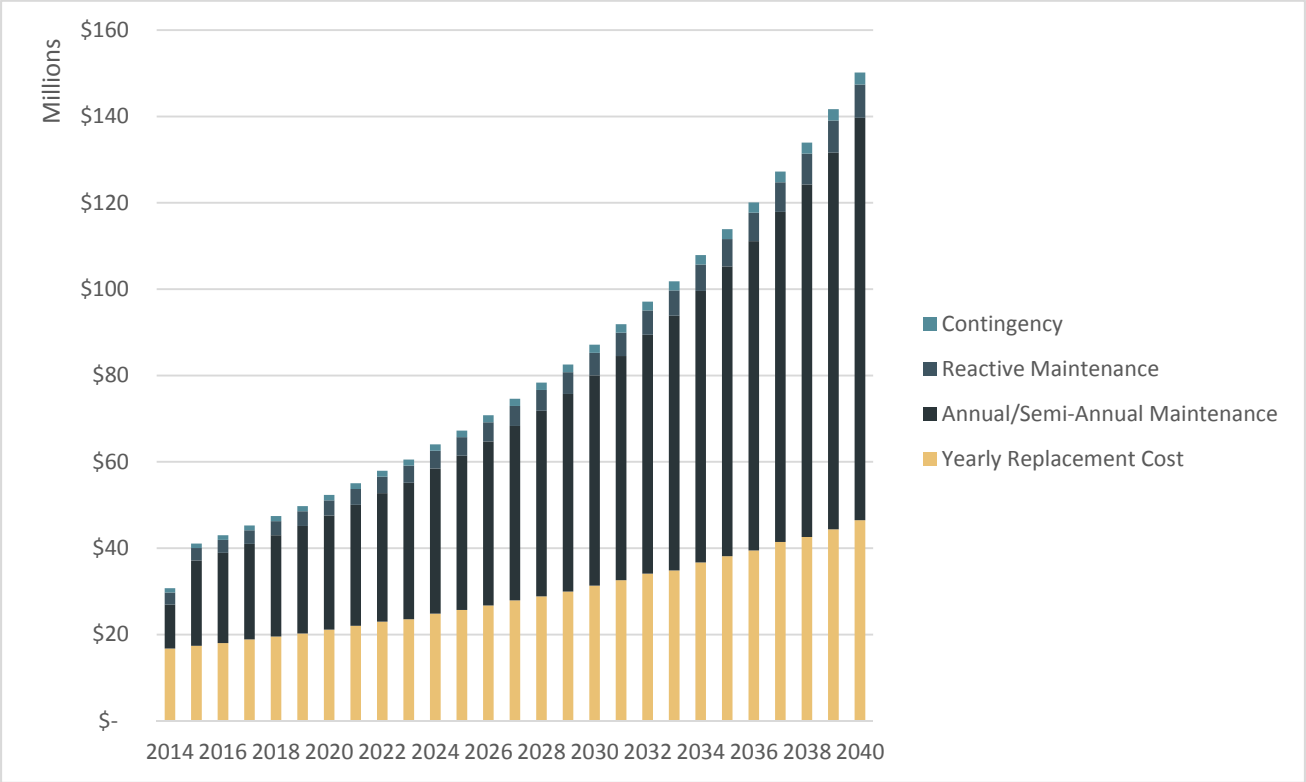
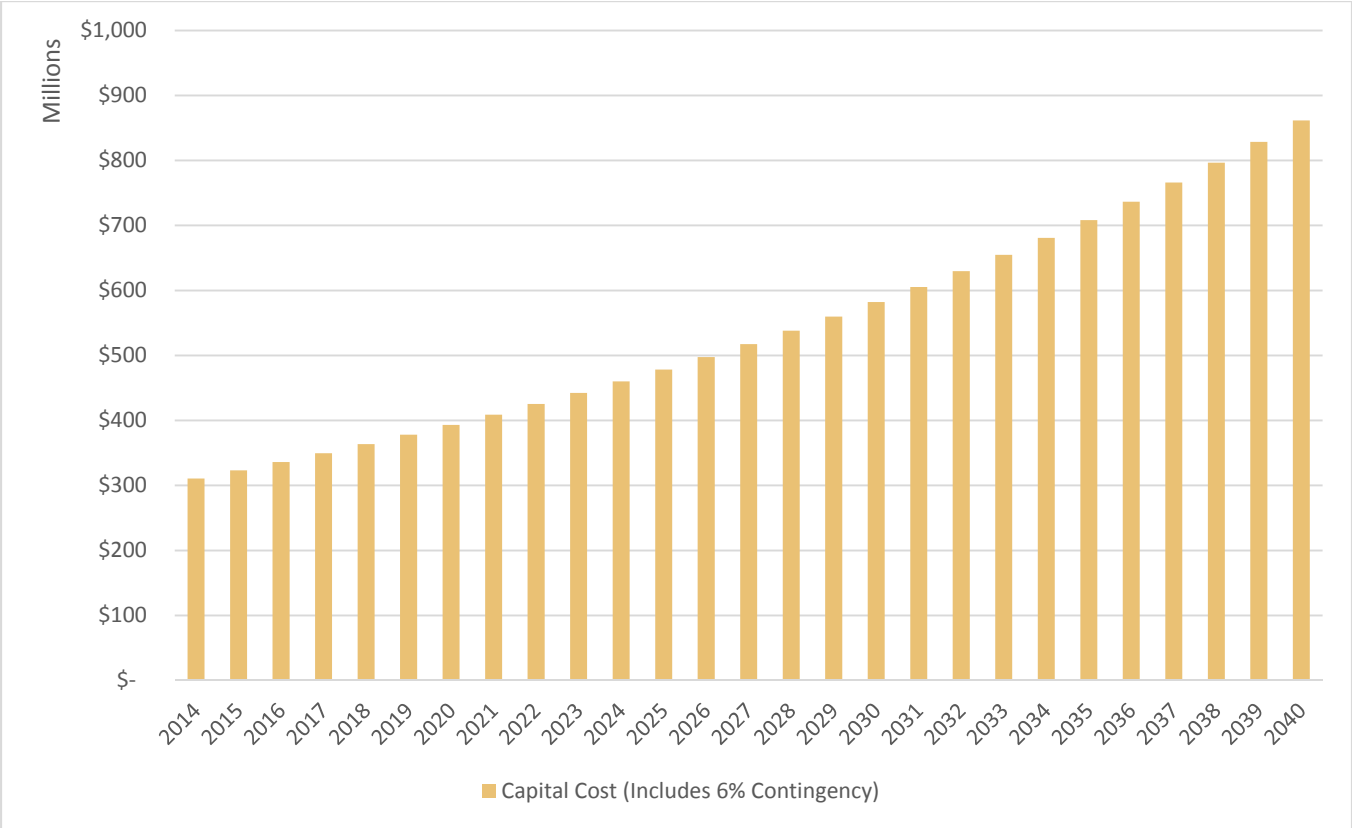
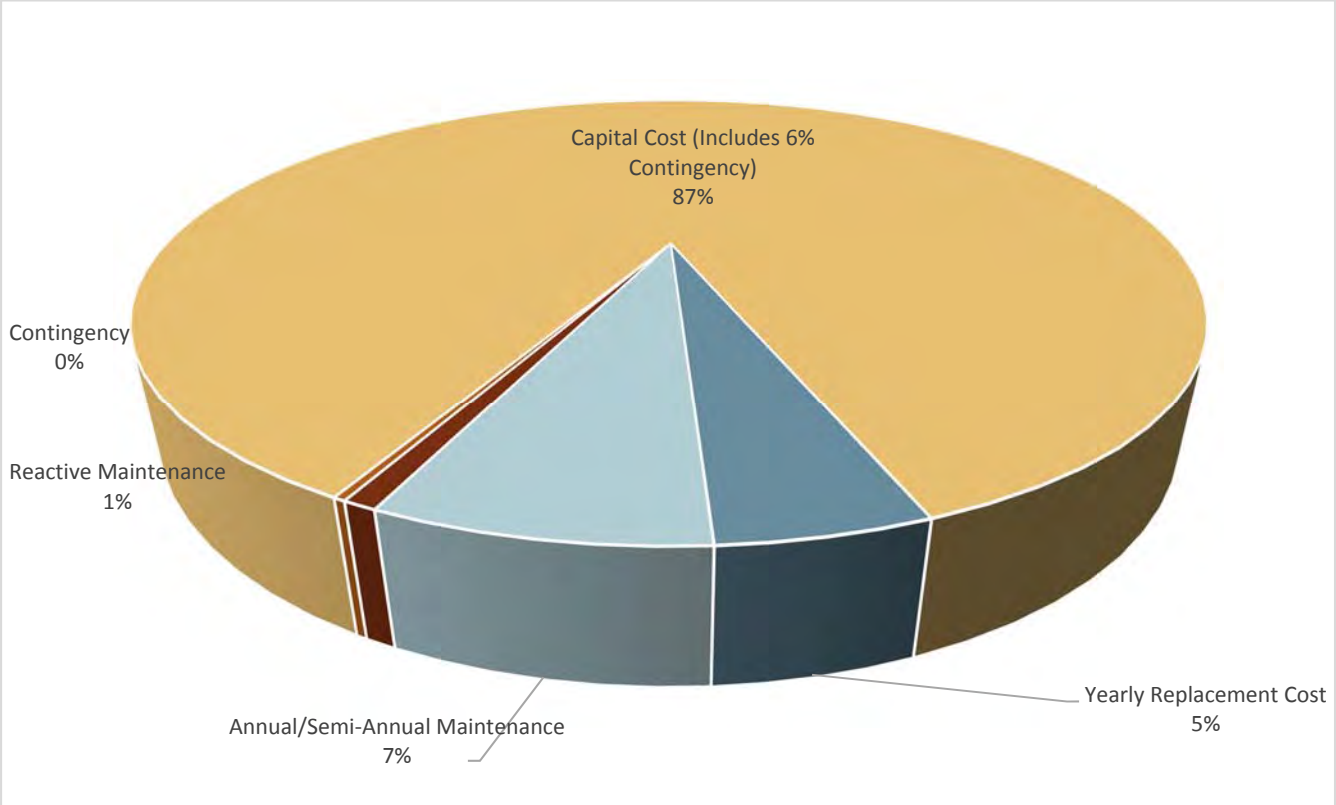



**Figure 2: ITS Capital Projects (YOE)**



As mentioned above, contingency and reactive maintenance are included in the budgets. One should expect that these would reduce over time as maintenance becomes a regular part of the lifecycle of an ITS device. It should also be noted that the majority of the funding is to implement future capital projects (and corresponding future maintenance) as shown in **Figure 3**.

**Figure 3: ITS Total Needs By Magnitude Total LCM Costs (2013-2040) Unconstrained (with Inflation)**




## 4.0 Anticipated Revenues and Funding Gap

Upon evaluating the TxDOT financial documents, including revenue forecasts and historical expenditures, the average annual transportation revenue anticipated through 2040 is $11.6 billion. Of this amount nearly all ($11.5 billion) is earmarked to highway/bridge and transit, which leaves less than $100 million to fund all other modes, including ITS. The ITS needs alone exceed $300 million, so it should be expected that the ITS needs will not be fully met in the future.

## 5.0 Fiscally-Constrained Analysis

As the methodology described above shows, the ITS capital projects are not programmed and therefore are assumed to be implemented equally through 2040. A funding shortage allocated to ITS would result in slower implementation of the ITS capital projects, which in turn would result in lower yearly maintenance costs of all future projects. Since the earmarked funding for ITS projects is not available, it cannot be determined what the gaps or tradeoffs would be when considering different scenarios other than using a straight hypothetical percentage.

The figures below display two funding scenarios—75% (**Figure 4**) and 50% (**Figure 5**) of the needs funded.

**Figure 4: Total LCM Costs of ITS Assets – 75% Funded (YOE)**

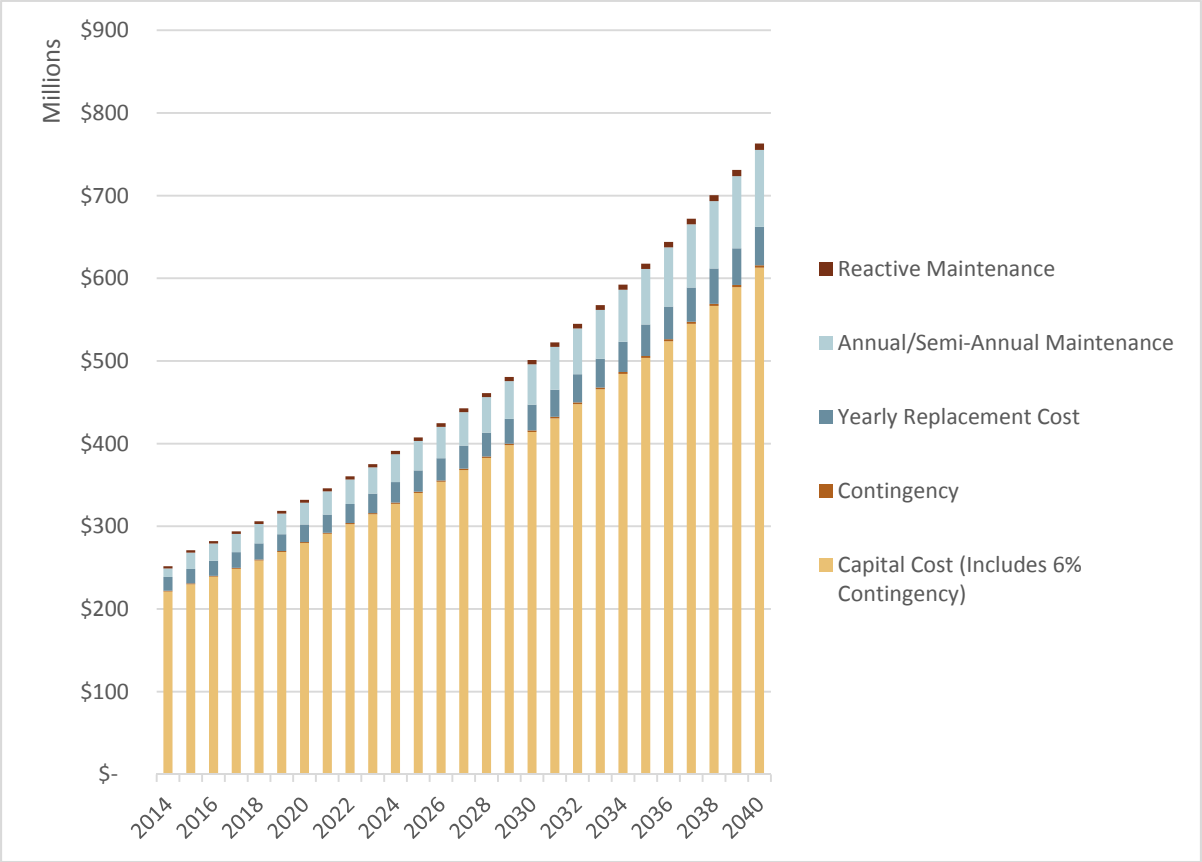
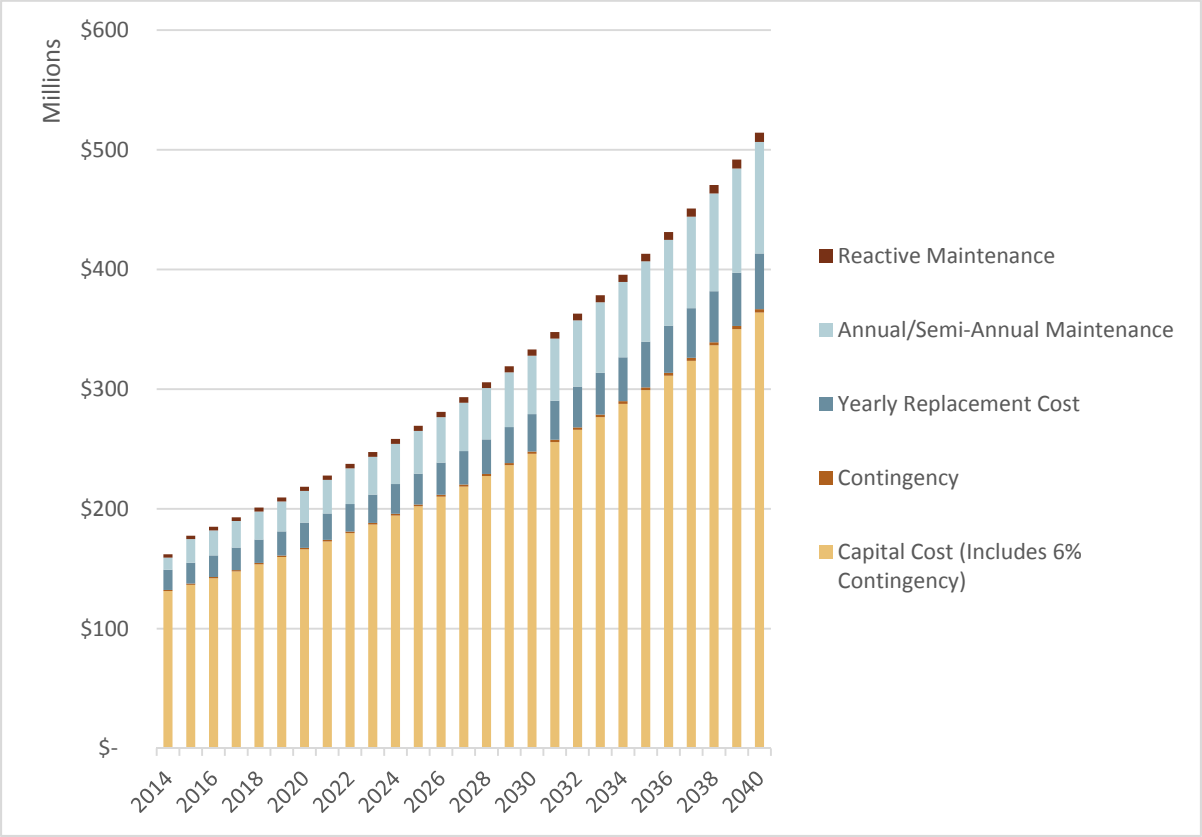


**Figure 5: Total LCM Costs of ITS Assets – 50% Funded (YOE)**




Under both scenarios the annual maintenance and replacement costs will remain steady at $30 million per year (2014 dollars). If the funding meets 75% of the ITS needs, this will result in the reduced implementation of capital projects of approximately $90 million per year (2014 dollars). By 2040 the total ITS needs would have a shortfall of approximately $10 billion (2014 dollars). Should the funding meet only 50% of the ITS needs, this would result in the reduced implementation of capital projects of approximately $190 million per year (2014 dollars). By 2040, the total ITS needs would have a shortfall of approximately $12 billion (2014 dollars). In any event, it is apparent that it will be difficult to fully fund the ITS needs through 2040 based on the overall existing funding of all TxDOT assets. At a minimum, TxDOT should anticipate providing funding to cover the needs of all existing ITS assets. In the future, before implementing ITS capital projects, the future maintenance needs of each should be accounted for in the total funding needs.

There are methods to decrease the necessary ITS funding. The most direct way is to continue with the inventory of all ITS devices throughout the state and document not only the location, but include date of implementation, current condition, and dates and costs of maintenance. This data would allow each district to better anticipate when devices fail, decreasing the need to rely on contingency funding and reactive maintenance funding. It would also allow each district to better understand and forecast maintenance costs for specific devices.

# Texas Transportation Plan

## Tech Memo 6: Passenger Rail Modal Profile

August 21, 2014

## Acknowledgements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# 1.0 Introduction

The purpose of this technical memorandum is to document the process conducted to identify the existing and planned and programmed passenger rail systems in preparation for and support of the Texas Transportation Plan (TTP) update, public outreach and associated performance evaluations. It should be noted that this document is not intended to supplement the legislative requirements put forth in Senate Bill 1382 (Section 201.6012-6013 – Transportation Code), which mandates an annual update for the statewide passenger rail system.

The process to document passenger rail initiatives included compiling and reviewing passenger rail system plans, in addition to obtaining and reviewing plans and programs for new and/or expanded passenger rail services throughout the state of Texas. For the purposes of this report, passenger rail services identified and researched include High Speed Rail and Intercity Passenger Rail as outlined in subsequent sections.

# 2.0 Overview of Existing Conditions

The following section provides an overview of existing conditions in relation to current or planned passenger rail service. In order to obtain this information, federal, state and local plans were reviewed as discussed in the following section. *The Texas Rail Plan, November 2010* served as the basis for this effort due to a recent update of the Passenger Rail chapter (Chapter 4) in December 2013. The *Texas Rail Plan* was reviewed in detail, the accuracy of the information assessed, the plans and programs identified were catalogued, and updated versions were reviewed and obtained, as necessary.

## *2.1 High Speed Rail*

The Federal Railroad Administration (FRA) has defined and categorized High Speed Rail (HSR) services into three distinct categories as listed in Table 1.

**Table 1. High Speed Rail Facility Types**

| Type | Corridor Length (miles) | Top Speeds (mph) | Dedicated Tracks | Population Served | Level of Service |
|---|---|---|---|---|---|
| Core Express Corridors | Up to 500 | 125-250 | Yes, except in terminal areas | Major population centers | Frequent express, electrified |
| Regional Corridors | 100-500 | 90-125 | Dedicated and shared tracks | Mid-sized urban areas and smaller communities | Frequent |
| Emerging/Feeder Routes | 100-500 | Up to 90 | Shared tracks | Moderate population centers, with smaller, more distant areas | Less frequent |

Currently, there are no existing HSR operations in Texas. In fact, the only operational system in the United States is Amtrak's Acela Train service that provides services between Boston, Massachusetts and the District of Columbia (Washington, DC) with top speeds of up to 150 miles per hour (MPH). **Figure 1** depicts the federally designated HSR corridors. The two rail corridors in Texas that have received federal designation as future high speed rail corridors are the "South Central" and "Gulf Coast." The Gulf Coast corridor was designated in 1998; the South Central corridor was designated in 2000. These two corridors coincide with portions of existing Amtrak routes.

**Figure 1. Federally Designated High Speed Rail Corridors**

## 2.2 *InterCity Passenger Rail*

The National Railroad Passenger Corporation (Amtrak) is currently the sole provider of intercity passenger rail service in Texas. The three Amtrak routes in Texas include the Heartland Flyer, Texas Eagle, and Sunset Limited. The Heartland Flyer is operated on a 206-mile corridor between Fort Worth and Oklahoma City and is jointly funded by Texas and Oklahoma. The Texas Eagle route includes stops from San Antonio to Chicago and the Sunset Limited travels from Los Angeles to New Orleans.

### 2.2.1 Existing Intercity Rail

An overview of the Amtrak intercity services, such as the route description, station locations, ridership and schedule are included in the following sections:

Texas Eagle

The Texas Eagle provides daily service between San Antonio and Chicago via Fort Worth, Dallas, and St. Louis, for a distance of 1,305 miles (**Figure 2**). Within Texas, the Texas Eagle operates on approximately 404 miles of Union Pacific track, except between Temple and Fort Worth where the trains operate on 126 miles of Burlington Northern Santa Fe (BNSF) track. The Texas Eagle joins the Sunset Limited in San Antonio and continues to Los Angeles for a total route length of 2,728 miles between Chicago and Los Angeles. After San Antonio, the Texas Eagle connects with and follows the schedule of the Sunset Limited. Current service between San Antonio and Los Angeles involves a three-times-per-week connection with the Sunset Limited at San Antonio. According to *Amtrak's Fiscal Year 2013 Ridership and Revenue Report*, ridership on the Texas Eagle resulted in a minor increase of 0.6% from 337,973 to 340,081 passengers for the period of October 2012 to September 2013. During this same time period, ticket revenue was up 5.1% from $26,304,505 to $27,650,161. **Table 2** lists information for each station along the route including location description, boardings and alightings, and transportation connections / transfer options.

**Figure 2. Texas Eagle from Chicago to San Antonio *(to Los Angeles with Sunset Limited)***

Source: www.sharemap.org/public/Amtrak_Texas_Eagle Year: 11/23/13

**Table 2. Texas Eagle Stations**

| Amtrak – Texas Eagle Route | | | |
|---|---|---|---|
| Station | Boardings/Alightings | | Description and Transit Connections |
| | 2012 | 2013 | |
| Alpine, TX (ALP) | 4,416 | 4,921 | • Limited on-site parking<br>• Greyhound Bus Services located 0.5 miles west of station |
| Austin, TX (AUS) | 41,638 | 38,929 | • Limited on-site parking<br>• Capital Metropolitan Transportation Authority Bus Station is located 0.15 miles southwest of station |
| Cleburne, TX (CBR) | 4,536 | 4,143 | • Limited on-site parking<br>• Station also services a regional bus station and dispatching station for CLETRAN (Cleburne's local transit) |
| Dallas, TX (DAL) | 55,764 | 56,564 | • Limited short-term parking, hourly and contract parking<br>• Station also services Trinity Rail Express (TRE) and Dallas Area Rapid Transit (DART) light rail and local bus<br>• Greyhound Bus Services located 6 blocks northeast of station |
| Del Rio, TX (DRT) | 2,175 | 2,443 | • Limited short-term parking on-site and long-term street parking off-site<br>• Station also services a local bus service<br>• Del Rio International (DRT) Airport is 1.5 miles northwest of the station |
| El Paso, TX (ELP) | 12,329 | 13,093 | • Station also services El Paso Sun Metro local bus and Las Cruces Shuttle<br>• Greyhound Bus Services located 6 blocks east of station |
| Fort Worth, TX (FTW) | 141,696 | 129,389 | • Limited on-site parking, long-term parking off-site<br>• Station is an Intermodal Transportation Center that services Trinity Railway Express (TRE), the Fort Worth Transportation Authority's local bus service (the "T"), Greyhound Bus services, the Lake Worth Shuttle, a bikeshare, and Molly the Trolley |
| Longview, TX (LVW) | 49,126 | 41,305 | • Limited on-site parking<br>• A major renovation completed in fall 2013<br>• Longview Transit Services located 0.7 miles northwest of station<br>• Greyhound Bus Services located 0.5 miles northwest of station |
| Marshall, TX (MHL) | 10,025 | 10,555 | • 20 long-term and 20 short-term parking spaces<br>• Ford's Affordable Rental Cards located 1.3 miles east of station<br>• Enterprise located 2.2 miles southeast of station<br>• National located 4.5 miles southeast of station |
| McGregor, TX (MCG) | 4,988 | 5,209 | • Unstaffed station<br>• 30 unattended parking spaces owned by BNSF Railway |
| Mineola, TX (MHL) | 6,956 | 7,213 | • Limited on-site parking |

**Table 2. Texas Eagle Stations**

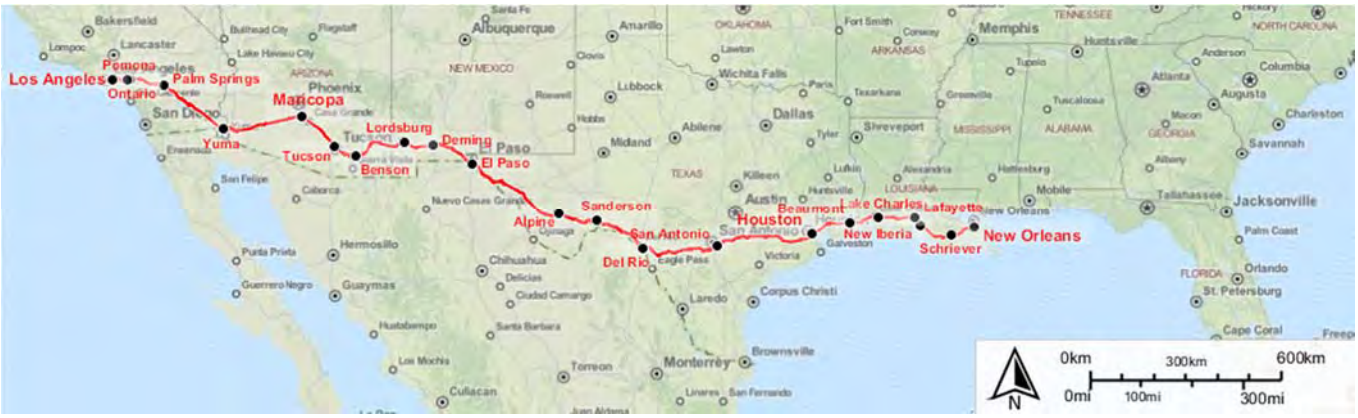
| Amtrak – Texas Eagle Route | | | |
|---|---|---|---|
| Station | Boardings/Alightings | | Description and Transit Connections |
| | 2012 | 2013 | |
| San Antonio, TX (SAS) | 70,161 | 68,268 | • No on-site parking<br>• VIA Metropolitan Transit Services located 2 blocks north of station<br>• Greyhound Bus Services located 1.2 miles northwest of station<br>• Rio San Antonio River Taxi Services located 0.4 miles west of station |
| San Marcos, TX (SMC) | 7,294 | 7,995 | • Station also services Capital Area Rural Transportation System Services interurban coach passengers, and Greyhound/Trailways/Kerrville Bus Services |
| Sanderson, TX (SND) | 255 | 261 | • Flag stop station |
| Taylor, TX (TAY) | 4,979 | 5,425 | • Station also services a Union Pacific office building |
| Temple, TX (TPL) | 17,856 | 17,690 | • Ample on-site parking<br>• Greyhound Bus Services located 2 blocks north of station |

Note:
Any other local transit within 5 miles of the station is listed.

## Sunset Limited

The Sunset Limited is an east-west route that traverses Texas for 937 miles on Union Pacific (UP) track between New Orleans to Los Angeles (**Figure 3**). In Texas, the Sunset Limited provides service to Houston, San Antonio, and El Paso, with stops in Beaumont, Del Rio, Sanderson, and Alpine also shown on **Figure 3**. After leaving Texas, the route continues through New Mexico, Arizona, and California before terminating in Los Angeles. This route is currently scheduled to run three times a week in each direction, providing transportation options for trips within the state as well as to destinations outside of Texas. The Sunset Limited travels a total of approximately 3,000 miles as it crosses five states. According to *Amtrak's Fiscal Year 2013 Ridership and Revenue Report*, ridership on the Sunset Limited resulted in a minor increase of 1.7% from 101,217 to 102,924 passengers for the period of October 2012 to September 2013. During this same time period, ticket revenue was up 6.0% from $11,584,844 to $ $12,275,400. **Table 3** lists information for each station along the route including location description, boardings and alightings, and transportation connections/transfer options.

**Figure 3. Sunset Limited from New Orleans to LA**




Source: www.sharemap.org/public/Amtrak_Sunset_Limited Year: 11/10/13

**Table 3. Sunset Limited Stations**

| Amtrak – Sunset Limited Route | | | |
|---|---|---|---|
| Station | Boardings/Alightings | | Description and Transit Connections |
| | 2012 | 2013 | |
| Alpine, TX (ALP) | 4,416 | 4,921 | • Limited on-site parking<br>• Greyhound Bus Services located 0.5 miles west of station |
| Beaumont, TX (BMT) | 2,724 | 3,458 | • Limited on-site short-term and long-term parking<br>• Greyhound Bus Services located 4 miles northeast of station |
| Del Rio, TX (DRT) | 2,175 | 2,443 | • Limited short-term parking on-site and long-term street parking off-site<br>• Station also services a local bus service<br>• Del Rio International (DRT) Airport is 1.5 miles northwest of the station |
| El Paso, TX (ELP) | 12,329 | 13,093 | • Station also services El Paso Sun Metro local bus and Las Cruces Shuttle<br>• Greyhound Bus Services located 6 blocks east of station |
| Houston, TX (HOU) | 20,327 | 21,617 | • Limited on-site parking<br>• This station has plans to be moved when the new Burnett Plaza station is completed<br>• METRO Rail Light Rail Services (UH-Downtown stop) located 7 blocks northeast<br>• Greyhound Bus Services located 1.6 miles south |
| San Antonio, TX (SAS) | 70,161 | 68,268 | • No on-site parking<br>• VIA Metropolitan Transit Services located 2 blocks north of station<br>• Greyhound Bus Services located 1.2 miles northwest of station<br>• Rio San Antonio River Taxi Services located 0.4 miles west of station |
| Sanderson, TX (SND) | 255 | 261 | Station is a flag stop |

Note:
Any other local transit within 5 miles of the station is listed.

## Heartland Flyer

The Heartland Flyer route includes a 206-mile corridor providing daily service to/from Fort Worth and Oklahoma City. This route is subsidized by TxDOT in partnership with the Oklahoma Department of Transportation (ODOT) with TxDOT contributing approximately $1.4 million annually. The Heartland Flyer provides one trip daily in each direction and serves the Texas cities of Fort Worth and Gainesville, providing connections to the Texas Eagle at Fort Worth (**Figure 4**). In Texas, the Heartland Flyer operates on 72 miles of BNSF Railway (BNSF) track. According to *Amtrak's Fiscal Year 2013 Ridership and Revenue Report*, ridership on the Texas Eagle resulted in a moderate decrease of 7.6% from 87,873 to 81,226 passengers for the period of October 2012 to September 2013. During this same time period, ticket revenue was down -3.0% from $2,086,587 to $ 2,022,956. **Table 4** lists information for each station along the route including location description, boardings and alightings, and transportation connections/transfer options.

**Figure 4. The Heartland Flyer**

**Table 4. Heartland Flyer Stations**

| Amtrak – Heartland Flyer Route | | | |
|---|---|---|---|
| Station | Boardings/Alightings | | Description and Transit Connections |
| | 2012 | 2013 | |
| Fort Worth, TX (FTW) | 141,696 | 129,389 | • Limited on-site parking, long-term parking off-site<br>• Station is an Intermodal Transportation Center that also services Trinity Railway Express (TRE), the Fort Worth Transportation Authority's local bus service (the "T"), Greyhound Bus services, the Lake Worth Shuttle, a bikeshare, and Molly the Trolley |
| Gainesville, TX (GNS) | 8,055 | 6,476 | • Limited on-site parking<br>• Jefferson Lines (Intercity Bus) located 2.1 miles northwest of station |

Note:
Any other local transit within 5 miles of the station is listed.

# 3.0 Unconstrained Needs Determination

The following sections provide an overview of all planned and programmed projects for passenger rail throughout the state of Texas. Section 3.1 identifies the plans reviewed, which served as the basis for the methodology and assumptions used in the unconstrained analysis.

## *3.1 Methodology and Assumptions*

In order to ensure the most current passenger rail system plans were identified in support of the TTP, the latest year documents were compiled and reviewed. This information was supplemented by coordination with TxDOT and other agencies, technical resources, and industry professionals with working knowledge of federal, state and local planning efforts. Table 5 lists the plans and programs that were collected and reviewed for this task.

**Table 5. Reviewed Plans and Programs**

| Agency/Program Name | Documents |
|---|---|
| Amtrak's Texas Eagle, Sunset Limited, Heartland Flyer, Tower 55 Multi-modal Improvement Project, and Southwest Chief | Amtrak Fact Sheet of Texas Ridership, Fiscal Years 2012 and 2013 |
| Dallas Area Rapid Transit (DART) and Fort Worth Transportation Authority's Trinity Railway Express | DART 2030 Transit System Plan, 2012 National Transit Database |
| Denton County Transportation Authority (DCTA)'s A-Train | DCTA Long Range Service Plan, DCTA Comprehensive Annual Financial Report |
| Capital Metropolitan Transportation Authority's MetroRail | Capital Metropolitan Strategic Plan FY2013, Capital Metropolitan Transportation Authority Operating and Capital Budget and Five Year Capital Improvement Plan FY 2014 and ServicePlan2020 |
| Dallas Area Rapid Transit's DART Rail | DART 2030 Transit System Plan, 2012 National Transit Database |
| Metropolitan Transit Authority of Harris County (METRO)'s METRORail | http://www.ridemetro.org/Services/Rail.aspx |

**Table 5. Reviewed Plans and Programs**

| Agency/Program Name | Documents |
|---|---|
| City of Austin's Urban Rail | http://centralaustincdc.org/transportation/austin_urban_rail.htm |
| North Central Texas Council of Governments (NCTCOG)'s Texas Local Option Transportation Act (TLOTA)-formerly Rail North Texas | Regional Rail Corridor Study, Mobility 2035 – 2013 Update, Unified Work Program, TIP 2011-2014 |
| East Texas Council of Governments (ETCG)'s Ark-La-Tex Corridor Council and East Texas Corridor Council (ETCC) | Bossier City-DFW Rail Service, May 1999, http://www.etcog.org/513/About-UsHistory.htm |
| Texas High Speed Rail and Transportation Corporation (THSRTC)'s T-Bone | Texarkana MTP 2035, San Antonio – Bexar Mobility 2035, Dallas – Mobility 2035, Houston MPO 2035 |
| Capital Area Metropolitan Planning Organization (CAMPO) | Annual Project Listing, TIP 2013-2026, Regional Transportation Plan, MTP 2035 |
| Lone Star Rail District (LSRD)'s LSTAR | 2004 Feasibility Study, Station Area Economic Impact Analysis (2006), Financial and Economic Benefits Study (2007) |
| South East Texas Regional Planning Commission MPO (SETRPC-MPO)'s Exempt Project Jefferson-Orange-Hardin Regional Transportation Study | MTP 2035 |
| Abilene MPO's Abilene Metropolitan Area | MTP 2010-2035 |
| Amarillo MPO's Amarillo Urban Transportation Study | MTP 2010-2035 |
| Brownsville MPO | MTP 2010-2035 |
| Bryan/College Station MPO | MTP 2010-2035 |
| Corpus Christi MPO | Long-Range Project Listing, TIP 2013-2016, MTP 2010-2035 |
| El Paso MPO's Horizon | Rail Project Feasibility and Development Report, Transit Corridor Feasibility Study, TIP 2013-2016, Amended Mission 2035 MTP, MTP 2040 |
| Harlingen-San Benito MPO | MTP 2010-2035 |
| Hidalgo County MPO | MTP 2010-2035, MTP Amendment on 07-18-2013 |
| Houston-Galveston MPO's H-GAC | TIP Summarized Project Listing 2012, TIP 2013-2016, 2035 RTP Update |
| Killeen-Temple MPO's Killeen-Temple Urban Transportation Study (K-TUTS) | MTP 2035 |
| Laredo MPO's Laredo Urban Transportation Study | STIP 2013-2026, MTP 2010-2035 |
| Longview MPO | MTP 2035, Traffic Operations Plan |
| Lubbock MPO | MTP 2012-2040 |
| Midland Odessa Transportation Organization (MOTOR) MPO | MTP 2035, 2035 Transportation Plan Update |
| San Angelo MPO | MTP 2010-2035 |
| Alamo Area MPO's Smart Way SA | LRTP, Transit Project Listing, TIP 2015-2018, Mobility 2035 |
| Sherman-Denison MPO's Transportation Outlook | MTP 2035 |
| Texarkana MPO's Texarkana Urban Transportation Study (TUTS) | MTP 2035 |
| Tyler Area MPO | MTP 2035 |

**Table 5. Reviewed Plans and Programs**

| Agency/Program Name | Documents |
|---|---|
| Victoria MPO's Victoria Urbanized Area | MTP 2035 |
| Waco MPO | Unified Planning Work Program FY 2014 & 2015, Connections 2035 (MTP) |
| Wichita Falls MPO | MTP Project List 2010-2020, 2010-2035 MTP Update |

## *3.2 High Speed Rail Initiatives*

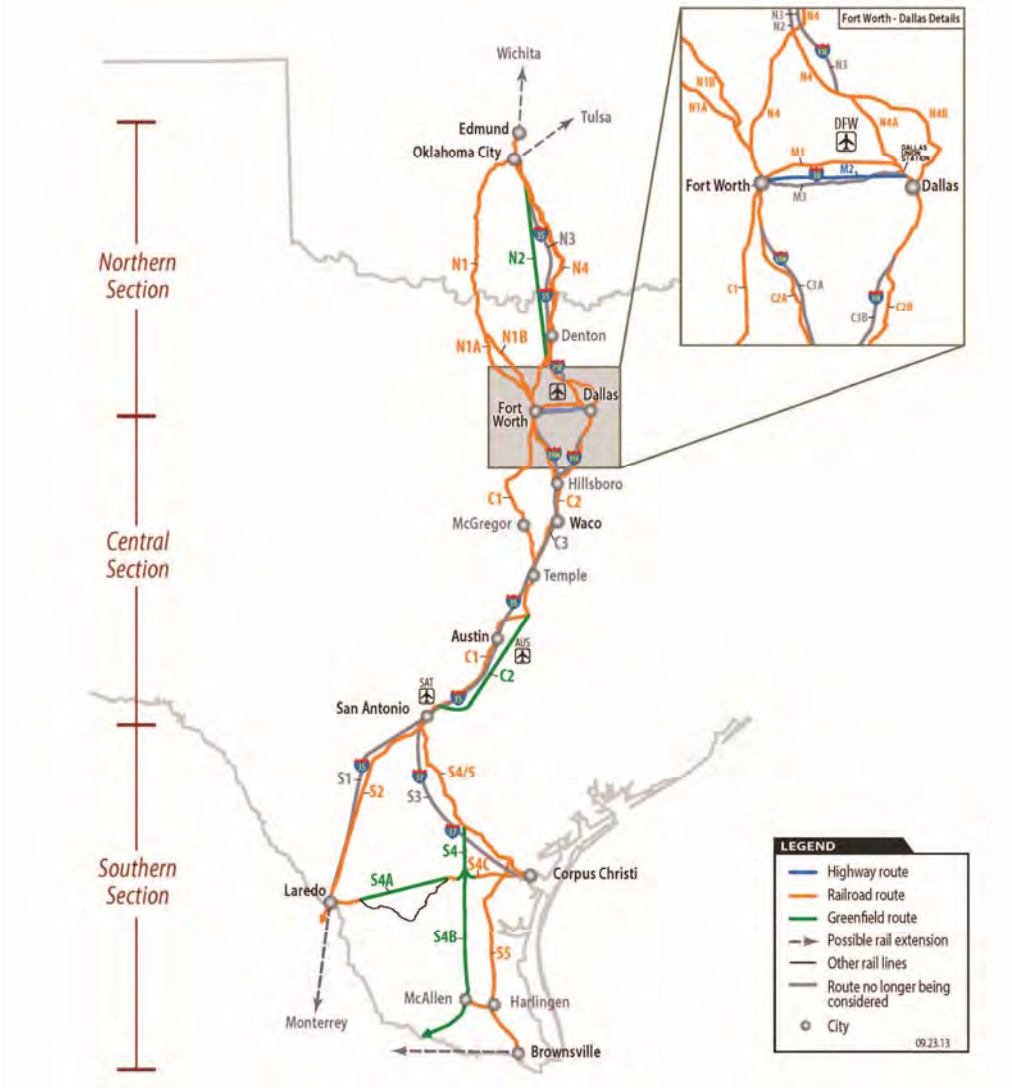
The following sections describe the Texas HSR initiatives, which primarily involve four rail corridors including the Oklahoma City to South Texas corridor, Dallas-Fort Worth to Houston corridor, Austin to Houston corridor, and the Texas "T-Bone" concept.

Two potential HSR corridors are currently being evaluated within the State of Texas, which includes routes from Oklahoma City to South Texas and Dallas-Fort Worth to Houston. TxDOT, in cooperation with the Oklahoma Department of Transportation, is conducting a study to evaluate a range of passenger rail service options in an 850-mile corridor from Oklahoma City to South Texas through the Texas-Oklahoma Passenger Rail Study. Limited information, as discussed below, is available regarding the Texas Central Railway's plans for HSR between Dallas-Fort Worth and Houston. Previous studies include an evaluation of HSR from Austin to Houston and the Texas "T-Bone".

### Oklahoma City to South Texas

The federally funded Texas to Oklahoma Passenger Rail Study (TOPRS) is evaluating a range of passenger rail service options along the 850-mile IH-35 corridor from Oklahoma City to South Texas. The study will end with a service level environmental impact statement (EIS) and service development plan. The study is being conducted to account for the increase in population and employment, with much of its growth occurring in the congested IH-35 corridor area. TxDOT is anticipate to complete the study by December 2014. As part of the National Environmental Policy Act (NEPA) requirements, a service-level environmental impact study (EIS) is documenting the costs, benefits, and impacts of rail route and service alternatives as compared to a no-build, or do nothing, alternative (**Figure 5**). According to preliminary analysis, the project has the potential to serve approximately 3 million riders annually on a combination of the alternatives being considered. Initial cost estimates are estimating the project cost to exceed $11 billion.

**Figure 5. Oklahoma to South Texas HSR Alternatives**




A service development plan will also provide a high-level review of rail needs and potential service options in the corridor. The study could conclude with a decision to advance individual projects for more detailed study or a decision against making further investments in passenger rail in the corridor.

### Dallas/Fort Worth to Houston

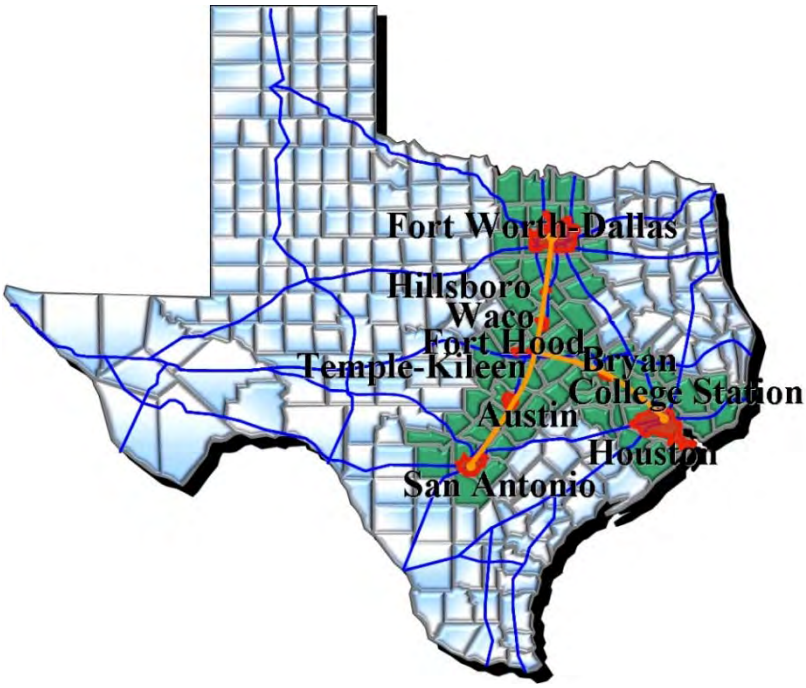
The Texas Central Railway (TCR) is evaluating the feasibility of providing high-speed intercity passenger rail along an approximately 250-mile corridor between Dallas/Fort Worth and Houston, which is considered Phase 1. The project will be privately-funded with $15 million obligated by FRA in federal funding. Preliminary cost estimates are not readily available, but it is anticipated that the project may exceed $10 billion. Moreover, the latest available ridership projections based on a 2009 Study are estimated at approximately 108,000 riders per day in 2025. The Texas Central Railway has identified a second phase of the project that would connect the cities of Austin and

San Antonio to the system along the I-35 corridor. It should also be noted that Memoranda of Understanding are in place with FRA with TxDOT handling the Fort Worth to Dallas section and TCR handling the Dallas to Houston section.

### Texas T-Bone Corridor

The Texas High Speed Rail and Transportation Corporation (THSRTC) has evaluated a high speed rail network referred to as the 'Texas T-Bone'. The Texas T-Bone is a 490-mile corridor that would connect the four largest metropolitan areas in Texas by 2020: Dallas/Fort Worth, San Antonio, Austin, and Houston (**Figure 6**). The corridor would also connect with future and existing transit systems, highways, airports, and seaports. The goal of the system would be to extend into Oklahoma City and into Tulsa, Oklahoma and through Franklin and Bowie Counties into North Little Rock, Arkansas and potentially into Memphis, Tennessee.

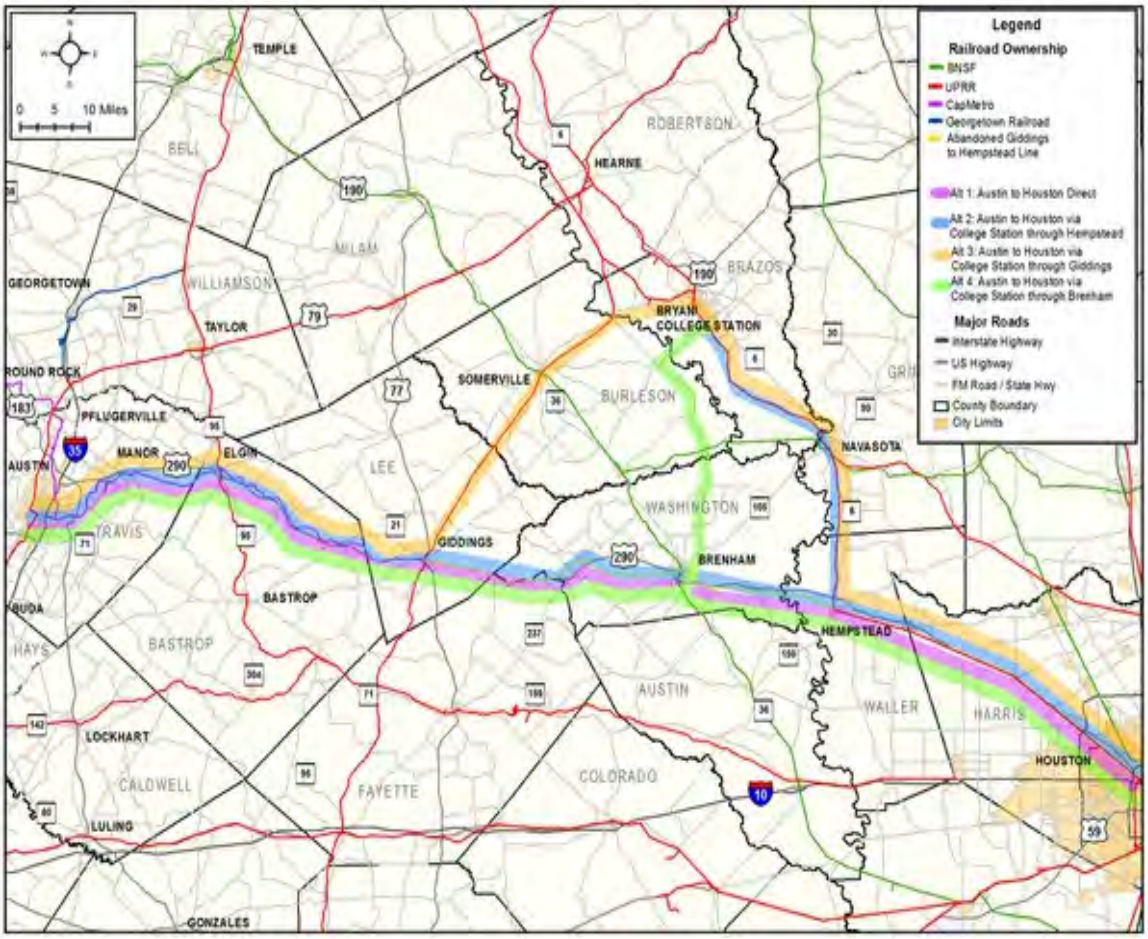
**Figure 6. The 'Texas T-Bone' Corridor**




## *3.3 Others Initiatives – Austin to Houston Passenger Rail Study*

The Austin to Houston Passenger Rail Study was completed in December 2011 and included the evaluation of four alternatives as shown in **Figure 7**. This study involved the evaluation of an intercity passenger rail service from Austin to Houston with speeds of up to 110 mph. The intent of the study was to identify infrastructure needs and did not evaluate environmental impacts or ridership projections. The study identified potential connections in Elgin, Giddings, Brenham, Hempstead and Bryan/College Station. According to the 2011 study, the start-up cost for this system is estimated between $936 million and $1.2 billion.

**Figure 7. Austin to Houston HSR Alternatives**




## 3.4 *Planned Intercity Rail Improvements and Expansions*

The following sections provide an overview of proposed route changes in addition to planned and programmed capital improvements for the three intercity services including rolling stock, stations, track, and signal system upgrades.

### 3.4.1 Planned Amtrak Expansions and Reroutes

Potential expansion, rerouting, and other enhancements to the Texas Eagle, Sunset Limited, and Heartland Flyer Routes are discussed in the following sections:

#### Texas Eagle

Amtrak is in discussions to plan a reroute of its Texas Eagle route between Dallas and Fort Worth to the Trinity Railway Express (TRE). If the Texas Eagle shifts to the TRE route, rail service between Dallas and Houston would be reestablished and several new stops would be implemented. The cost for reroute to the Union Pacific line is estimated to cost approximately $7 million per mile (based on a 2012 study of the Texas Eagle) for a total of nearly $210 million. Signal upgrades and grade

crossing improvements are not included in the cost estimate, which could be upwards of $40-50 million.

Additionally, the City of Longview is experiencing congestion related to freight operations on the existing rail line near the Longview Station. The Longview MPO realizes that future passenger rail is closely tied to freight traffic because they share the same track. In an effort to alleviate congestion, the Longview MPO has identified the need to double track the Union Pacific rail line between Longview and Marshall. This 23-mile existing single track runs parallel to U.S. 80 and is critical to the north, south, east and west of the train junction.

### Sunset Limited

In coordination with the reroute of Amtrak's Texas Eagle, there is potential to develop a passenger rail service between Houston and Dallas. This potential 240-mile intercity rail corridor could shift the need away from short airline trips and has the potential to relieve the two primary air hubs in Texas (DFW International Airport and George Bush Intercontinental Airport).

Amtrak also has a goal to increase passenger service on the Sunset Limited by adding daily passenger service and increasing speeds up to 40 mph. Amtrak is investigating two locations, either between San Antonio and Houston (200 miles) or Houston and New Orleans (350 miles).

### Heartland Flyer

Amtrak has recently completed a project to improve crossing signal timing in the BNSF Fort Worth subdivision on the Heartland Flyer route. Between Fort Worth and Gainesville, signal improvements were implemented to increase the operating speed to 79 mph. TxDOT acquired over $3 million from the FRA to fund the improvements and decrease the overall trip time by approximately 18 minutes. TxDOT recently completed a project with BNSF Railway to improve crossing signal timing at 15 highway-rail grade crossings.

### Southwest Chief

The Southwest Chief is a passenger rail route that presently goes through Chicago and Albuquerque to Los Angeles while traveling north of Texas. Amtrak is currently in discussion with BNSF and other states to reroute Southwest Chief to the new BNSF Transcon route. Cost estimates associated with the reroute exceed $10 million annually for operations and maintenance and include a one-time capital investment of approximately $100,000,000. The Transcon route has the same starting and ending locations as the Southwest Chief route but the Transcon route travels south into Kansas and would allow travel into North Texas. TxDOT has already evaluated potential rail station sites in the Amarillo area in hopes to have access to more passenger rail.

### Dallas/Fort Worth to Arkansas and the Louisiana Border

Although there is currently passenger rail between Dallas and Arkansas and Louisiana along the Texas Eagle route, the East Texas Corridor Council (ETCC) is hoping to improve track infrastructure to accommodate higher speeds. One of the ETCC's long-term goals is to fund a double-tracking of

the Union Pacific (UP) main line between the Metroplex and Arkansas and Louisiana border connections. The I-20 and U.S. 59 (I-69) rail infrastructure upgrade is seen as an incremental step toward higher speed passenger rail.

### 3.4.2 Other Amtrak Proposals

Amtrak is proposing a new connection on their Crescent route. The current Crescent route travels from New York to New Orleans. Amtrak envisions a connection route from Dallas/Fort Worth to Meridian, Mississippi. This plan is supported in East Texas by passenger rail advocates promoting a route between Dallas and Shreveport, Louisiana. TxDOT and Amtrak are currently working together on developing the Texas portion of this route.

Amtrak and TxDOT are also in the process of performing a feasibility study to evaluate new Amtrak service between Bossier City, in Northwest Louisiana to Dallas and Fort Worth. This passenger rail corridor would run along I-20 twice daily with seven intermediate stops. TxDOT requested that locations at DFW Airport (Centre Point), Mesquite, Forney, Terrell and Wills Point be considered during the study. The ETCC received $265,000 in federal funds for the corridor study, which was conducted by Amtrak.

Amtrak is currently discussing a new long-distance route that will travel from Fort Worth to Denver, Colorado. This 840-mile potential rail corridor has been deemed the “Caprock Express” and will travel through the Panhandle of Texas. The route would travel through the cities of Abilene, Lubbock, and Amarillo on the way to La Junta, Colorado Springs, and Denver, Colorado.

TxDOT has partnered with Amtrak to improve infrastructure in San Antonio, including a proposed bypass route for non-local UP freight. San Antonio is planning to reroute freight traffic in the hopes of developing an intercity passenger rail service between Round Rock and San Antonio. If freight traffic is cleared from this rail corridor, it would be possible to provide service on the existing tracks that Amtrak travels now. TxDOT is studying the feasibility of this idea while the rerouting of trains is studied further.

### 3.4.3 Miscellaneous Amtrak Statistics and Improvements

Tables 6 and 7 provide an overview of the 2017 Capital Plan and Funding Source.

**Table 6. 2017 Capital Plan by Asset Type**

| | Capital Plan by Asset Type ($ millions) | | | | | |
|---|---|---|---|---|---|---|
| | FY2013 | FY2014 | FY2015 | FY2016 | FY2017 | Total |
| Track and Other Infrastructure | $628 | $1,421 | $1,385 | $1,067 | $1,330 | $5,830 |
| Rolling Stock Acquisitions | 314 | 608 | 266 | 326 | 468 | 1,981 |
| Rolling Stock Overhauls and Engineering | 235 | 332 | 375 | 290 | 232 | 1,463 |
| Technology Programs | 53 | 82 | 136 | 73 | 71 | 415 |
| Customer Experience Programs | 17 | 42 | 29 | 29 | 22 | 140 |
| Security Programs | 37 | 10 | 13 | | | 60 |
| Environmental Remediation | 5 | 9 | 14 | 18 | 12 | 58 |
| Other | 6 | 8 | 30 | 18 | 15 | 76 |
| **Total Capital Plan** | **$1,295** | **$2,513** | **$2,248** | **$1,820** | **$2,149** | **$10,024** |

**Table 7. 2017 Capital Plan by Funding Source**

| | Capital Plan by Funding Source ($ millions) | | | | | |
|---|---|---|---|---|---|---|
| | FY2013 | FY2014 | FY2015 | FY2016 | FY2017 | Total |
| Federal General Capital | $703 | $2,032 | $1,793 | $1,511 | $1,867 | $7,906 |
| Sandy Capital Relief Appropriation | | 91 | 91 | 19 | 19 | 220 |
| NY-NJ High Speed Rail Grant | 51 | 86 | 130 | 94 | 55 | 416 |
| Railroad Rehabilitation & Improvement Financing | 131 | 70 | 98 | 59 | 1 | 359 |
| DOT Early Buy Out Grant | 110 | | | | | 110 |
| Internal Amtrak Funds | 62 | 1 | | | | 63 |
| Department of Homeland Security | 36 | 10 | 6 | | | 51 |
| State, Local and Other Funds | 202 | 222 | 130 | 137 | 208 | 899 |
| **Total Capital Plan** | **$1,295** | **$2,513** | **$2,248** | **$1,820** | **$2,149** | **$10,024** |

### 3.4.4 Amtrak Rolling Stock Upgrades

Amtrak anticipates that its non-Northeast Corridor (NEC) equipment acquisition during the FY2013 – FY2017 period will consist of completing the acquisition of 130 single-level, long distance passenger cars pursuant to a contract entered into with CAF USA in August 2010. Amtrak anticipates delivery of the first cars for testing by end of calendar year 2014 with the final unit entering revenue service by the end of calendar 2015. The total project cost will be $342.8 million.

The FY2013 payment for acquisition of these cars and related spare parts is being requested as part of the federal capital appropriation request.

Amtrak is also responsible for the condition and reliability of its rolling stock fleet. The fleet is a unique competitive advantage for Amtrak as it provides the basis for daily service and has the capability, if the national network is maintained, to provide "surges" of capacity in response to changes in demand, such as seasonal traffic or disaster relief needs. While the capacity of lines and terminals cannot be changed in the short term, the fleet provides vital flexibility that allows Amtrak to develop or improve service on short timelines, and it is therefore a uniquely important asset. Equipment requires continual maintenance and cannot be purchased on the spur of the moment. Its configuration and operating qualities are long-term factors that can exert major influence on revenues and costs. For these reasons, the fleet requires detailed and careful management. Amtrak's planned FY2013 - FY2017 Fleet Overhaul program calls for $697 million in funding for the non-NEC fleet as shown in the following table. Descriptions of the fleet overhaul programs is provided in Table 8.

Amtrak is migrating from a conventional overhaul philosophy to a Life Cycle Progressive Maintenance (LCPM) program for the non-NEC diesel locomotives, plus modifications required by Federal agencies including the Transportation Safety Administration (TSA), Environmental Protection Agency (EPA), and Federal Railroad Administration (FRA). This program enables Amtrak to maintain the locomotive fleet to a state of good repair, increase locomotive reliability and availability, extend the useful life of the locomotive, comply with applicable federal rules and regulations, and mitigate future expenses associated with an aging fleet.

The passenger car programs fund the various levels of overhauls that range from mandatory maintenance to complete equipment overhauls, reconfigurations and conversions of equipment, and modifications required by statutes including the Americans with Disabilities Act (ADA) and modifications required by the FRA. The non-NEC programs service the Superliner, Auto Carrier, Viewliner, Talgo, Heritage, Horizon, and Surfliner fleets. All car configurations including passenger coach, diner, café/club, lounge, sleeper, and cab cars are included. These passenger car programs enable Amtrak to maintain equipment in a state of good repair, to return the assets to current Amtrak standards, improve reliability and availability of equipment, enhance overall customer experience, comply with applicable federal regulations, and mitigate equipment failures that result in customer discomfort and inconvenience.

**Table 8. Fleet Overhaul Program**

| $ millions | Fleet Overhauls – Federal Capital | | | | | | Other Funds | Fleet Overhauls – Total Funding | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FY2013 | FY2013 | FY2015 | FY2016 | FY2017 | 5 Years | FY2013 | FY2013 | FY2013 | FY2015 | FY2016 | FY2017 | FY2013 | 5 Years |
| Locomotives – non-NEC | 29 | 41 | 27 | 35 | 30 | 162 | | 29 | 41 | 27 | 35 | 30 | | 162 |
| Superliner | 54 | 64 | 106 | 95 | 90 | 410 | 3 | 57 | 64 | 106 | 95 | 90 | | 413 |
| Auto Carrier | 1 | | 7 | 1 | 1 | 10 | | 1 | | 7 | 1 | 1 | | 10 |
| Heritage | 3 | 2 | 1 | | | 6 | | 3 | 2 | 1 | | | | 6 |
| Horizon | 7 | 8 | 12 | 9 | 9 | 44 | | 7 | 8 | 12 | 9 | 9 | | 41 |
| Surfliner | 4 | 1 | 5 | 4 | 4 | 18 | | 4 | 1 | 5 | 4 | 4 | | 18 |
| Talgo | 1 | 1 | 1 | | | 2 | | 1 | 1 | 1 | | | | 2 |
| Viewliner | 8 | 9 | 9 | 8 | 8 | 42 | | 8 | 9 | 9 | 8 | 8 | | 42 |
| **Total Overhauls non-NEC** | **$106** | **$126** | **$168** | **$152** | **$142** | **$694** | **$3** | **$109** | **$126** | **$126** | **$152** | **$142** | | **$697** |

### 3.4.5 Amtrak Station Improvements

Amtrak is currently upgrading five stations on the three routes throughout the state of Texas as part of the Accessible Stations Development Program (ASDP). The plan is based on funding at the average annual rate of approximately $50 million over the next several years, to support such station work as ASDP, passenger information display systems, and a platform gap solution. The five stations currently under design, as of the date of this report, include the Alpine Station, McGregor Station, Marshall Station, Longview Station, and Houston Station.

### 3.4.6 Amtrak Positive Train Control

Positive Train Control (PTC) is a communication system that has the potential to improve traditional collision prevention measures and adds automated protection by enforcing permanent and temporary speed restrictions. On January 15, 2010 the FRA issued its PTC Rule which, pursuant to the Rail Safety Improvement Act of 2008, requires Class I railroads and each railroad hosting intercity or commuter rail passenger service to have a PTC system installed and operating by December 31, 2015. This is applicable for all main lines, which are defined as having five million or more gross tons of railroad traffic annually or used for intercity or commuter rail passenger service.

According to Amtrak's Fiscal Years 2013 – 2017 Five Year Plan, "Additional funding to fully comply with PTC requirements is necessary. It is important to note that compliance with PTC requirements on the host railroads outside of the NEC could drive significant costs to Amtrak. Amtrak's contribution to PTC installation and maintenance on host railroad property will be based on the federal statute governing 'incremental costs,' which are costs incurred by hosts solely as a result of Amtrak's presence. Changes in freight and passenger traffic on Class I host railroad lines could cause changes to PTC requirements. If those incremental costs can be attributed solely to Amtrak's operations on the property, the company could be responsible for significant costs outside of its own infrastructure."

### 3.4.7 Amtrak Expenditures and Projected Ridership

Amtrak's five-year capital program proposals total $10.024 billion. Expenditures for the Texas routes are summarized in **Table 9.** The majority of this program is dedicated to infrastructure improvements, the acquisition of rolling stock including exercising buyout options on leased equipment, overhauling existing rolling stock, and technology investments.

**Table 9. 2017 Statistics By Route**

| $ millions except Contr./(Loss) per Rider | Ridership | Revenue | Expense | Allocation of Federally Funded Capital Projects(2) | Contr./(Loss) per Rider | Avg. PM per Core employee (000's)(3) | Avg. SM per Core employee (000's)(3) |
|---|---|---|---|---|---|---|---|
| Texas Eagle | 356,056 | $34.0 | $72.0 | $10.7 | ($106.69) | 42 | 54 |
| Sunset Limited | 110,166 | $15.4 | $62.8 | $10.0 | ($430.22) | 21 | 39 |
| Heartland Flyer | 94,628 | $8.7 | $10.5 | $1.8 | ($18.88) | 24 | 48 |

Notes:

(1) Budget route results are projected based on APT historical ratios. Expenses exclude depreciation, accruals for post-retirement benefits, non-capitalizable project costs, and interest expense.

(2) This represents the allocation of Federally Funded Capital Projects to Routes.

(3) Employee data is not aggregated by route in Amtrak's Financial Systems. The data presented here is based on an allocation of Core employees based on total costs of each route.

PM = Passenger Miles

SM = Seat Miles

### 3.4.8 Tower 55

The Tower 55 Multimodal Improvement Project is focused on improvements around a rail intersection known as Tower 55. The project is composed of improvements to bridges and underpasses, city streets and intersections, emergency vehicle access, and rail capacity, including a new track, a new interlocker, approach trackage, and signaling. These improvements will happen along Burlington Northern and Santa Fe Railway's (BNSF) Fort Worth and Wichita Falls Subdivisions and in Union Pacific's (UP) Duncan, Choctaw, Fort Worth and Dallas Subdivisions. One of the goals of the project is to reduce delays and improve on-time performance for the Heartland Flyer and Texas Eagle routes. The project is fully funded, with $65 million combined from BNSF and UP Railroad and $34 million from a TIGER grant awarded to TxDOT. TxDOT and the City of Fort Worth also provided $1 million each.

### 3.4.9 Miscellaneous Improvements

BNSF plans to invest approximately $240 million on maintenance and rail capacity expansion projects in Texas. These capacity improvement projects include expansion of rail capacity at Tower 55 in Fort Worth, completing replacement of the Galveston Causeway Bridge, installation of a siding extension near Somerville, expansion of the Houston Intermodal Facility, construction of a loop track facility in San Antonio, and signal upgrades for positive train control. BNSF will continue its track maintenance program, which includes an estimated 4,400 miles of track improvements including the replacement of about 115 miles of railroad.

## 3.5 Methodology and Assumptions

The following section reviews the methodology and assumptions used to assess existing conditions and predict future conditions for passenger rail service.

### 3.5.1 Project Identification and Consideration

The projects identified in Section 3.1 were identified and considered for reasonability and feasibility based on factors such as maintenance of an existing route, planned expansion, and implementation of the new system. These projects were then further considered on the basis of cost and current stage of project development. These qualitative measures were supplemented by discussions with project stakeholders, the TxDOT rail office, and desktop research to determine what projects should be included in the unconstrained needs analysis in the 2040 forecast year.

## 3.6 Unconstrained Needs to 2040

### 3.6.1 Amtrak Expansions

The following Amtrak expansions were identified for consideration into the Metro Quest Tool.

1. Southwest Chief Reroute
    a. Reroute through southern Kansas, the Texas Panhandle, and eastern New Mexico
    b. $10 million annual O&M / $100,000,000 capital investment
    c. Estimated Ridership: 102,924 annual trips, based on 2013 ridership
2. Heartland Flyer
    a. Existing route from Fort Worth to Oklahoma City
    b. Annual TxDOT contribution: $1.4 million on average annually
    c. Estimated Ridership: 81,226 annual trips, based on 2013 ridership
3. Texas Eagle Reroute
    a. Relocate Texas Eagle on Union Pacific's line between Dallas and Fort Worth
    b. Estimated cost: $7 million per mile (based on a 2012 study of the Texas Eagle) x 30 miles = $210 million. Signal upgrades and grade crossing improvements not included in the cost estimate, which could be estimated at $40-50 million.
    c. Estimated Ridership: 340,081 annual trips, based on 2013 ridership
4. Sunset Limited Reroute
    a. Introduce new service from Houston to Dallas/Fort Worth
    b. Estimated cost: Cost not available
    c. Estimated Ridership: 102,924 annual trips, based on 2013 ridership

### 3.6.2 High Speed Rail

The following High Speed Rail projects were identified for consideration into the Metro Quest Tool.

1. TOPRS (assumes Higher Speed Rail)
    a. 850-mile corridor from South Texas to Oklahoma City, Oklahoma
    b. Estimated cost: $11 billion (combination of alternatives – northern, central, and southern)
    c. Estimated Ridership: 3 million annual riders (combination of alternatives – northern, central, and southern)
2. Texas Central Railway HSR
    a. 250-mile corridor between Dallas/Fort Worth and Houston
    b. Estimated cost: $10-$12 billion
    c. Estimated Ridership: 108,000 riders per day in 2025 based on a 2009 Study, per the Texas Rail Plan

## 4.0 Anticipated State Contributions for passenger rail

As previously mentioned, TXDOT contributes approximately $1.4 million annually to the Heartland Flyer route which consists of an approximately 206-mile route that provides daily service to/from Fort Worth and Oklahoma City. In addition, TxDOT contributed $1 million for the Tower 55 improvement project. It is anticipated that additional state funding for capital and operations and maintenance costs will be required for the TOPRS project in addition to other major investments in passenger rail services as projects are identified.

## 5.0 Financial and Funding Considerations Summary

Due to the nature of funding sources for existing and planned and programmed for intercity passenger rail services, the future condition for this mode is largely dependent on appropriations from the United States Congress via FRA funding, various federal grants, and, in the case of High Speed Rail, private funding sources and investors. Therefore, the information contained herein is intended to provide an overview of identified planning-level cost estimates for various passenger rail projects and associated infrastructure to support these services.

# Texas Transportation Plan

## Tech Memo 6: Highway Pavement Modal Profile

August 15, 2014

## Acknowledgements

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## 1.0 Introduction

The Texas Transportation Plan (TTP) 2040 is the official statewide long-range transportation plan to document the 2014 to 2040 needs to provide and maintain a multimodal transportation system serving passenger travel and freight movement needs in Texas.

Texas has the largest highway system in the nation. As an important asset of that system, highway pavements account for most of the linear length of the highway system. The pavements are aging while freight movement in Texas continues to grow. Therefore, it is vital to maintain highway pavements in good condition to provide an acceptable level of service for passengers and freight.

In supporting the TTP, this technical memorandum describes the existing condition of Texas pavements and presents unconstrained needs as well as financially-constrained needs assessments through 2040 for the existing on-system pavements. In the needs assessment process, to make the best use of limited resources, a performance-based decision-making methodology was applied to link pavement State-of-Repair with investment levels.

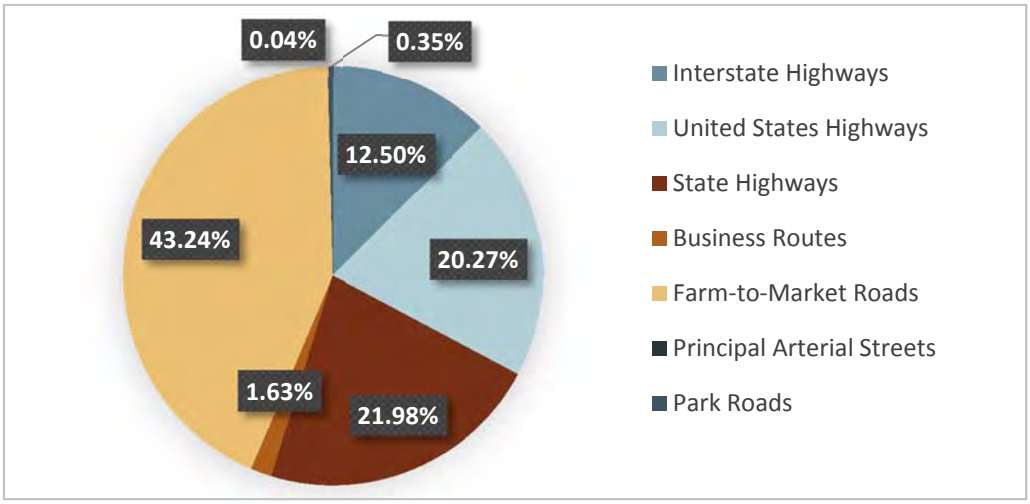
## 2.0 Overview of Existing Conditions

The Texas Department of Transportation (TxDOT) maintains a Pavement Management Information System (PMIS), which maintains the basic inventory information and the annual condition inspection data for all on-system pavements. Based on PMIS, in 2013, TxDOT owns/maintains 197,201.8 lane miles of pavements. **Table 1** presents the lane miles for each highway system. **Figure 1** shows the share of each particular highway system. The Farm-to-Market Road System has the largest share (43.24 percent) and has around 85K lane miles. The Interstate Highway System has 24.65K lane miles and accounts for 12.5 percent.

**Table 1. Texas Highway Lane Miles by Highway System 2013**

| Highway System | Lane Miles |
|---|---|
| Interstate Highways | 24,650.0 |
| United States Highways | 39,964.8 |
| State Highways | 43,352.2 |
| Business Routes | 3,210.2 |
| Farm-to-Market Roads | 85,262.0 |
| Principal Arterial Streets | 79.8 |
| Park Roads | 682.8 |
| **Total** | **197,201.8** |

**Figure 1. Texas Highway Shares by Highway System 2013**



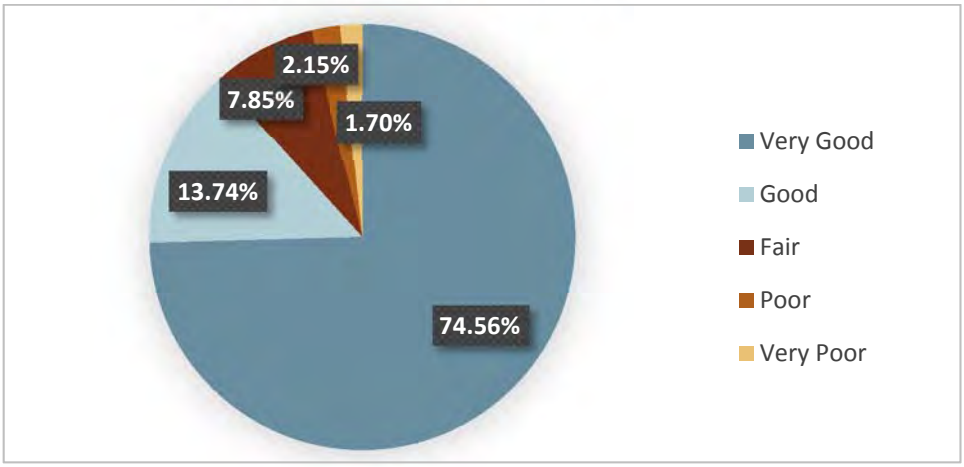

In Texas, there are three types of pavements: Flexible or Asphalt Concrete Pavement (ACP), Continuously Reinforced Concrete Pavement (CRCP), and Jointed Concrete Pavement (JCP). **Table 2** presents the lane-miles for each type of pavement. More than 90 percent of the pavements are asphalt concrete pavements.

**Table 2. Texas Highway Pavement Miles by Pavement Type 2013**

| Pavement Type | Lane Miles | Percentage |
|---|---|---|
| Flexible or Asphalt Concrete Pavement | 179,599.9 | 91.1% |
| Continuously Reinforced Concrete Pavement | 13,778.7 | 7.0% |
| Jointed Concrete Pavement | 3823.2 | 1.9% |
| **Total** | **197,201.8** | **100.0%** |

Based on the condition inspection data in PMIS, the State-of-Repair of Texas pavements in 2013 is shown in **Figure 2**. Pavements rated "Good" or better total 88.3 percent.

**Figure 2. Texas Highway State-of-Repair 2013**




# 3.0 Unconstrained Needs Determination

## *3.1 Methodology and Assumptions*

### 3.1.1 Defining "Needs" and State-of-Good Repair

Pavement Condition Score is used as the primary performance measure for assessing pavement conditions in the Texas Transportation Plan (TTP). It is an overall pavement condition index in the TxDOT PMIS and combines the evaluations of all types of pavement distresses and ride quality to form a single index ranging from 1 (very poor) to 100 (very good). The classes of Pavement Condition Score are presented in **Table 3**. The pavements in "Good" or better condition by Pavement Condition Score are considered as in State-of-Good-Repair in Texas.

**Table 3. Pavement Condition Score Classes**

| Pavement Condition Score | Description |
|---|---|
| 90 - 100 | Very Good |
| 70 - 89 | Good |
| 50 - 69 | Fair |
| 35 - 49 | Poor |
| 1 - 34 | Very Poor |

Pavement International Roughness Index (IRI) is used as a secondary performance measure in the TTP. IRI is a standard measure of pavement roughness and is incorporated into the Pavement Condition Score in the form of pavement ride quality. However, MAP-21 requires the use of IRI as the national pavement performance measure. Therefore, IRI is used as a secondary performance measure in the TTP to report pavement roughness. TxDOT also defines the pavement classes based on IRI for the Interstate System and Non-Interstate National Highway System (NHS) using the

definition shown in **Table 4** (Source: TxDOT Performance Measures, Texas Department of Transportation, 2013). The pavements in "Good" condition by IRI are considered as in State-of-Good-Repair for Texas NHS in TTP.

**Table 4. IRI Classes for NHS**

| Pavement Condition (IRI) | Description |
|---|---|
| < 95 | Good |
| 95 – 170 | Fair |
| >170 | Poor |

### 3.1.2 Investment Identification

Pavement unconstrained needs refer to the pavement treatments and timings that maintain pavements in good condition without considering budget limitations. Pavement treatments can be divided into two groups: (1) routine maintenance (RM) and (2) preventive maintenance and rehabilitation (M&R). Routine maintenance is typically conducted to repair localized failures to prevent further deterioration of roadways. Examples of routine maintenance activities include crack sealing, pothole repair, and edge repair. Preventive maintenance, rehabilitation, and replacement are more expensive and extensive pavement treatments to restore pavement's functional and structural condition.

Since routine maintenance is conducted with regularity, the average annual cost over the past five years was used for the routine maintenance cost estimation.

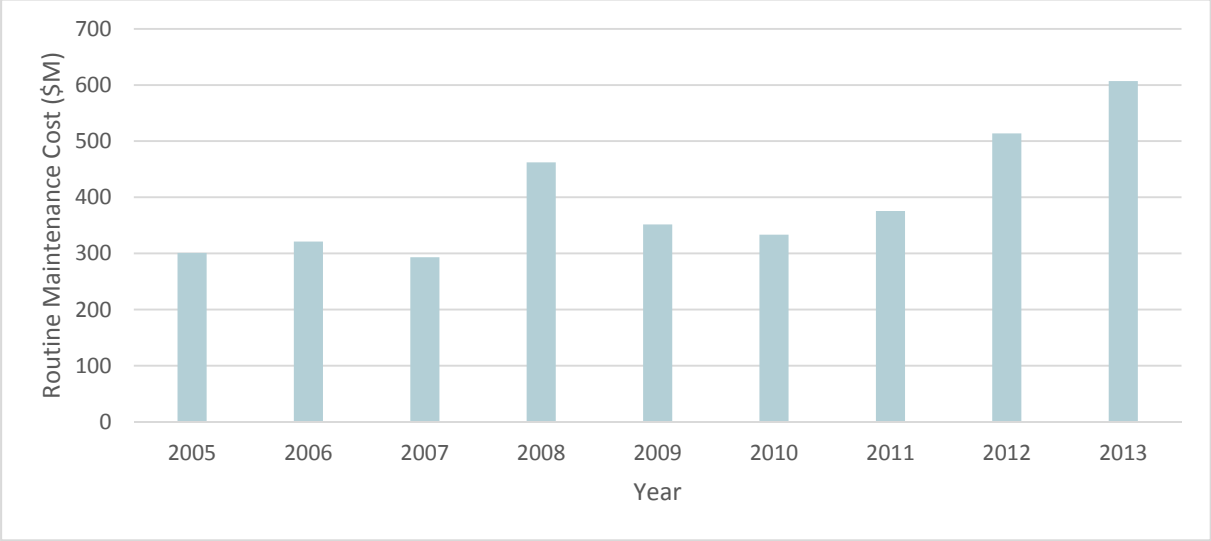
The decision trees presented in Tech Memo 3 were used to identify the preventive maintenance and rehabilitation needs. Decision trees provide a methodology to identify the most effective treatment based on pavement distresses and ride quality. Pavement preventive maintenance and rehabilitation needs assessment can be conducted both at the project level and network level. At the project level, decision trees are used to identify treatments for each pavement section based on predicted pavement condition. However, during the planning horizon, there could be several possible combinations of treatments and timings. Life-cycle cost analysis was applied to identify the optimal set of treatments and corresponding timings that can minimize the life-cycle cost of the pavements while maintaining the pavement sections in good condition. The sum needs of all the pavement sections represent the unconstrained pavement needs for the entire network.

## 3.2 *Unconstrained Needs to 2040*

### 3.2.1 Routine Maintenance

PMIS documents routine maintenance cost for every on-system pavement segment. **Figure 3** summarizes the annual pavement routine maintenance costs of the entire network from 2005 to 2013. The average annual routine maintenance cost over the past 5 years is about $436M (in 2014 dollars).

**Figure 3. Annual Pavement Routine Maintenance Costs (in 2014 dollars)**




### 3.2.2 Preventive Maintenance and Rehabilitation

The unconstrained needs assessment was conducted based on the existing pavement condition and pavement treatment decision tree. The annual preventive maintenance and rehabilitation costs are presented in **Figure 4**. Under this unconstrained needs assessment, 100 percent of the pavements are in "Good" or better condition. The needs fluctuate across the planning horizon and are larger at the beginning due to the existing backlogs. The overall needs for preventive maintenance and rehabilitation through 2040 are $99.94B.

**Figure 4. Annual Pavement Preventive Maintenance and Rehabilitation Needs (in 2014 dollars)**

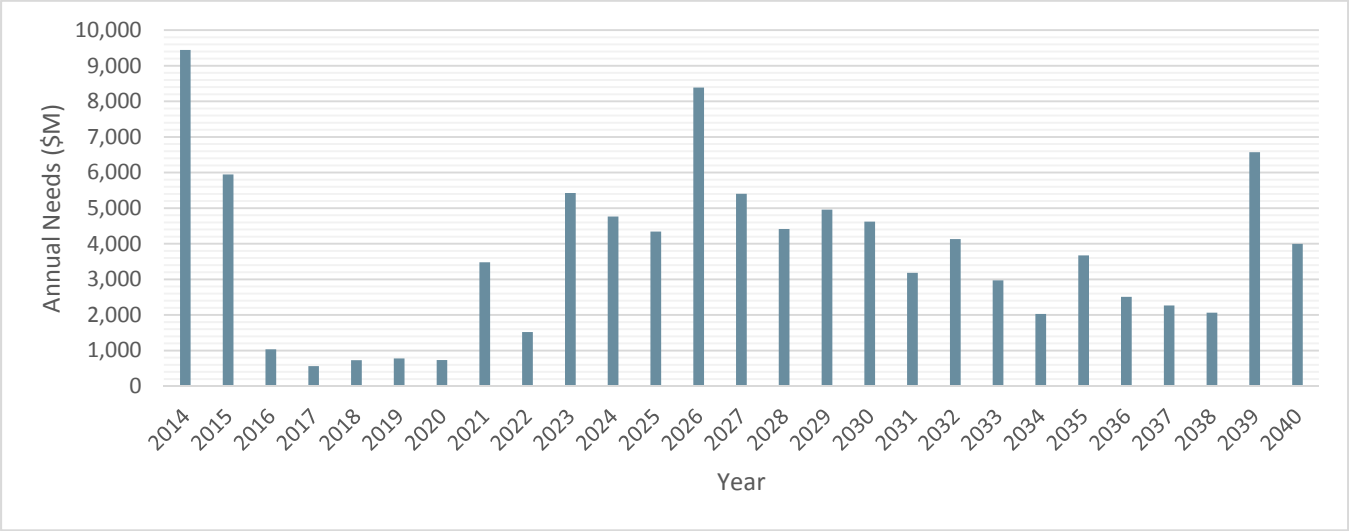
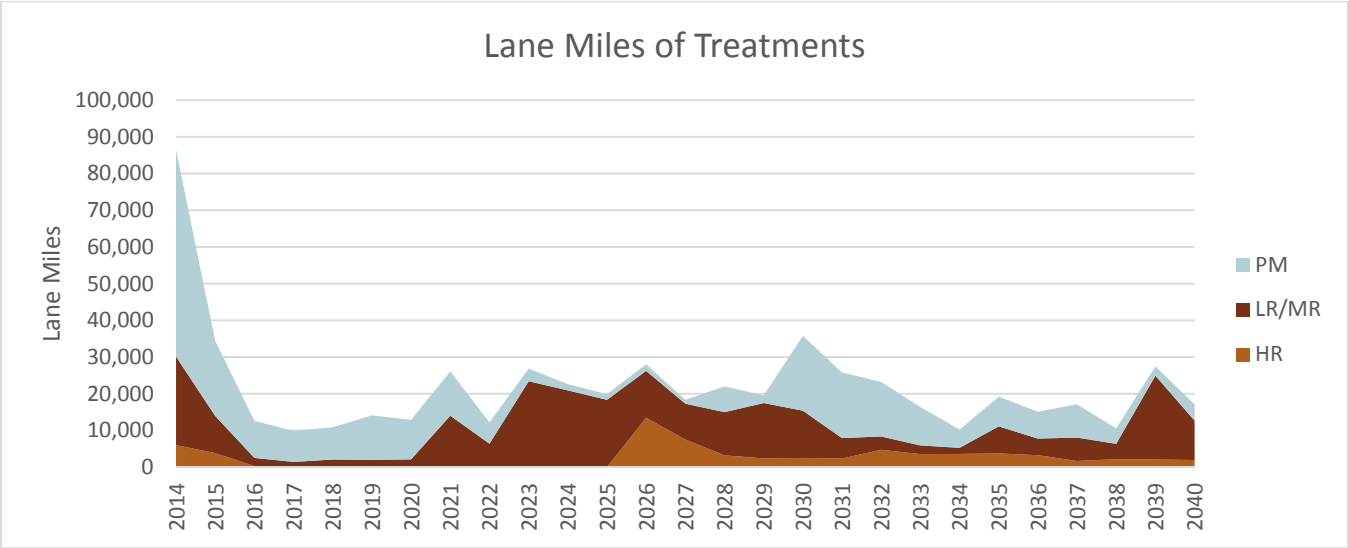



**Figure 5** shows the unconstrained needs (lane miles of treatments) by treatment type. There are large needs (lane miles of treatments) at the beginning, which corresponds to the large needs (in $) at the beginning in **Figure 4**. Overall, most of the treatment needs (lane miles) are preventive maintenance (PM) and light/medium rehabilitations (LR/MR). This is consistent with common sense that it is better to conduct more preventive maintenance and light/medium rehabilitations, rather than to perform expensive heavy rehabilitation (HR) (i.e., replacement).

**Figure 5. Lane Miles of Treatment Needs by Treatment Type**



Correspondingly, **Table 5** presents the unconstrained needs by treatment type. About 60 percent of the costs go to light/medium rehabilitation.

**Table 5. Summary of Unconstrained Needs by Treatment Type**

| | Preventive Maintenance | Light/Medium Rehabilitation | Heavy Rehabilitation |
|---|---|---|---|
| Total Cost | $7.72B | $59.51B | $32.72B |

**Table 6** summarizes the unconstrained pavement needs through 2040. It shows that the total needs through 2040 are $111.71B (in 2014 dollars), about $4.14B per year. **Table 7** presents the needs by highway system.

**Table 6. Summary of Unconstrained Needs through 2040**

| Category | 2014-2040 Needs | Equivalent Annual Needs |
|---|---|---|
| Routine Maintenance | $11.77B | $0.436B |
| Preventive Maintenance and Rehabilitation | $99.94B | $3.70B |
| **Total** | **$111.71B** | **$4.14B** |

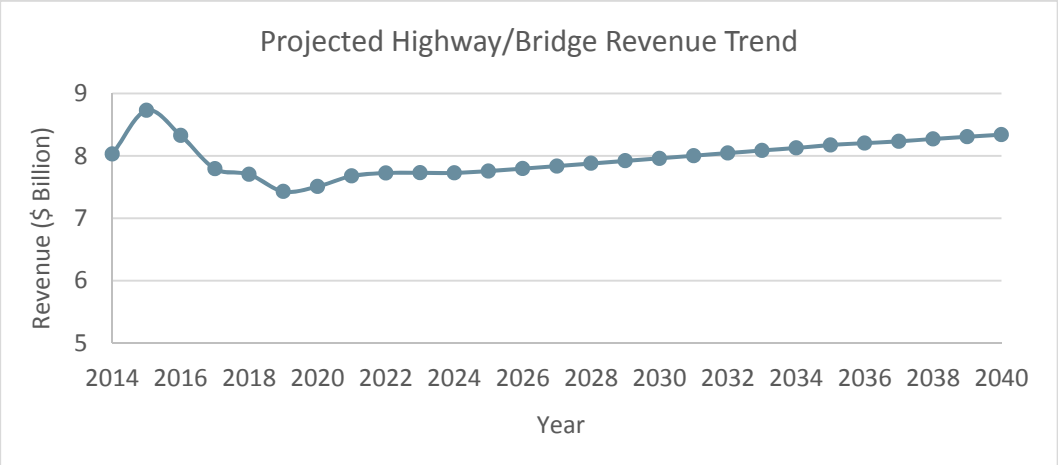
**Table 7. Unconstrained Pavement Needs by Highway System**

| Highway System | Needs in 2014$ |
|---|---|
| NHS Interstate | $18.09B |
| NHS Non-Interstate | $24.80B |
| Non-NHS | $68.82B |
| Statewide | $111.71B |

## 4.0 Anticipated Revenues and Funding Gap

The main funding sources for the highway/bridge mode are state motor fuel tax, FHWA reimbursements, and vehicle registration fees. The revenue forecasting team has finished 2014-2040 revenue projection for the TTP, which has been approved by TxDOT for public outreach. The predicted revenue trend for highway/bridge is presented in **Figure 6**. The average revenue is $8B/year, which is then distributed to three areas: pavements, bridges/culverts, and highway expansion. The share for pavement projects is $2.75B/year. Compared to the unconstrained needs, $4.14B/year, the funding shortfall is approximately $1.39B/year.

**Figure 6. Highway/Bridge Revenue Forecasting 2014-2040**




# 5.0 Fiscally-Constrained Analysis

## *5.1 Project Prioritization/Optimization*

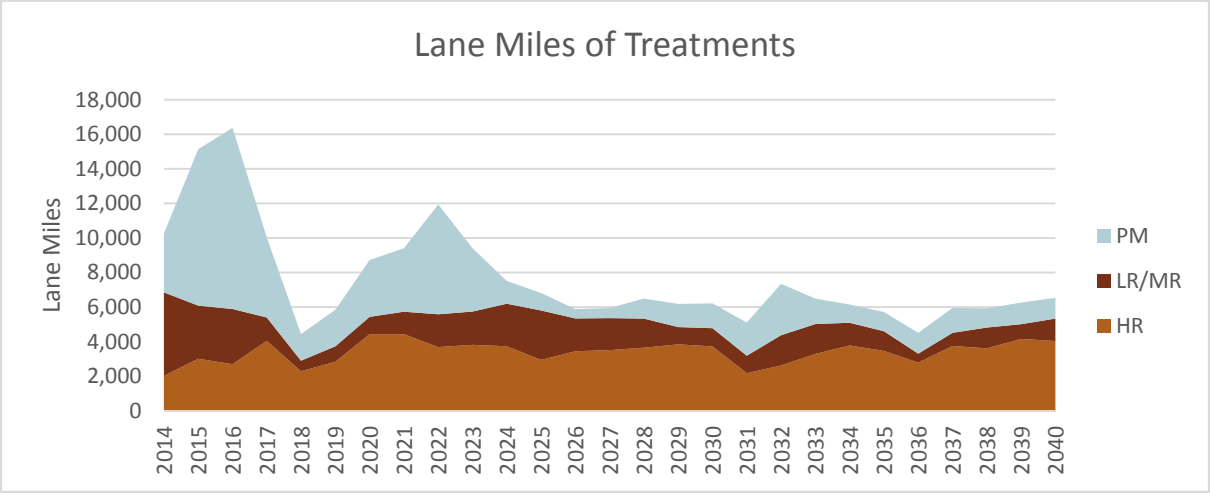
As shown in Section 4, the predicted revenue is not enough to cover the unconstrained needs, so a financially-constrained analysis is necessary to identify the best utilization of the limited budget. Using the methodology presented in Tech Memo 3 for this process, the prioritization/optimization techniques identified alternatives to optimize the pavement performance under the limited budget.

In the project prioritization process, the routine maintenance budget is first set aside from the total budget; the remaining budget is then used for the prioritization for all the preventive maintenance and rehabilitation projects. In addition, to avoid "Very Poor" pavements, the pavements with "Very Poor" condition will have a high programming priority.

The predicted budget for pavements is $2.75B/year. The routine maintenance budget is $436M/year; thus, the budget for preventive maintenance and rehabilitation is $2,314M/year. At this budget level, the financially-constrained needs assessment was conducted.

**Figure 7** presents the lane miles of each type of treatment during the planning horizon. Compared to unconstrained needs in **Figure 5**, the total lanes miles of pavements that receive treatments are fewer. It also shows that, among the pavements receiving treatment, a higher proportion of pavements received HR (heavy rehabilitation) than in the unconstrained needs (**Figure 5**). This is because when the budget is not enough to cover all the PM and LR/MR in the unconstrained needs, some pavement treatments are delayed to a point when the pavement deteriorates to such a bad condition (for example, "Very Poor" condition) that only HR can be applied.

**Figure 7. Lane Miles of Treatment Needs (Constrained) by Treatment Type**




Correspondingly, for the fiscally-constrained analysis, the summary of pavement treatments is presented in **Table 8**. By comparing **Table 5** and **Table 8**, it can be seen that, in unconstrained needs (**Table 5**), about 60 percent of the costs go to light/medium rehabilitation. However, in constrained needs (**Table 8**), more than 75 percent of the costs go to heavy rehabilitation. As explained previously, this is because the delay of LR/MR treatments causes some pavements to deteriorate to such a condition that only HR can be applied. **Table 9** presents the constrained needs by highway system. Compared with the unconstrained needs (**Table 7**), the Non-NHS decreases the most.

**Table 8. Summary of Constrained Needs by Treatment Type**

| | Preventive Maintenance | Light/Medium Rehabilitation | Heavy Rehabilitation |
|---|---|---|---|
| Total Cost ($B) | $2.10B | $10.78B | $49.60B |

**Table 9. Financially-Constrained Pavement Needs by Highway System**

| Highway System | Needs in 2014 Dollars |
|---|---|
| NHS Interstate | $15.12 B |
| NHS Non-Interstate | $22.26 B |
| Non-NHS | $36.87 B |
| Statewide | $74.7 B |

The State-of-Repair based on Pavement Condition Score for the financially-constrained analysis is presented in **Figure 8**. Under the constrained needs, about 65 percent of pavements would be in "Poor" or "Very Poor" condition in 2040. Correspondingly, the percentage of pavements in "Good" or better condition is show in **Figure 9**. Compared to the unconstrained needs, where 100 percent of pavements would be in "Good" or better condition, it can be seen that by 2040, only around 35 percent of pavements will be in "Good" or better condition.

**Figure 8. Pavement State-of-Repair under Constrained Needs**

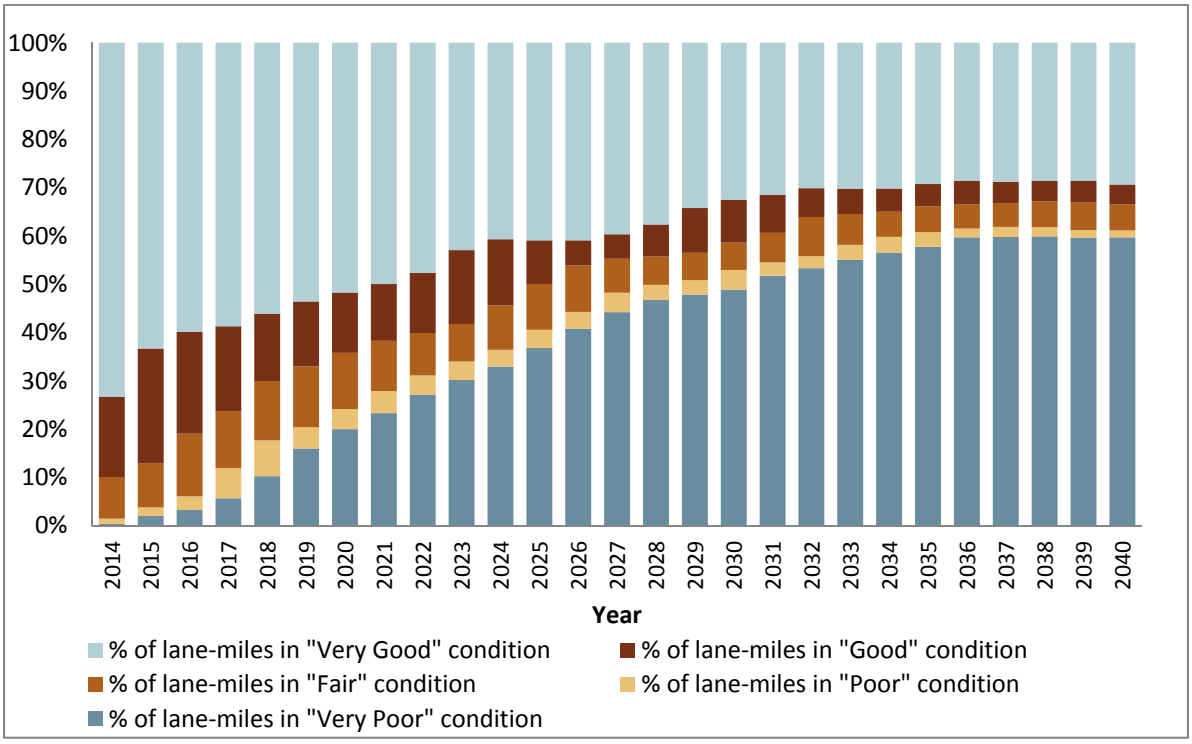



**Figure 9. Percentage of Pavements in "Good" or Better Condition under Constrained Needs**

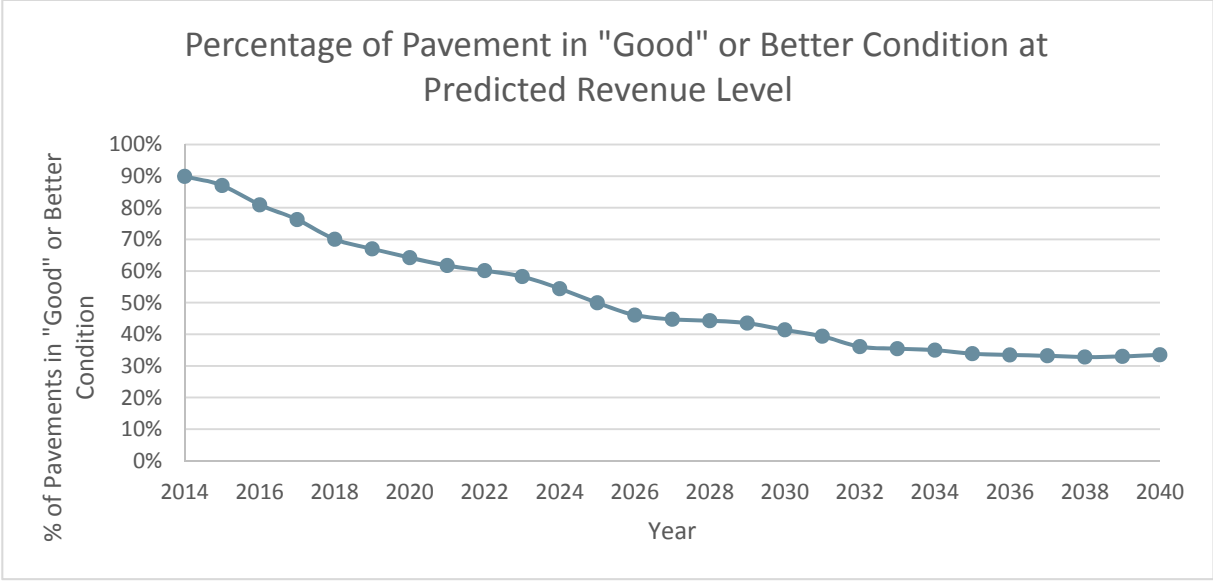
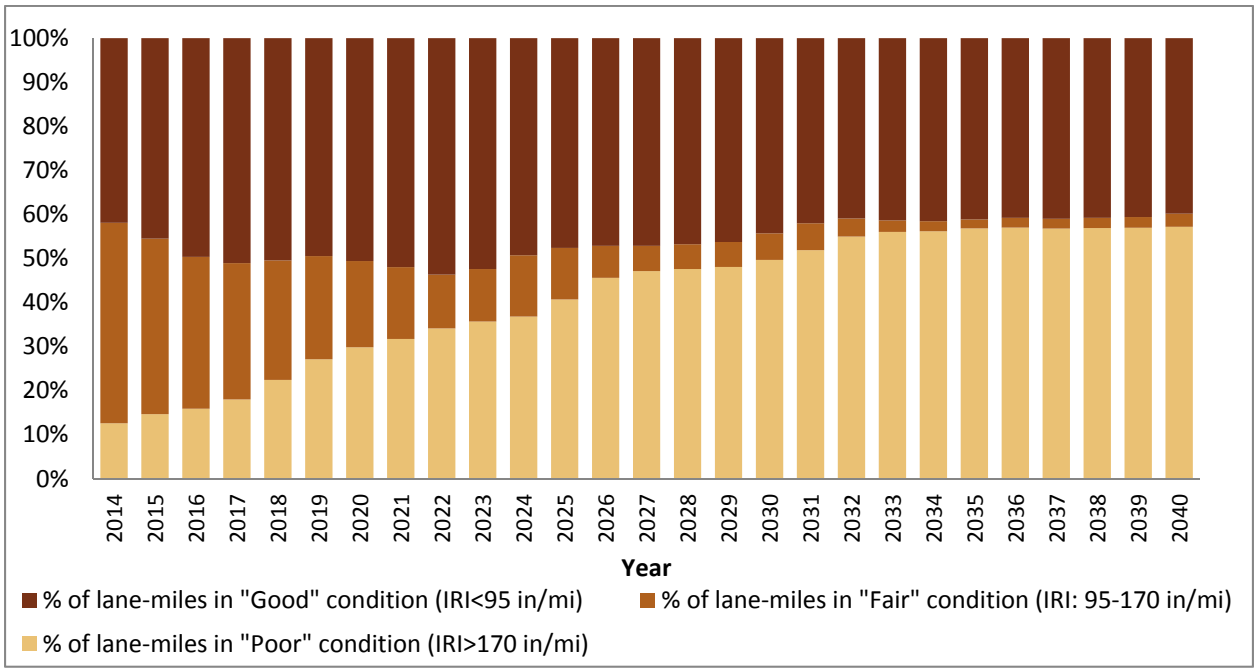


**Figure 10** presents the State-of-Repair based on IRI for the financially-constrained needs assessment. By 2040, more than 55 percent of pavements would be in "Poor" condition based on IRI.

**Figure 10. Pavement State-of-Repair by IRI under Financially-Constrained Needs**




Fortunately, MAP-21 only sets the State-of-Repair definition for Interstate and Non-Interstate NHS. **Figures 11** and **12** present the State-of-Repair based on IRI for the Interstate System and for Non-Interstate NHS, respectively. Still, about 35 percent of Interstate and 30 percent of Non-Interstate NHS pavements would be in "Poor" condition by 2040.

**Figure 11. Interstate Pavement State-of-Repair based on IRI**

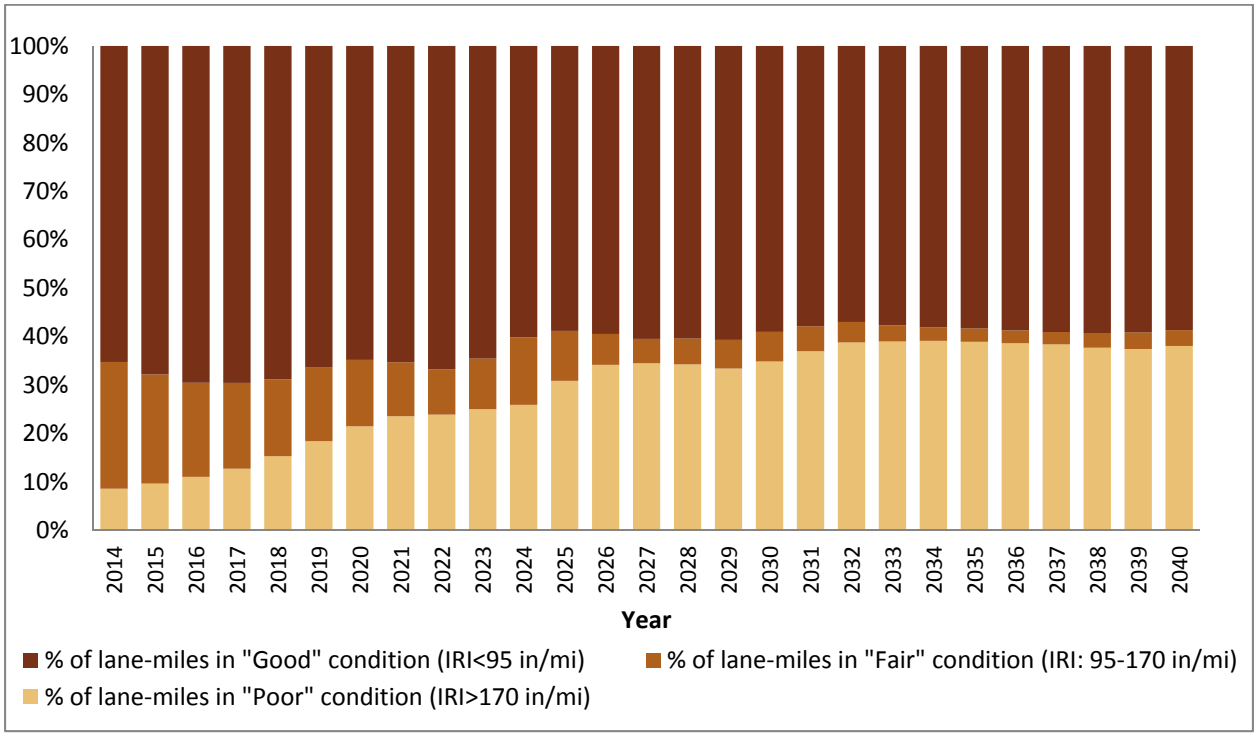
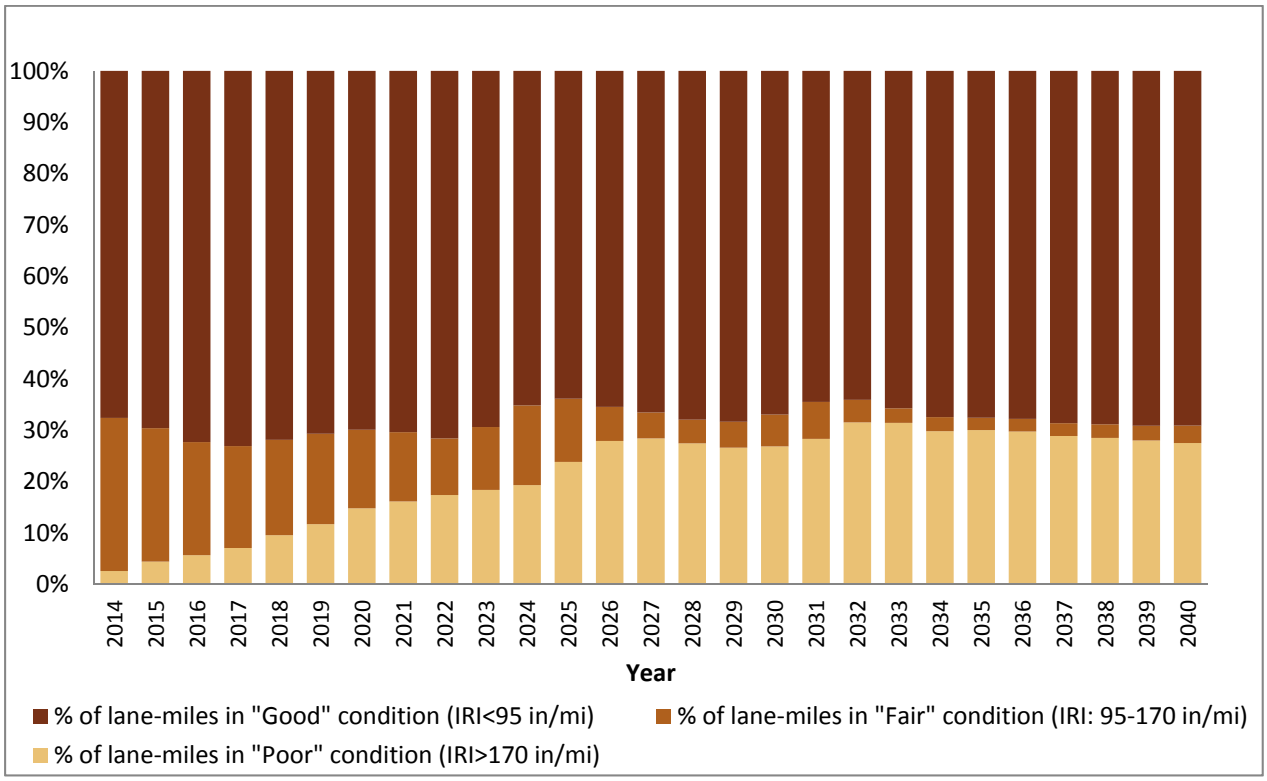
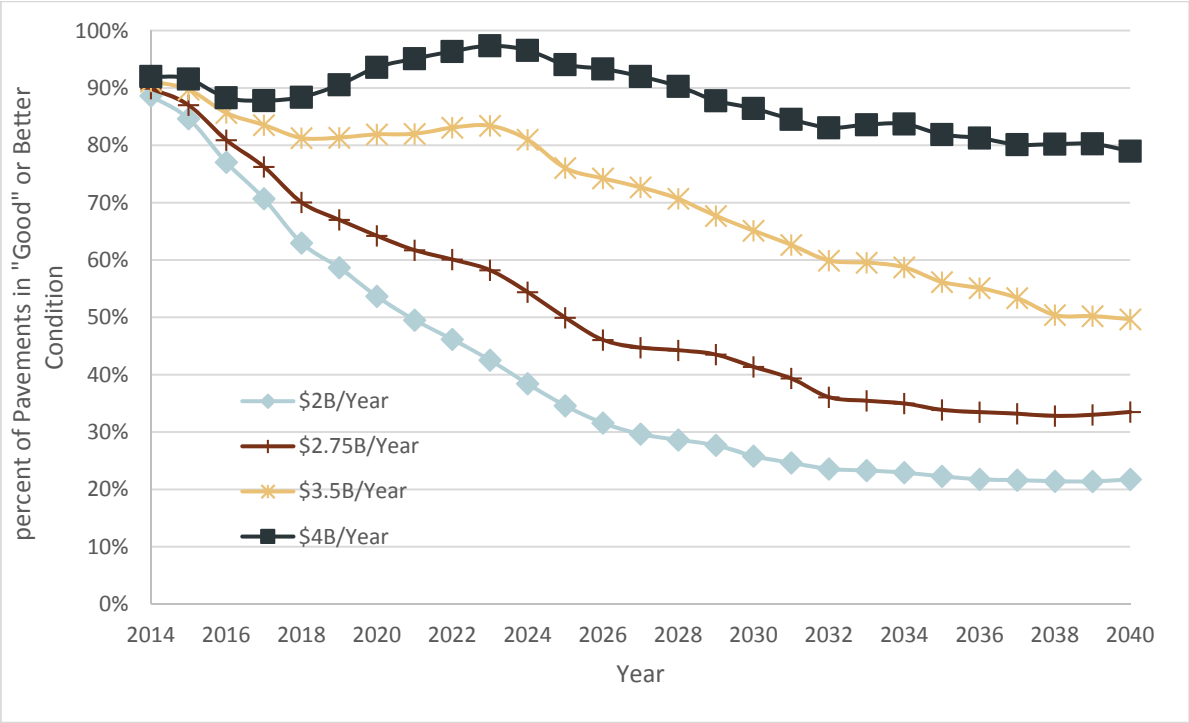



**Figure 12. Non-Interstate NHS Pavement State-of-Repair based on IRI**



Given uncertainties in future revenue and the potential for an infusion of resources, tradeoff analyses were conducted at different budget levels (**Figure 13**). If funds are increased by $750M/year, then the percentage of pavements in “Good” or better condition in 2040 would be expected to increase by 16 percent.

**Figure 13. Pavement State-of-Good-Repair Trend at Different Budget Levels**



# Texas Transportation Plan

## Tech Memo 6: SAM Baseline Documentation

August 15, 2014

## Acknowledgements

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# 1.0 Introduction

The purpose of this Technical Memorandum is the delivery of an updated 2010 Baseline and 2040 financially constrained scenarios for support of the Texas Transportation Plan (TTP). The 2040 run includes capacity expanding roadway projects in any of the Metropolitan Transportation Plans (MTPs) developed by each of the 25 Texas Metropolitan Planning Organizations (MPOs) or the Texas Statewide Transportation Improvement Plan (STIP).

The memo is organized into two sections: 1) Overview of the Statewide Analysis Model (SAM), including the demographics, transportation system, and validation; and 2) Modeled scenarios descriptions and results. The results section contains descriptions of model outputs including some accompanying examples of what can be produced using those outputs. The memo is accompanied by a geodatabase containing the SAM 2010 and 2040 network assignment results, along with a comprehensive data dictionary of all contained variables.

# 2.0 Statewide AnalySis Model (SAM)

The Texas State Department of Transportation (TxDOT) maintains a robust statewide travel demand model, referred to as the Texas Statewide Analysis Model (SAM). The SAM is an advanced state of the practice multimodal travel model that provides highway traffic forecasts for both passenger vehicles and trucks, intercity and high speed passenger rail ridership, urban rail and bus travel, freight rail tonnage forecasts, and forecasts of air passenger travel. The model is useful in statewide planning in that it can be used to perform analyses of specific transportation infrastructure under consideration, alternate demographics forecasts, the impact or freight movements on highways and rail facilities, and modal investment tradeoffs.

Key to the SAM's ability to forecast passenger and freight travel demand and the transportation system congestion that is an issue in many places are detailed estimates of demographic and employment that allow for the estimation of travel demand and a representation of the current and planned transportation system.

## *2.1 Demographic and Employment Data*

The SAM assesses the viability of the statewide transportation network and produces travel demand metrics through use of baseline and forecast demographic and employment data. Demographic and employment data are critical components of regional travel demand models because the amount of households and employment help determine the number of trips produced by the model. The SAM uses 2010 as the base year, and has the capability to provide forecasts for 2020, 2030, and 2040; model results for the TTP utilize a 2010 base year and a 2040 forecast year. The following subsections provide an overview of how the demographic and employment data are incorporated into the SAM.

### 2.1.1 Data Sources

The SAM model incorporates various sources of existing demographic and employment data from public and proprietary sources. Data sources used in the model include:

- U.S. Decennial Censuses
- U.S. Census Bureau's American Community Survey (ACS)
- Metropolitan Transportation Planning Organizations (MPOs) Demographic and Employment Forecasts
- U.S. Census Bureau's County Business Patterns (CBP)
- U.S. Bureau of Labor Statistics Quarterly Census of Employment and Wages (QCEW)
- Texas Workforce Commission (TWC)
- Texas State Data Center (TxSDC)
- Woods & Poole Complete Economic and Demographic Data Source (CEDDS)

### 2.1.2 MPO Population and Employment Data

Each of Texas' 25 Metropolitan Planning Organizations (MPOs) regularly produce baseline and forecast population and employment estimates at the traffic analysis zone (TAZ) level. MPOs are a useful source for urban population and employment forecasts because their datasets disaggregate the population employment forecasts to TAZs. MPOs typically update their models and demographic forecasts every five years, or, if the region is classified as being in non attainment for existing air quality standards, every three years.

The forecast methodologies and timeline for releasing these forecasts are often times inconsistent between the various MPOs. It is therefore difficult to make direct comparisons of regional population and employment for a given year. In order to make direct comparisons between MPOs, the population and employment estimates for common years must be interpolated or extrapolated, as necessary. **Table 1**, on the following page, shows the base year and forecast year demographic data available for the Texas MPOs.

**Table 1: Texas MPO Demographic Forecasts Incorporated into the SAM Travel Demand Model**

| MPO | Base Year | Forecast Year | Interim Years |
|---|---|---|---|
| Amarillo | 2005 | 2035 | |
| Austin (CAMPO) | 2005 | 2035 | 2008, 2010, 2015, 2025, |
| Bryan-College Station (BCS) | 2006 | 2035 | |
| Beaumont (JORTS) | 2007 | 2030 | 2015, 2025 |
| Dallas -Fort Worth (NCTCOG) | 2012 | 2035 | 2020 |
| El Paso | 2007 | 2040 | 2010, 2020, 2030 |
| Houston (HGAC) | 2011 | 2035 | |
| Killeen Temple (KTMPO) | 2010 | 2040 | 2020, 2030 |
| Laredo | 2003 | 2035 | |
| Longview | 2002 | 2035 | |
| Lubbock | 2000 | 2030 | |
| San Angelo | 2003 | 2035 | |
| San Antonio | 2008 | 2035 | 2015, 2025 |
| Sherman Dennison | 2003 | 2035 | |
| Tyler | 2002 | 2035 | 2015, 2025 |
| Wichita Falls | 2005 | 2035 | |
| Regional Valley (RGV) | 2004 | 2035 | |

### 2.1.3 Demographic Control Totals

County-level population and household control totals derived from 2010 U.S. Census Bureau estimates. In order to ensure consistent county-level control totals across Texas, the SAM forecasts take into consideration projections from the Texas State Data Center, more detailed national forecasts available at the county level, and the interplay of population and employment growth to estimate the control total population for the 2040 model forecast year.

### 2.1.4 Baseline Demographics

The baseline demographics used in the SAM model were updated using data from three sources:

- 2010 U.S. Census data at the Census Tract and County levels;
- 2010 mid-year U.S. Census population estimates at the County level; and
- 2010 American Community Survey (ACS) 5-year median household income estimates at the Census Tract level.

### 2.1.5 Demographic Forecasts

The following sources were used to derive the TAZ-level demographic forecasts:

- 2010 U.S. Census population and household estimates at the county level;
- Woods & Poole 2012 CEDDS total population, persons per household and total households forecast data at the county level out to 2040; and
- Available MPO demographic forecasts.

### 2.1.6 Employment Control Totals

Employment data provides an important source of trip attractions and productions, and therefore has a significant role in the allocation of trips. Unlike population data from the U.S. Census Bureau, however, employment data is not always reported in a manner that accurately provides an employer's physical location, nor are all employers always included.

County-level employment estimates and projections were available from three government agencies and one proprietary source:

1. The U.S. Bureau of Labor Statistics (BLS),[1]
2. State workforce commissions,
3. U.S. Census Bureau's County Business Pattern data (CBP),[2] and
4. Woods & Poole Economics, Inc. (W&P).

The CBP county-level employment data serves as the source of employment control totals. Government and farm employment were included in each county's employment control totals from separate census sources to represent all employment categories.[3] The forecasted county employment control totals were derived by applying county level CEDDS growth rates to the base year control totals by employment type. Population to Employment (P/E) ratios were calculated from CEDDS data for each county and each analysis year as a secondary reasonableness check on the forecasts.

### 2.1.7 Baseline Employment

The datasets used to develop the SAM baseline employment inputs included:

- 2010 Census county-level population data
- U.S. Census Bureau's 2010 County Business Pattern (CBP) data
- Texas Workforce Commission employment data at Census Block level
- 2012 Woods & Poole Complete Economic and Demographic Data Source (CEDDS)
- Bureau of Economic Analysis (BEA)

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[1] More information can be found at http://www.bls.gov/data/#employment

[2] More information can be found at http://www.census.gov/econ/cbp/index.html

[3] Military employment is included in the SAM V3 as a special generator. The employment data to populate this file is being provided by TxDOT.

The estimated baseline employment by type for the urban TAZs (i.e. those within an MPO), was calculated by aggregating the MPO's TAZ employment by type into the SAM TAZ geography. The SAM TAZ employment by type data were then summed to county totals. Next, the total CBP employment by type for each county was divided by the MPO's total employment by type. This adjustment factor was then multiplied by the MPO's estimated employment by type for each SAM TAZ to produce the baseline employment estimates.

### 2.1.8 Employment Forecasts

The SAM 2040 TAZ-level employment forecasts were prepared using the following data sources:

- 2010 Texas Workforce Commission (TWC) employment at the Census Block level
- 2010 County Business Pattern (CBP) employment at the County level
- 2010 Census population at the County level
- 2003-2035 Woods & Poole 2012 CEDDS population and employment at the County level.

### 2.1.9 Summary of Demographic and Employment Updates

**Table 2** shows the final statewide population estimates after updating the population data. Under these projections the total population of Texas will grow from 25.1 million residents in 2010 to 40.5 million residents in 2040, which represents an increase of 60.8 percent over that time period.

**Table 2: Forecasted Statewide Population Control Totals for Texas, 2010 and 2040**

| | 2010 | 2040 |
|---|---|---|
| Total Population | 25,145,561 | 40,458,796 |
| Average Annual Change | -- | 510,441 |
| Compounded Annual Growth Rate | -- | 1.60% |

**Table 3** summarizes the household forecasts for the SAM study area. According to these projections, the total number of households in the SAM model area is forecasted to grow by 5.4 million households from 2010 to 2040, representing an increase of 60.2 percent. **Figure 1** on the next page shows the geographic distribution of population growth by TAZ in the model area between 2010 and 2040.

**Table 3: Forecasted Statewide Household Control Totals for the SAM Study Area, 2010 and 2040**

| Measure | 2010 | 2040 |
|---|---|---|
| Total Households | 8,922,933 | 14,298,386 |
| Average Annual Change | -- | 179,182 |
| Compounded Annual Growth Rate | -- | 1.58% |

**Figure 1: Population Annual Average Growth Rate by TAZ for the SAM Study Area, 2010 to 2040**

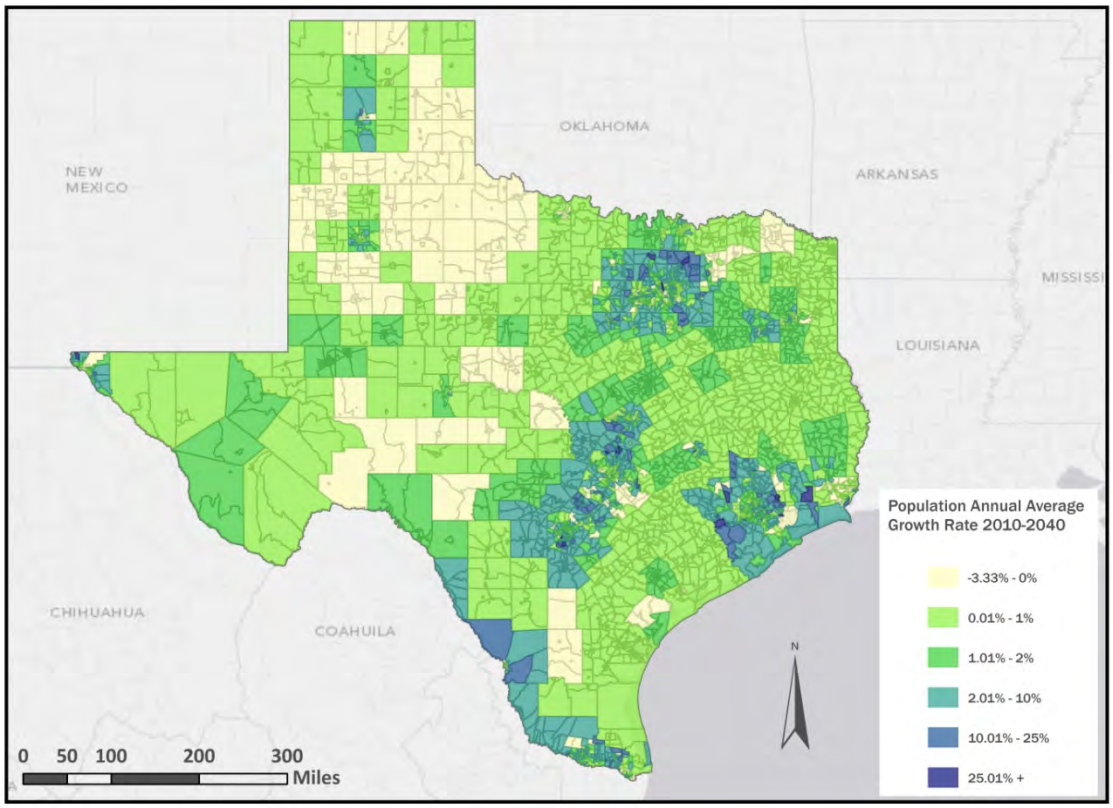
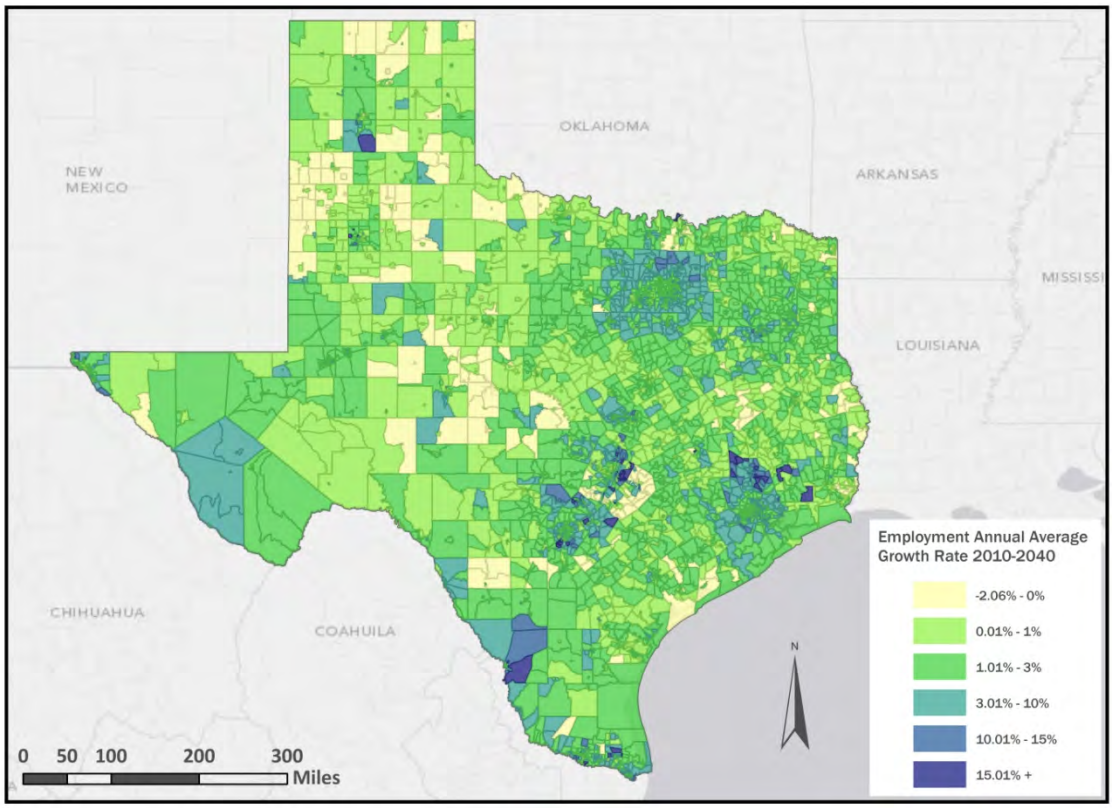



**Table 4** shows the final results after updating the employment control total data for the SAM model at the statewide level. The employment forecasts anticipate robust job growth over the 30-year forecast horizon, with Texas expected to add 7.7 million jobs over that time period, representing an overall growth of 70.9 percent. **Figure 2** presents geographic distribution of employment growth and loss by TAZ in the modeled area between 2010 and 2040.

**Table 4: Forecasted Statewide Employment Control Totals for the SAM Study Area, 2010 and 2040**

| | 2010 | 2040 |
|---|---|---|
| Total Employment | 10,787,208 | 18,438,457 |
| Average Annual Change | -- | 255,042 |
| Compounded Annual Growth Rate | -- | 1.80% |

**Figure 2: Employment Annual Average Growth Rate by TAZ for the SAM Study Area, 2010 to 2040**




## *2.2 Transportation System Update*

In order to model the most current and comprehensive transportation system for development of the TTP, updates were made to the SAM transportation system. The SAM network stores information about the current and future characteristics of each facility in the Texas transportation system. This information includes physical attributes such as posted speed limit and number of lanes, as well as future changes, such as road widening projects. As part of the transportation system update, the project team refined the SAM network to include the most up-to-date conditions—as well as future conditions—of the Texas transportation system. This section describes how the project team determined which projects should be included in the refined SAM network, how those projects were coded into the network, and how the network was validated.

### 2.2.1 Plans Review

For urbanized areas with a population greater than 50,000, the planning and coordination of federal highway and transit investments are the responsibility of Metropolitan Planning Organizations (MPOs). Each of the 25 MPOs in Texas are required to maintain and update a Transportation Improvement Program (TIP) and Metropolitan Transportation Plan (MTP) to provide a short and long-term plan for transportation investments in their respective regions. In refining the

SAM network, the project team thoroughly reviewed all financially committed projects within each MPO's MTP, as well as in the Statewide Transportation Improvement Program (STIP). Table 5 below shows the plans that were reviewed for this task.

**Table 5: Plans Incorporated into the SAM Network Update**

| MPO | Reference Name | Adoption Date |
|---|---|---|
| Statewide Transportation Improvement Program (STIP) | STIP, by District | August 2012 |
| Abilene MPO | Abilene MPO MTP 2010-2035 | January 12, 2010 |
| Amarillo MPO | Amarillo MTP 2010-2035 | October 20, 2011 (amended) |
| CAMPO (Austin) MPO | CAMPO 2035 RTP | May 24, 2010 |
| Beaumont – Port Arthur MPO | SETRPC-MPO for the JOHRTS Area MTP 2035 | April 19, 2013 |
| Brownsville MPO | 2010-2035 Brownsville MTP | December 9, 2009 |
| Bryan – College Station MPO | BCS MPO 2010-2035 MTP | February 9, 2011 (amended) |
| Corpus Christi MPO | Corpus Christi MTO MTP 2010-2035 | March 3, 2011 (amended) |
| Hidalgo County MPO (Pharr) | 2010-2035 MTP | December 10, 2009 |
| El Paso MPO | Horizon 2040 MTP | October 4, 2013 |
| Houston Galveston MPO | The 2035 RTP Update | January 25, 2011 (approved) |
| Harlingen MPO | 2010-2035 MTP | December 9, 2009 |
| Killeen – Temple MPO | Mobility 35 MTP | October 21, 2009 (amended) |
| Laredo MPO | Laredo MTP 2010-2035 Update | December 11, 2009 |
| Longview MPO | Transportation 2035 Longview MTP | May 15, 2013 (amended) |
| Lubbock MPO | Lubbock MTP 2012-2040 | August 21, 2012 |
| Midland Odessa MPO | Midland Odessa 2035 Transportation Plan Update | November 30, 2009 |
| North Central Texas MPO | 2035 Mobility, 2013 Update | June 13, 2013 (amended) |
| San Angelo MPO | San Angelo MTP 2010-2035 | January 2013 (amended) |
| San Antonio – Bexar County MPO | Mobility 2035 MTP | December 7, 2009 |
| Sherman – Denison MPO | Transportation Outlook 2035 | April 25, 2012 (amended) |
| Texarkana MPO | TUTS 2035 MTP | October 1, 2009 |
| Tyler Area MPO | TAMPO MTP 2035 | April 22, 2010 (amended) |
| Victoria MPO | Victoria Urbanized Area MTP 2035 | December 11, 2012 (amended) |
| Waco MPO | Connections 2035 Waco MTP | August 2010 |
| Wichita Falls MPO | Wichita Falls MPO 2010-2035 MTP Update | June 4, 2012 |

The project team identified regionally significant projects from the above plans that would affect the capacity of the transportation system. These projects include new roadways, managed lanes/tollways and HOV lanes; road widening projects, including new turning lanes, conversion of existing lanes to tolled or managed facilities, and other capacity-altering projects. While the majority of projects listed in the MPTs and STIP were already included in the SAM network, 108 new projects from 11 MPOs were identified for addition to the SAM multimodal network. Table 6 below shows the number and types of projects added to the SAM network during this process.

**Table 6: Projects Added to SAM Network**

| Project Type | Projects Added |
|---|---|
| Widen | 41 |
| Change to Toll | 27 |
| New Managed Lanes (widen) | 20 |
| New road (non toll) | 16 |
| New HOV | 4 |
| **Total** | **108** |

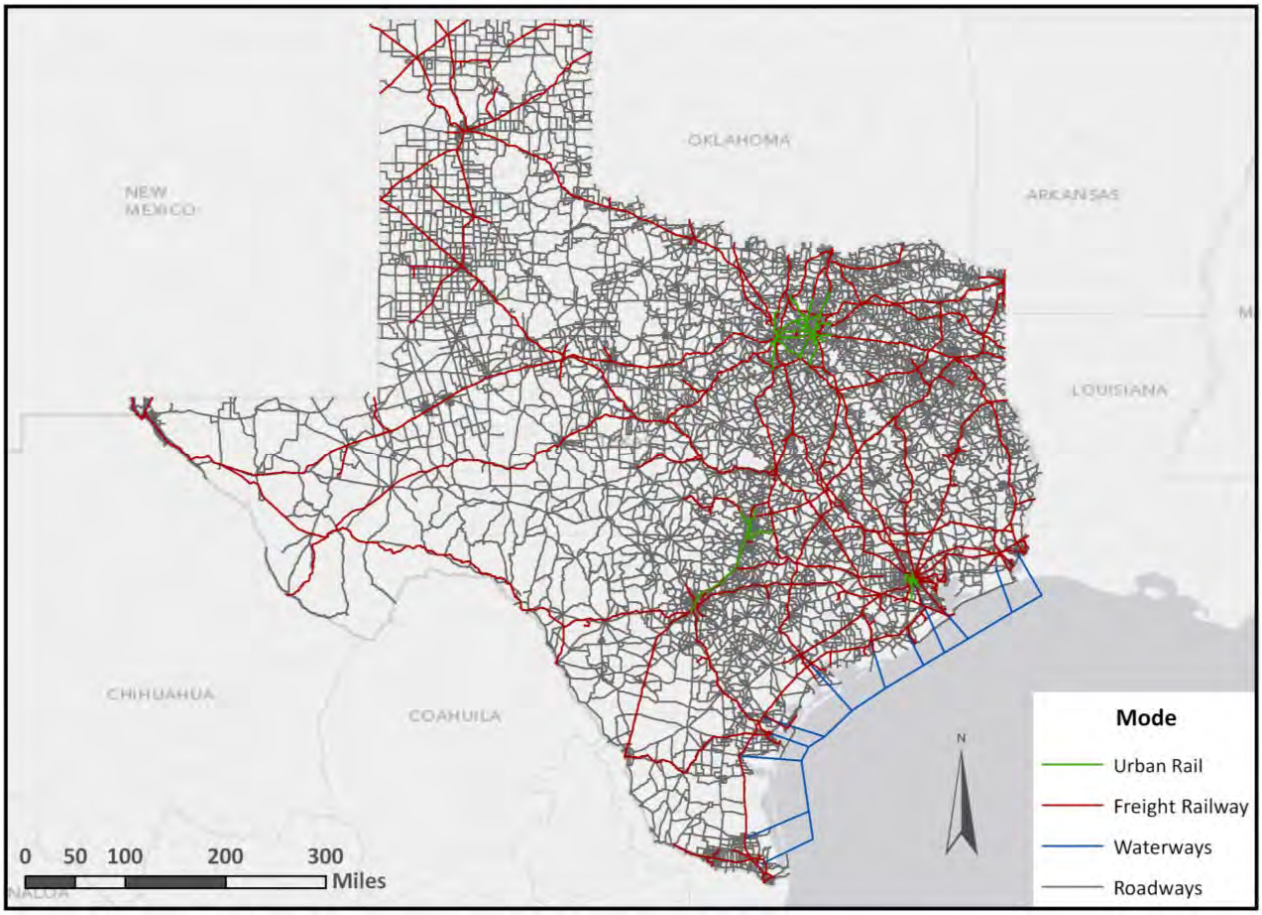
After the new projects were selected, the project team coded them into the SAM network by inputting attributes (described in Table 7) about each project into a Microsoft Access database. The database was then read by the SAM to automatically update the network attributes of the transportation system for each specified model year. The use of the project database allows for facilities that are affected by multiple projects over time to be updated incrementally. For example, a single roadway segment may have three projects associated with it, each adding additional lanes in separate years. To code this, the three projects are listed separately in the project database with their expected completion dates, and are then read by SAM to automatically update the attributes of that segment after running the network update procedure. This method allows modelers to add or remove specific projects from a given scenario for analysis. For example, one can observe the effect of adding a freeway in 2020 that is not planned to be constructed until 2040. Table 7 describes the attributes that are inputted into the SAM project database.

**Table 7: Project Database Attributes**

| Field Name | Description |
|---|---|
| ID | Automatically generated Microsoft Access ID. |
| AddRemove | Flag denoting whether to include or exclude a project from a given scenario. |
| ProjectID | Unique identifier for a project. The ProjectID is coded on each link in the network affected by the project. The format of the Project ID is: MPO abbrev. + MPO project ID |
| ProjectYear | Year project begins operation. |
| RemovedYear | Year facility is removed from network. |
| OneWay | Controls how the number of lanes is populated on the network line layer. A "ONEWAY" flag in this field tells the interface to divide the value in the field “NumLanes” by two and transfer the value to the network directionally. |
| NumLanes | The total number of lanes associated with the roadway |
| FC | The functional classification of the roadway |
| DIV | Flag denoting if the facility is divided or not |
| Shoulder | Shoulder width if the project includes adding a shoulder |
| Posted_SP | Posted speed for roadway |
| MODE_CODE | Mode code of a link |
| Terrain | Flag denoting the topology of land. Topology affects the capacity of roadways.<br>1 = flat, 2 = rolling, 3=mountainous |
| Parking | Parking value to use for number of parking movements. The presence of on street parking reduces roadway capacity. |
| Lane_Config | Only for links at roadway intersection. Contains a code used to determine the lane group configuration (e.g. “L1LS0T3RS1R1” = # dedicated left, # shared left, # through, # shared right, # dedicated right) |
| ProjectSource | Note documenting the source of the project information |
| CSJ | Note that can be used to document the project CSJ |
| Name | Name of the facility |
| Type | Project types:<br>• Build frontage road<br>• Change to Toll<br>• New HOV<br>• New Managed Lanes<br>• New road<br>• Widen<br>• Upgrade to expressway<br>• Upgrade to freeway |
| Note | Optional field for notes |
| Alternative ID | Optional field for other ID for a project |
| MTP version | Optional field for MTP information |
| Toll Notes | Optional field to document the toll way note |

**Figure 3** below shows the SAM multimodal transportation system after the network update task was completed.

**Figure 3: 2040 SAM Transportation System by Mode**




## 2.3 SAM Validation

After the network was updated, a full SAM model run was conducted in order to compare base year travel volumes from the model with observed travel data. This validation process helped to ensure that the SAM model provides a realistic and reliable estimate of the magnitude and pattern of future travel in Texas. Validation procedures were conducted for highway, urban rail, Amtrak, and air modes. The validation results and data sources used for each of these modes are described in **Appendix A**, starting on page 21.

# 3.0 Scenario Descriptions and Results

## *3.1 Scenario Descriptions*

As part of Task 4, the project team prepared two baseline scenarios for analysis: a demographic scenario for 2010 and a financially constrained scenario for 2040. The baseline 2010 scenario included the 2010 population and employment estimates discussed previously, as well as the multi-modal Texas transportation network as it existed in 2010. The financially constrained scenario included the 2040 population and employment forecasts, as well as the financially committed, capacity-altering projects added as part of the transportation system update process described in the previous section.

The remainder of this memorandum provides the results of the modeled scenarios performed in preparation of the Texas Transportation Plan. The 2010 demographic and 2040 financially constrained scenarios were analyzed using the SAM travel demand model, including updates made to the transportation system through inclusion of the most recent regional MTPs and STIP. The forecast year for all model results presented in this technical memorandum is 2040.

## *3.2 Statewide Results*

Table 8 presents key summary statistics for each modeled scenario year.

**Table 8: SAM Summary of Results**

| | 2010 | 2040 |
|---|---|---|
| Population | 25,145,561 | 40,458,796 |
| Employment | 10,787,208 | 18,438,457 |
| Vehicle Miles Traveled | 688,003,585 | 1,104,744,458 |
| Vehicle Hours Traveled | 16,319,425 | 29,425,865 |
| Number of Personal Trips (Total) | 71,021,132 | 111,523,231.74 |
| Number of Personal Trips (by Transit*) | 1,344,361 | 2,106,377.68 |
| Number of Vehicle Trips | 50,202,955 | 78,946,246.14 |

Note:
*Transit is defined as Bus and Urban Rail modes

From 2010 to 2040, Texas trip volumes are expected to increase by 57 percent, as shown in Table 9.

**Table 9: SAM Transportation Mode by Scenario Year**

| | 2010 | 2040 | % Increase |
|---|---|---|---|
| Drive Alone | 36,437,250 | 57,378,639 | 57% |
| Share Ride (2 persons) | 18,017,893 | 28,296,880 | 57% |
| Share Ride (3+ Persons) | 15,221,627 | 23,741,335 | 56% |
| Bus | 1,213,906 | 1,759,183 | 45% |
| Urban Rail | 105,820 | 303,613 | 187% |
| Long Distance Trip (Air and Intercity Rail) | 24,635 | 43,582 | 77% |
| **Total** | **71,021,132** | **111,523,232** | **57%** |

### 3.2.1 Transportation Mode and Trip Purpose

**Figure 4** (2010) and **Figure 5** (2040) indicate single-occupancy vehicle as the predominant travel mode in both modeled scenario years. From 2010 to 2040, the overall percentage of trips by bus decreases, while the percentage trips of urban rail increases.

**Figure 4: 2010 SAM Mode Share**

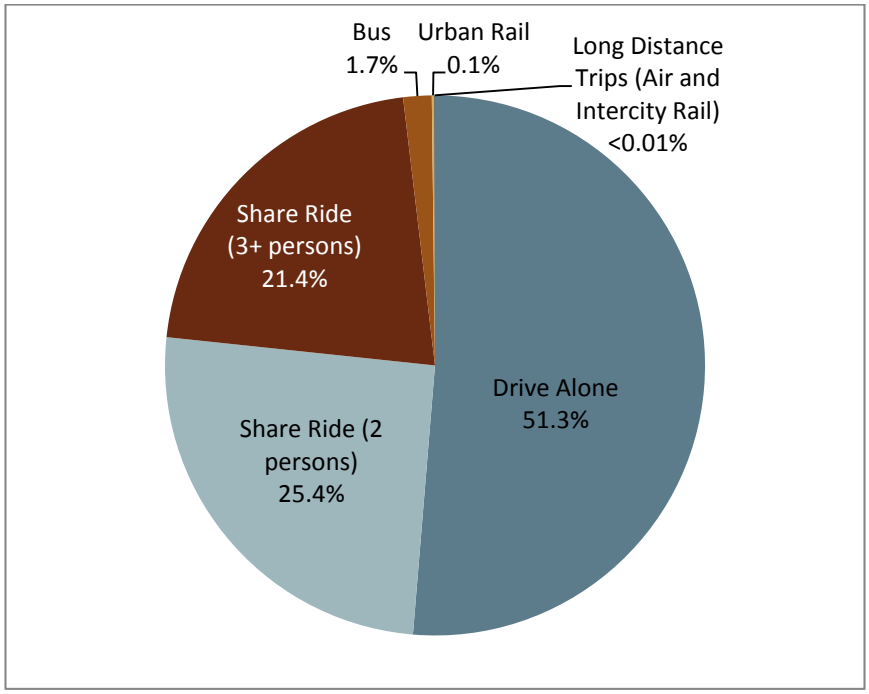


**Figure 5: 2040 SAM Mode Share**

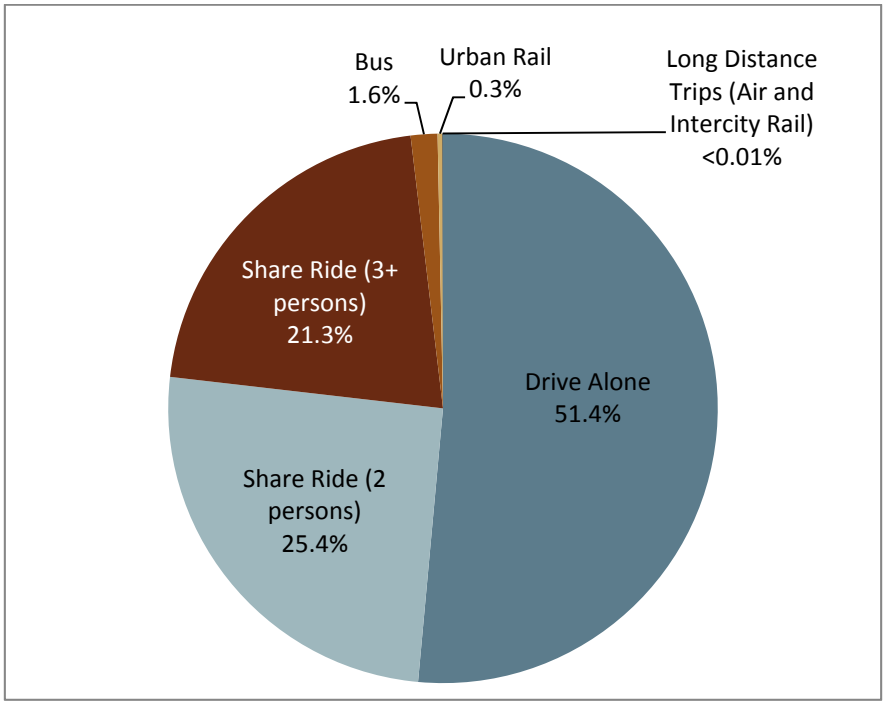



**Figure 6** and **Figure 7** below present the distribution of trip purpose for 2010 and 2040, respectively. Home-based non-work (HBO) trips represent the majority of travel, followed by Home-based work (HBW). Infrequent long-distance work (ILDB) and Infrequent long-distance non-work (ILDO) trips represent the smallest share of trips for both modeled scenario years. The figures show little change in distribution of trip purpose over time.

**Figure 6: 2010 SAM Trip Purpose**

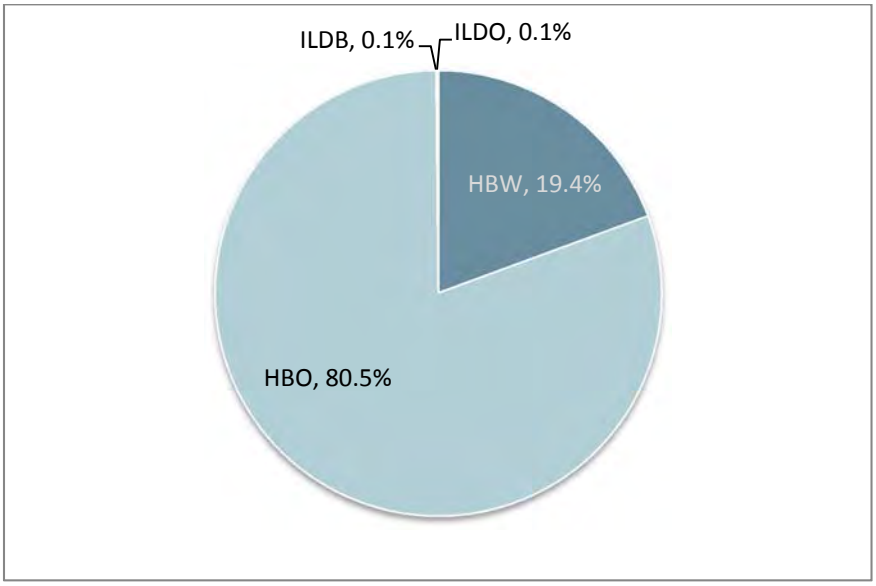
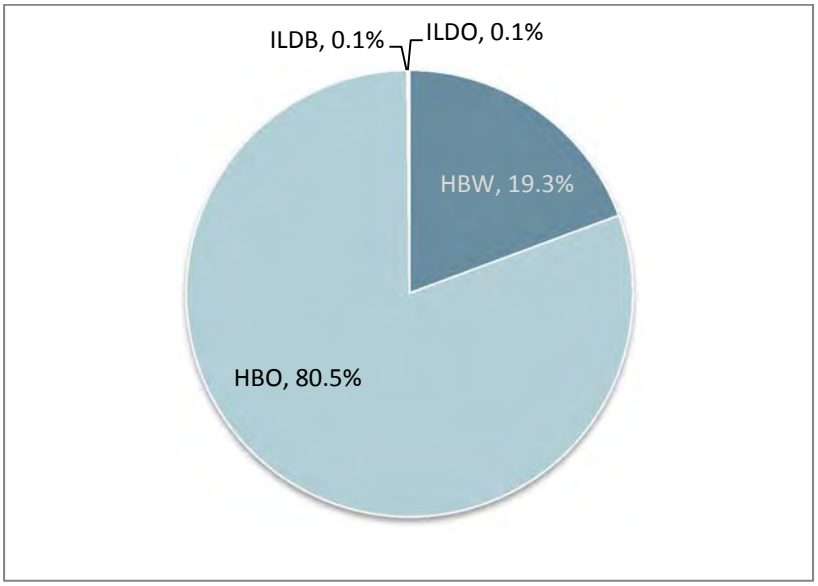


**Figure 7: 2040 SAM Trip Purpose**




### 3.2.2 Delay

Total delay measures the total time loss for all vehicles on the studied roadway segments. This measure can show improvements that affect a region's roadway system, or a particular corridor. This measure was calculated for two sub-classes within the region: regional highways, including all interstates, and regional arterials, comprising all other roadways within the Texas transportation system. These two classes are denoted in the Texas network in the attribute "REGION". See Table 10 for 24-hour total statewide delay in vehicle-hours, by roadway sub-class and scenario year.

**Table 10: Statewide Mobility Metrics**

| | | 2010 | 2040 |
|---|---|---|---|
| 24-hour Total Statewide Delay (Vehicle-Hours) | Arterials | 1,257,851 | 4,086,361 |
| | Highways | 493,408 | 1,573,048 |

### 3.2.3 Roadway Congestion Index

The Roadway Congestion Index (RCI) was originally developed by Texas Transportation Institute (TTI) to evaluate mobility levels on Texas streets and freeways, which is now computed annually for over 85 major U.S. cities. It is a measure of vehicle travel density on major roadways in an urban area. This measure produces a single value, calculated from delay associated with all links in the region.

$$RCI = \frac{\left(\frac{VMT_{freeway}}{Lane - mile_{freeway}}\right) * VMT_{freeway} + \left(\frac{VMT_{arterial}}{Lane - mile_{arterial}}\right) * VMT_{arterial}}{13000 * VMT_{freeway} + 5000 * VMT_{arterial}}$$

$$VMT_{freeway} = \sum_j \sum_k TotalVMT^k_{freeway,j}$$

$$VMT_{arterial} = \sum_j \sum_k TotalVMT^k_{arterial,j}$$

$$Lane - mile_{freeway} = \sum_k Total\ Number\ of\ Lanes^k_{freeway} * Length^k_{freeway}$$

$$Lane - mile_{arterial} = \sum_k Total\ Number\ of\ Lanes^k_{arterial} * Length^k_{arterial}$$

This measure assumes a capacity of 13,000 vehicles per lane per day for freeways and 5,000 vehicles per lane per day for arterials[4]. It assumes a baseline for congestion based on those capacities and does not account for daily peaking. **Table 11** presents the Regional Congestion Index for the state of Texas.

**Table 11: Statewide Mobility Metrics**

| | 2010 | 2040 |
|---|---|---|
| Regional Congestion Index (RCI) | 0.573685 | 0.843891 |

### 3.2.4 Vehicle Miles Traveled (VMT) and Vehicle Hours Traveled (VHT)

Vehicle Miles Traveled (VMT) and Vehicle Hours Traveled (VHT) are important indicators of travel behavior throughout Texas. The SAM produces statewide VMT statistics for each scenario over a given time period. Statewide VMT is defined as the total miles driven by all vehicles within a given time period. VMT growth from 2010 to 2040 is shown in **Figure 8**. **Table 12** below provides additional information.

4 "Alternative Performance Measures For Evaluating Congestion", New Jersey Institute of Technology, 2004.

**Figure 8: VMT Growth 2010-2040 by Time Period**

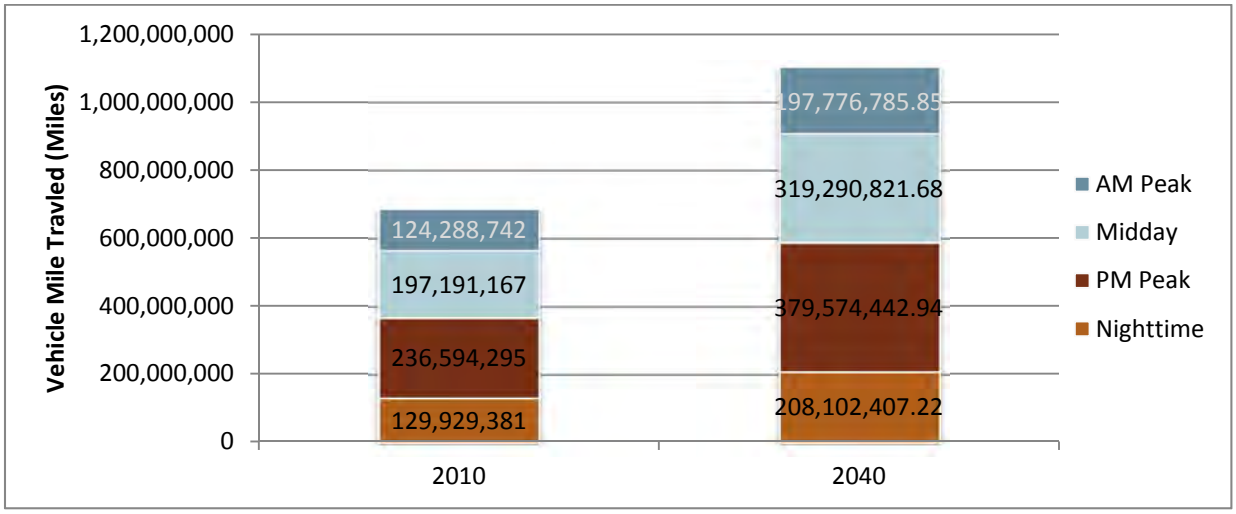



**Table 12: VMT by Year and Time Period**

| | 2010 | 2040 | % Change from 2010 to 2040 |
|---|---|---|---|
| Morning Peak | 124,288,742 | 197,776,785.85 | 59% |
| Mid-Day | 197,191,167 | 319,290,821.68 | 62% |
| Afternoon Peak | 236,594,295 | 379,574,442.94 | 60% |
| Nighttime | 129,929,381 | 208,102,407.22 | 60% |
| 24-Hour | 688,003,585 | 1,104,744,457.69 | 61% |

The Vehicle Hours Traveled (VHT) metric also provides an indication of delay across the state. Statewide VHT is defined as the total hours driven by all vehicles within a given time period. VHT growth from 2010 to 2040 is shown in **Figure 9**. **Table 13** on the next page provides additional information on VHT growth by year and time period.

**Figure 9: VHT Growth 2010-2040**

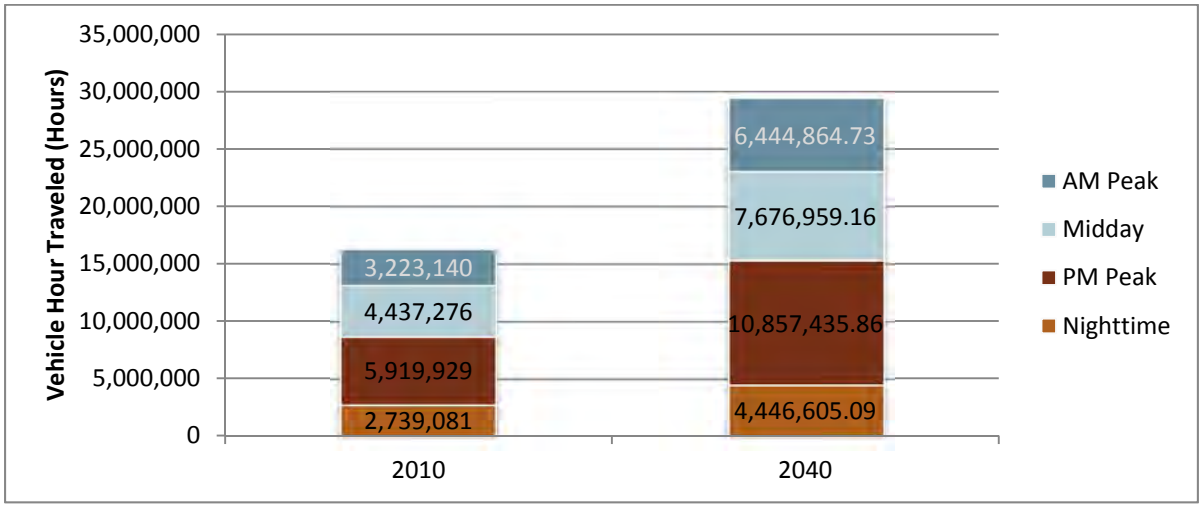



**Table 13: VHT by Year and Time Period**

| | 2010 | 2040 | % Change from 2010 to 2040 |
|---|---|---|---|
| Morning Peak | 3,223,140 | 6,444,864.73 | 100% |
| Mid-Day | 4,437,276 | 7,676,959.16 | 73% |
| Afternoon Peak | 5,919,929 | 10,857,435.86 | 83% |
| Nighttime | 2,739,081 | 4,446,605.09 | 62% |
| 24-Hour | 16,319,425 | 29,425,864.84 | 80% |

For this study, VMT and VHT were calculated by time period for the State of Texas. A summary of statewide VMT and VHT by functional class is contained in Appendix B.

### 3.2.5 Statewide Freight

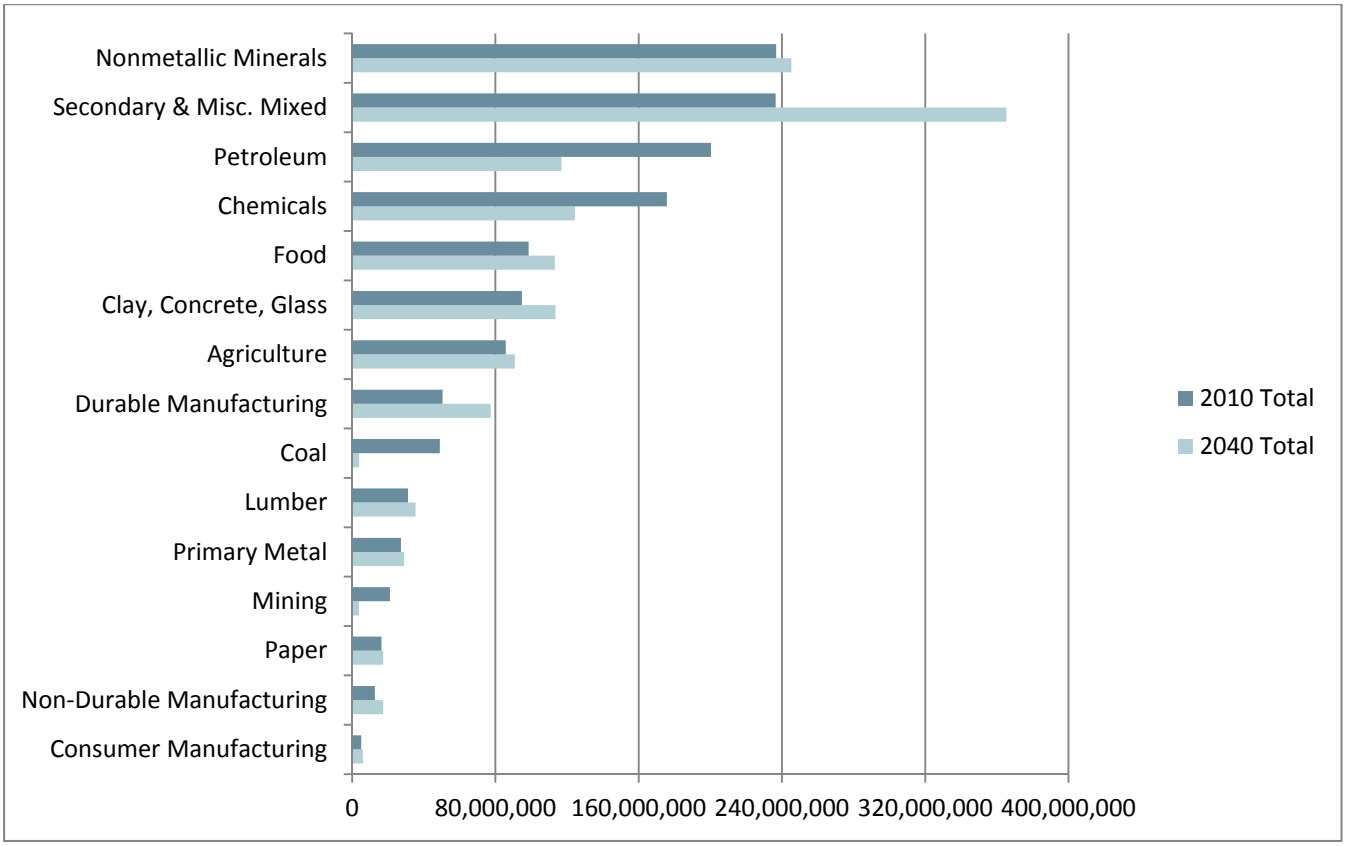
Freight statistics output by the SAM include tonnage by freight mode and freight productions and attractions by commodity group (as presented in Table 14).

**Table 14: Freight Tonnage by Mode and Scenario Year**

| | 2010 | 2040 |
|---|---|---|
| Truck | 970,384,709 | 1,359,665,251 |
| Rail Carload (CL) | 245,360,320 | 336,212,454 |
| Intermodal (IMX) | 23,958,736 | 75,883,902 |
| Air | 2,363,016 | 6,121,608 |
| Water | 99,646,503 | 93,014,260 |

**Figure 10** shows freight tonnage productions by commodity group and scenario year.

**Figure 10: SAM Tonnage Productions by Commodity and Scenario Year**




## *3.3 Link Level Results*

The travel demand model runs for each scenario provide metrics that can be used to measure and compare the performance of each scenario at the link level. These metrics are summarized in this section.

### 3.3.1 Volume to Capacity Ratios

The Volume to Capacity (V/C) ration is defined by TxDOT[5] as:

> *V/C – The ratio of flow rate to capacity. The V/C may be the actual or projected rate of flow on a designated lane group during a peak 15-minute interval divided by the capacity of the lane group. The V/C ratio is a measure of capacity sufficiency, that is, whether or not the physical geometry provides sufficient capacity for the subject movement.*

[5] Texas Department of Transportation, TxDOT Glossary, June 2010.

The Volume-Capacity ratio (V/C ratio) is a direct output of the traffic assignment procedure, produced by time period and scenario year. It is a measure that reflects the mobility and quality of travel of a facility or a section of a facility, specifically, the number of vehicles at a snapshot in time divided by the capacity of the roadway on a roadway segment.

### 3.3.2 24-hour Trip Volumes

The SAM also produces link level 24-hour trip volumes for all modes, as well as for truck modes, across the modeled transportation network, at the link level.

### 3.3.3 Link Level Freight

Freight volumes can be analyzed at the link level using the results of the SAM. The SAM outputs include the ability to analyze freight flows by commodity type at the link level.

### 3.3.4 Total Freight Congestion

The truck level of service measure "Total Freight Congestion Value" was developed by the American Transportation Research Institute (ATRI). The measure is calculated by taking the miles per hour below free flow speed that trucks are traveling and multiplying the value by the number of trucks on a roadway within each hour of the day to produce an hourly freight congestion value. The SAM model is used to calculate the Total Freight Congestion Value for four time periods (AM peak, Mid-day, PM peak, and Night) on major highways within Texas. The measure is reported by major highway to allow for comparison. The larger the value reported the lower the level of freight service for the facility during the specific time period.

# Appendix A: SAM Validation

After the network was updated a full SAM model run was conducted in order to compare base year travel volumes from the model with observed travel data. This validation process helped to ensure that the SAM model provides a realistic and reliable estimate of the magnitude and pattern of future travel in Texas. Validation procedures were conducted for highway, urban rail, Amtrak, and air modes.

## Highway

Highway traffic volumes from the model were validated against 2010 24-hour volume counts and vehicle classification counts obtained from TxDOT, as well as a 2007 origin/destination study conducted at 21 sites along the Interstate 35 (IH-35) corridor.

One measure used to evaluate the SAM model outputs is vehicle miles of travel (VMT). **Table A-1** compares the modeled VMT with observed VMT (2010) for Texas. These results show that modeled VMT was 107% of statewide VMT, which is within the ±10% validation target.

**Table A-1: HPMS VMT vs. Modeled VMT**

| HPMS VMT (2010) | Modeled VMT | % of HPMS VMT (Observed) | Validation Target |
|---|---|---|---|
| 641,809,936 | 688,003,582 | 107% | ±10% |

The overall validation results indicated that the SAM model provided a realistic and reliable predictor of the magnitude and pattern of highway travel in Texas.

### *Urban Rail*

Urban rail ridership from the SAM model was validated using ridership information from each of the urban rail lines operating in Texas in 2010: the MetroRail Red Line in Austin, the MetroRail system in Houston, the Trinity Railway Express in Dallas-Fort Worth, and DART Rail in Dallas. **Table A-2**, on the next page, compares the modeled urban rail ridership by route to the estimated daily ridership target. Urban rail, which serves mainly as an access mode for air and high speed rail in the SAM model, compared well with the ridership targets, with the only notable differences occurring at the individual rail line or city level.

**Table A-2: Modeled vs. Observed Urban Rail Trips by Route**

| Route | Location | Observed Average Daily | Model Result |
|---|---|---|---|
| MetroRail Red Line | Austin | 1,800 | 10,477 |
| MetroRail Light Rail | Houston | 35,251 | 46,753 |
| Trinity Railway Express | DFW | 8,500 | 7,180 |
| Light Rail | Dallas | 59,800 | 42,322 |
| **Total** | | **105,351** | **106,731** |

## *Amtrak*

Amtrak passenger rail ridership from the SAM was validated using 2010 boarding and alighting data for each of the three Amtrak routes located in Texas: the Heartland Flyer, the Texas Eagle, and the Sunset Limited. **Table A-3** compares modeled intercity rail ridership from SAM to the estimated average daily Amtrak route ridership.

**Table A-3: Modeled Vs. Observed Intercity Trips**

| Observed Average Daily | Model Result | Difference |
|---|---|---|
| 766 | 904 | 18% |

## *Air*

Passenger air volumes from the SAM model were validated by comparing model outputs with 2010 *Airline Origin and Destination Survey* data from the Bureau of Transportation Statistics. **Table A-4** presents the SAM modeled air trips versus observed air trips.

**Table A-4: Modeled Vs. Observed Daily Air Trips**

| Observed Average Daily | Model Result | Difference |
|---|---|---|
| 22,632 | 24,009 | 6.1% |

## *Freight*

The SAM freight model was validated by comparing 2010 modeled flows with TRANSEARCH freight flows for all applicable modes. **Table A-5** on the following page presents a comparison of daily truck trips derived from the TRANSEARCH truck-only flows and SAM freight mode choice truck trip tables. Overall, these numbers show that the model produces daily truck trips that are similar to the TRANSEARCH truck trips.

**Table A-5: Comparison of Daily Truck Trips from SAM Model and TRANSEARCH Data**

| Daily Truck Trips | TRANSEARCH | SAM Model | Difference |
|---|---|---|---|
| Internal-Internal, Internal-External, External-Internal | 151,000 | 157,765 | 4% |
| Internal-Internal | 110,000 | 112,049 | 2% |
| Internal-External, External-Internal | 41,000 | 45,717 | 12% |

Another validation procedure was conducted to compare SAM freight mode shares with TRANSEARCH mode shares for truck, carload rail, and intermodal rail. As Table A-6 indicates, the modeled mode shares were reasonably close to observed mode shares. Air and water shares are not shown here as they are inputted directly from the TRANSEARCH data. The SAM mode choice model does not directly capture air and water modes.

**Table A-6: Comparison of Modal Shares from the 2010 SAM Mode Choice Model and 2010 TRANSEARCH Commodity Flow Data (exclusive of Air and Water)**

| Commodity Group | | Truck % | | Carload Rail % | | Intermodal Rail % | |
|---|---|---|---|---|---|---|---|
| Code | Name | Actual | Modeled | Actual | Modeled | Actual | Modeled |
| 1 | Agriculture | 63.58% | 73.52% | 36.04% | 25.68% | 0.39% | 0.80% |
| 2 | Mining | 64.46% | 62.04% | 35.49% | 37.44% | 0.05% | 0.53% |
| 3 | Coal | 26.42% | 8.28% | 73.58% | 91.72% | 0.00% | 0.00% |
| 4 | Nonmetallic Minerals | 84.43% | 75.30% | 15.57% | 24.69% | 0.01% | 0.01% |
| 5 | Food | 80.43% | 86.16% | 19.41% | 13.83% | 0.16% | 0.01% |
| 6 | Consumer Manufacturing | 96.76% | 87.00% | 0.06% | 0.09% | 3.18% | 12.91% |
| 7 | Non-Durable Manufacturing | 97.87% | 95.02% | 1.28% | 0.42% | 0.86% | 4.56% |
| 8 | Lumber | 87.08% | 92.97% | 12.81% | 6.58% | 0.11% | 0.45% |
| 9 | Durable Manufacturing | 81.64% | 84.05% | 17.24% | 12.20% | 1.12% | 3.76% |
| 10 | Paper | 72.44% | 71.12% | 26.38% | 23.53% | 1.17% | 5.35% |
| 11 | Chemicals | 57.63% | 64.16% | 42.28% | 35.16% | 0.08% | 0.68% |
| 12 | Petroleum | 87.77% | 81.54% | 12.22% | 18.41% | 0.01% | 0.05% |
| 13 | Clay, Concrete, Glass | 93.77% | 96.03% | 6.16% | 3.93% | 0.07% | 0.04% |
| 14 | Primary Metal | 61.31% | 82.55% | 38.64% | 17.44% | 0.05% | 0.00% |
| 15 | Secondary & Misc. Mixed | 96.80% | 90.84% | 2.34% | 1.51% | 0.86% | 7.65% |
| Total | | 77.50% | 78.28% | 22.24% | 19.79% | 0.27% | 1.93% |

# Appendix B: VMT and VHT by Functional Classification

**Table B-1: 2010 VMT/VHT – Total (Passenger Vehicles and Trucks) Flow by Functional Class**

| Code | Code Description | VMT | VHT |
|---|---|---|---|
| 0 | Centroid Connector | 108,812,957.56 | 4,623,988.50 |
| 1 | Rural Interstate | 51,745,096.44 | 879,112.77 |
| 2 | Rural Principal Arterial | 71,074,747.17 | 1,486,363.81 |
| 6 | Rural Minor Arterial | 39,687,887.16 | 832,571.21 |
| 7 | Rural Major Collector | 43,514,262.78 | 906,122.07 |
| 8 | Rural Minor Collector | 8,087,376.79 | 164,198.62 |
| 9 | Rural Local | 3,275,687.39 | 102,067.59 |
| 11 | Urban Interstate | 112,648,599.59 | 1,872,358.70 |
| 12 | Urban Freeway & Expressway | 89,227,881.47 | 1,521,910.85 |
| 14 | Other Urban Principal Arterial | 116,576,647.61 | 2,921,485.13 |
| 16 | Urban Minor Arterial | 26,415,666.72 | 669,700.21 |
| 17 | Urban Collector | 4,748,248.06 | 129,835.41 |
| 19 | Urban Local | 221,179.10 | 11,178.74 |
| 30 | Water Ferry | 36,025.17 | 950.39 |
| 111 | HOV and HOT Lanes | 11,931,321.60 | 197,581.45 |
| Total | | 688,003,584.60 | 16,319,425.45 |

**Table B-2: 2040 VMT/VHT – Total (Passenger Vehicles and Trucks) Flow by Functional Class**

| Code | Code Description | VMT | VHT |
|---|---|---|---|
| 0 | Centroid Connector | 185,550,766.60 | 7,825,374.79 |
| 1 | Rural Interstate | 84,186,808.60 | 1,759,576.81 |
| 2 | Rural Principal Arterial | 103,058,094.24 | 2,456,609.40 |
| 6 | Rural Minor Arterial | 61,824,180.47 | 1,523,844.18 |
| 7 | Rural Major Collector | 72,481,065.53 | 1,820,905.24 |
| 8 | Rural Minor Collector | 14,641,424.10 | 373,820.32 |
| 9 | Rural Local | 6,217,295.82 | 201,690.57 |
| 11 | Urban Interstate | 174,377,603.66 | 3,219,052.97 |
| 12 | Urban Freeway & Expressway | 168,161,936.42 | 3,277,301.16 |
| 14 | Other Urban Principal Arterial | 159,876,211.55 | 4,875,214.75 |
| 16 | Urban Minor Arterial | 39,347,306.75 | 1,286,844.88 |
| 17 | Urban Collector | 7,911,903.80 | 276,658.62 |
| 19 | Urban Local | 404,993.79 | 28,085.60 |
| 30 | Water Ferry | 46,308.38 | 1,228.34 |
| 111 | HOV and HOT Lanes | 26,658,557.96 | 499,657.21 |
| Total | | 1,104,744,457.69 | 29,425,864.84 |

**Table B-3: 2010 VMT/VHT – Truck Flow (Heavy and Medium Trucks) by Functional Class***

| Code | Code Description | VMT | VHT |
|---|---|---|---|
| 0 | Centroid Connector | 1,637,301.70 | 188,430,724.13 |
| 1 | Rural Interstate | 15,100,778.25 | 523,920,683.46 |
| 2 | Rural Principal Arterial | 8,296,534.91 | 349,548,476.28 |
| 6 | Rural Minor Arterial | 3,348,488.50 | 150,147,555.71 |
| 7 | Rural Major Collector | 2,891,295.66 | 139,909,404.09 |
| 8 | Rural Minor Collector | 462,477.97 | 18,899,623.82 |
| 9 | Rural Local | 124,750.81 | 15,553,988.06 |
| 11 | Urban Interstate | 10,695,739.28 | 149,624,552.25 |
| 12 | Urban Freeway & Expressway | 3,742,532.90 | 57,352,337.34 |
| 14 | Other Urban Principal Arterial | 2,730,186.75 | 69,099,963.18 |
| 16 | Urban Minor Arterial | 644,773.62 | 17,565,292.73 |
| 17 | Urban Collector | 119,316.15 | 4,203,452.69 |
| 19 | Urban Local | 1,545.88 | 246,770.62 |
| 30 | Water Ferry | 944.3 | 69,171.82 |
| 111 | HOV and HOT Lanes | 1,639.76 | 32,416.47 |
| Total | | 49,798,306.44 | 1,684,604,412.66 |

Note:
*Truck VMT does not include smaller commercial vehicles

**Table B-4: 2040 VMT/VHT – Truck Flow (Heavy and Medium Trucks) by Functional Class***

| Code | Code Description | VMT | VHT |
|---|---|---|---|
| 0 | Centroid Connector | 2,630,034.90 | 309,501,235.98 |
| 1 | Rural Interstate | 19,549,508.39 | 940,084,985.72 |
| 2 | Rural Principal Arterial | 11,748,444.96 | 516,816,466.17 |
| 6 | Rural Minor Arterial | 5,252,717.07 | 245,478,132.31 |
| 7 | Rural Major Collector | 4,742,783.56 | 258,640,941.29 |
| 8 | Rural Minor Collector | 843,598.61 | 36,926,882.51 |
| 9 | Rural Local | 241,167.08 | 30,241,490.78 |
| 11 | Urban Interstate | 13,813,952.12 | 227,608,407.10 |
| 12 | Urban Freeway & Expressway | 7,028,791.60 | 161,392,913.96 |
| 14 | Other Urban Principal Arterial | 3,624,955.40 | 129,004,424.11 |
| 16 | Urban Minor Arterial | 882,290.04 | 42,822,414.29 |
| 17 | Urban Collector | 175,922.52 | 8,688,428.78 |
| 19 | Urban Local | 5,211.95 | 1,227,933.49 |
| 30 | Water Ferry | 1,173.47 | 81,643.23 |
| 111 | HOV and HOT Lanes | 176,015.51 | 5,266,159.91 |
| **Total** | | **70,716,567.18** | **2,913,782,459.64** |

Note:
*Truck VMT does not include smaller commercial vehicles

# Texas Transportation Plan

## Tech Memo 6: Transit Modal Profile

August 15, 2014

## Acknowledgements

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## 1.0 Introduction

The Texas Transportation Plan 2040 (TTP) is the State's long-range transportation plan which covers the size and scope of the Texas transportation system, including all modes of public transportation. This memo documents the existing conditions, current and future demand, funding needs, and fiscally-constrained investment scenarios for public transit agencies. The performance outcomes, based on conditions of assets and new transit ridership, are also projected for each funding scenario.

## 2.0 Overview of Existing Conditions

There are over 70 transit agencies operating in Texas, with most agencies providing multiple modes of service under varying contractual arrangements. The TTP includes agencies from all areas providing all modes of service in the state, including rail, bus, and demand response. The agencies are divided into tiers for analysis, including:

- Metropolitan Transit Authorities (MTAs), which are not funded by the state and are direct recipients of funding from the Federal Transit Administration (FTA).
- State Urban agencies which are funded by the state and serve smaller urban areas than the MTAs, as illustrated in **Figure 2-1**.
- Rural Transit Districts (RTDs), shown in **Figure 2-2**, which are subrecipients of federal funding through TxDOT.
- Special service operators who provide services under the Seniors and Individuals with Disabilities Program (Sect. 5310).
- Intercity bus services operated by private operators, such as Greyhound, also receive grant money from TxDOT to support intercity services.

For ease of reporting, all Non-MTA agencies are often grouped together in this memo as they are all direct recipients of funding from TxDOT, whereas the MTAs are not.

**Figure 2-1. Texas Urban Transit Agencies**

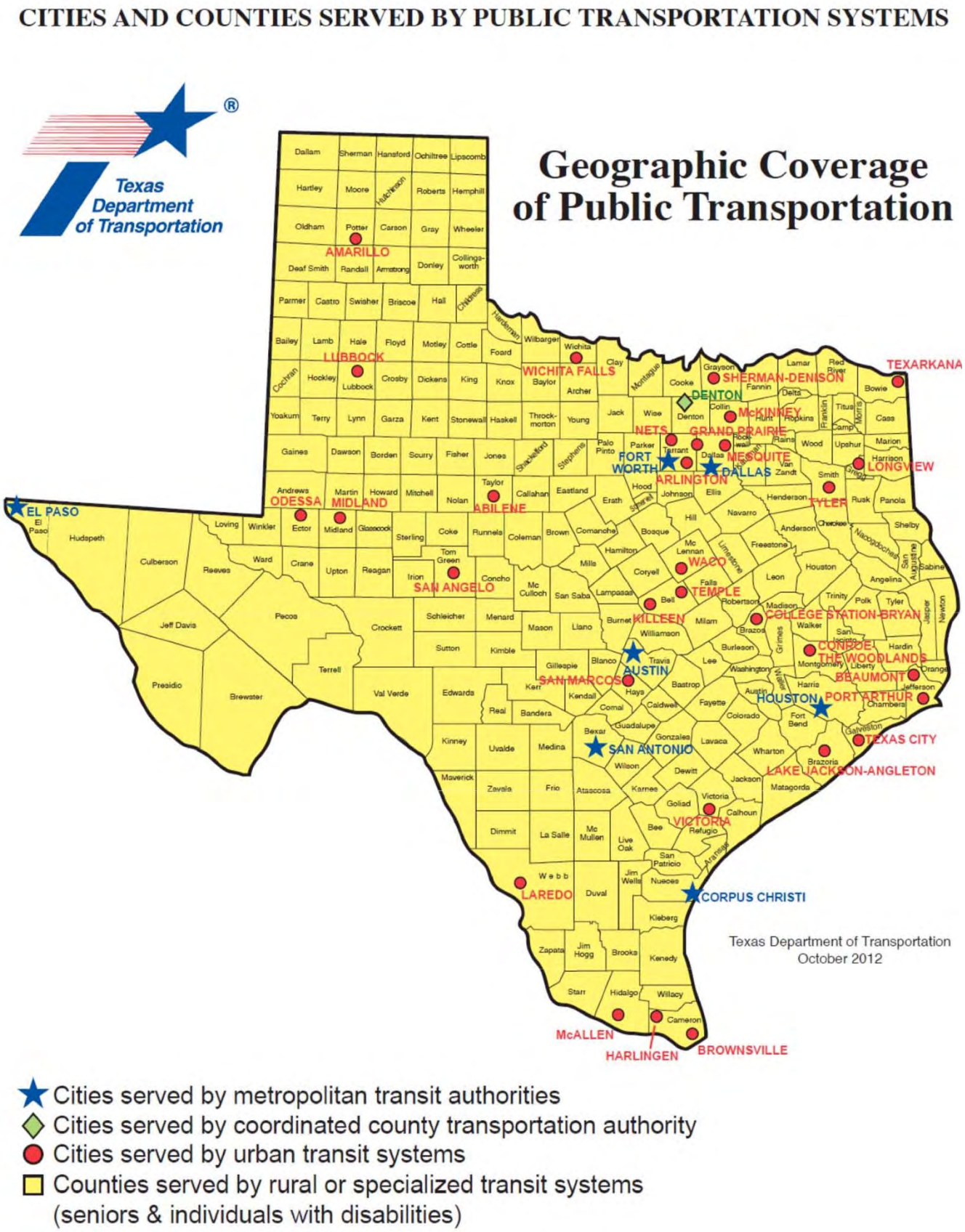
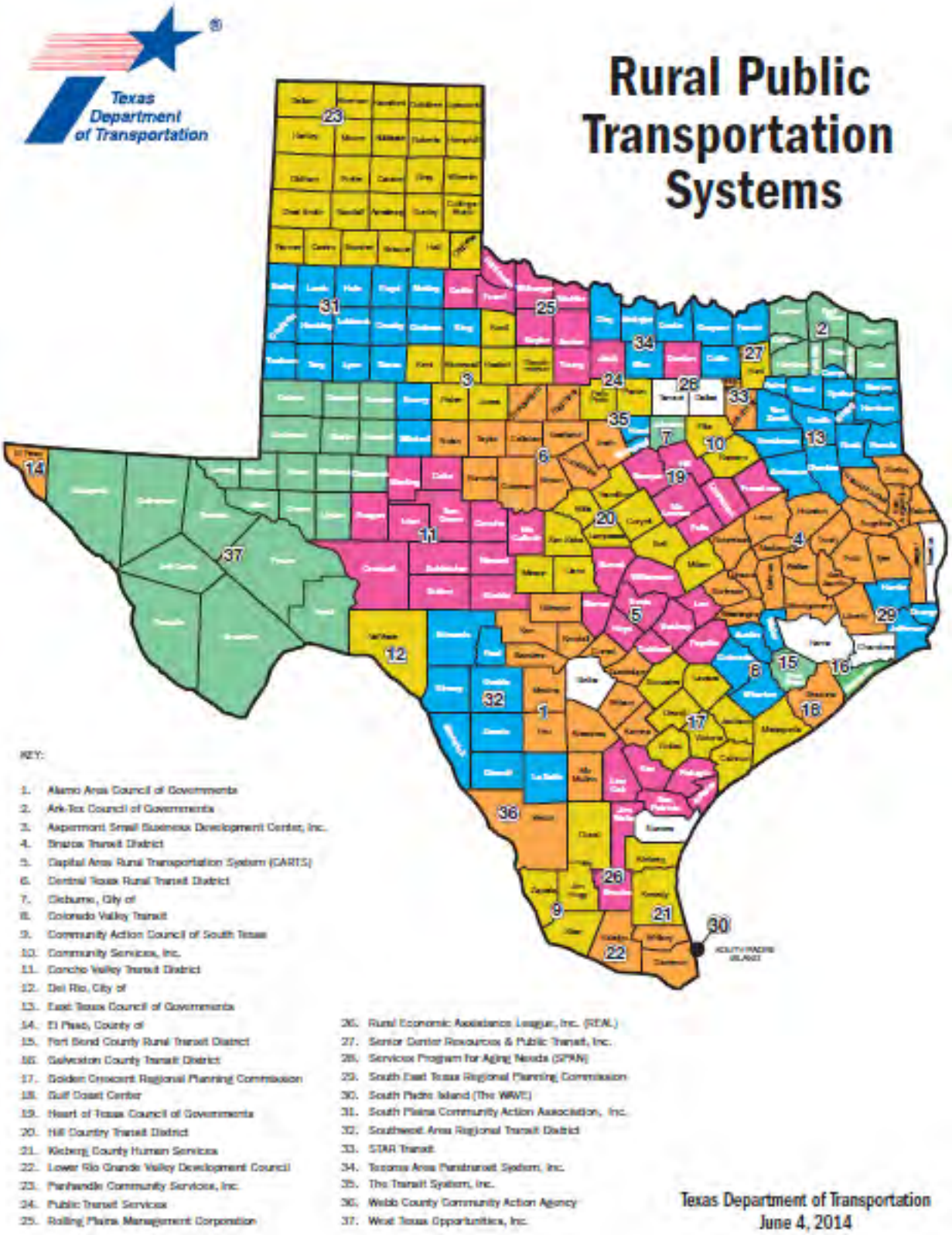


**Figure 2-2. Texas Rural Transportation Districts**



There are currently seven MTA agencies (in El Paso, Fort Worth, Houston, Austin, San Antonio, Corpus Christi and Dallas), and over 30 each of State Urban and RTD agencies. About 90 agencies also offer Special transit services for Seniors and Individuals with Disabilities.

A 2013 inventory of existing public transit assets was developed using inputs from TxDOT's Public Transportation Management System (PTMS) and assets reported to the National Transit Database (NTD) and TERM Federal, described in detail in the *Transit Analysis Methodology* memo. This inventory served as a baseline for estimating future state of good repair needs (SGR), described below in **Section 3.1.1**.

As seen in **Table 2-1**, this inventory totals over $17 billion. It is important to note that approximately 95 percent of the public transit assets in Texas are owned and operated by MTAs. Within the Non-MTA agencies, approximately half of the asset value is owned by State Urban agencies with a little less than half owned by the RTDs. Combined Intercity Bus and Special services make up less than five percent of the Non-MTA asset base. In total this inventory includes well over 10,000 revenue vehicles and approximately 350 stations and transit facilities.

**Table 2-1. Statewide Replacement Value of Transit Assets (Millions of $2014)**

| Mode | MTA | Non-MTA | Total |
|---|---|---|---|
| Motor Bus | $8,325 | $159 | $8,484 |
| Light Rail | $5,706 | $30 | $5,736 |
| Commuter Rail | $1,720 | $0 | $1,720 |
| Systemwide Assets | $330 | $2 | $333 |
| Demand Response | $259 | $761 | $1,021 |
| Vanpool | $178 | $0 | $178 |
| Ferry Boat | $14 | $0 | $14 |
| **Total** | **$16,533** | **$952** | **$17,485** |

As shown in **Figure 2-3**, the largest portion of public transit assets are providing bus services in Texas, making up about half of all transit assets by value. Light rail systems are the next largest group of assets, representing about a third of the asset base. The modal profile for MTAs is significantly different from that of Non-MTA agencies. **Figure 2-4** illustrates the primary differences in services provided by MTAs and Non-MTA agencies, with Demand Response dominating the State Urban, RTD, and Special services assets while MTAs are more evenly divided between fixed route, bus and rail, services.

**Figure 2-3. Proportion of Statewide Public Transit Assets by Mode**

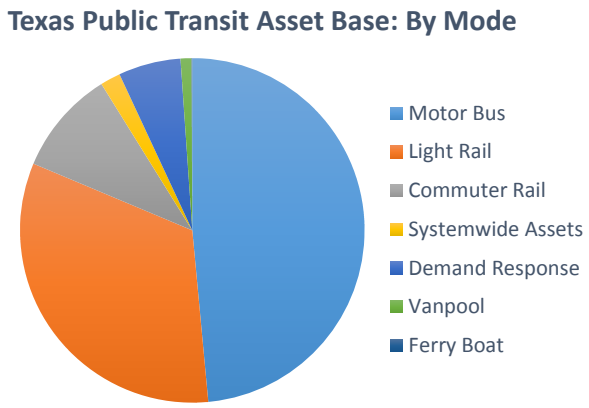
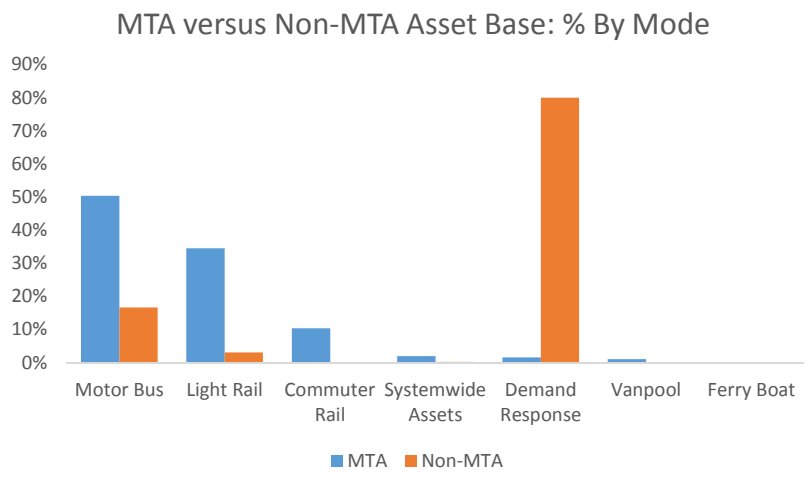
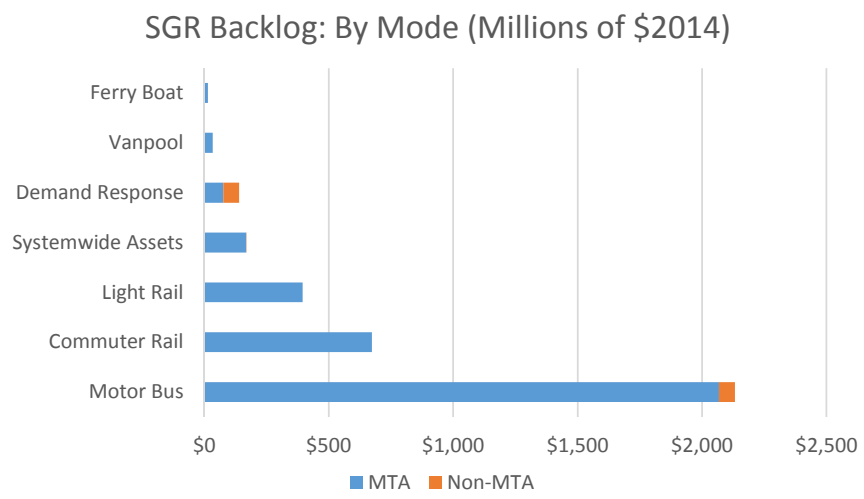


**Figure 2-4. Proportion of Public Transit Assets by Mode for MTA and Non-MTA Agencies**




The SGR backlog for public transit is estimated based on deferred rehabilitation and replacement needs. Based on the 2013 inventory, the SGR backlog for public transit in Texas is estimated to be valued at $3.6 billion, or about 20 percent of the asset base. This current SGR backlog represents all assets that are beyond their useful life and should be replaced. **Figure 2-5** shows the current SGR backlog by mode and agency tier.

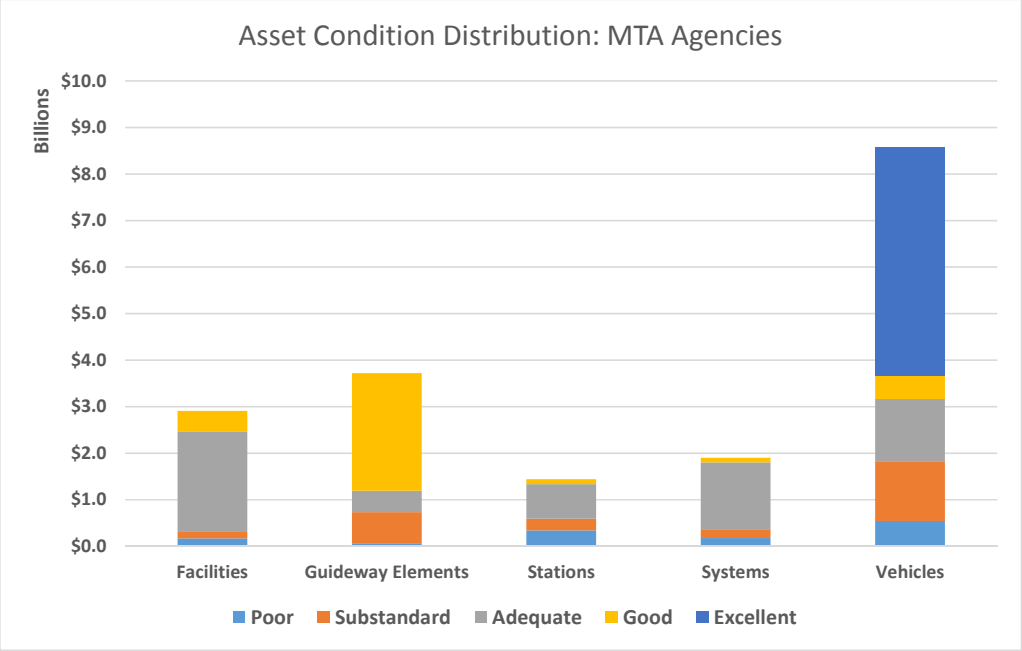
**Figure 2-5. Statewide Current SGR Backlog by Mode**

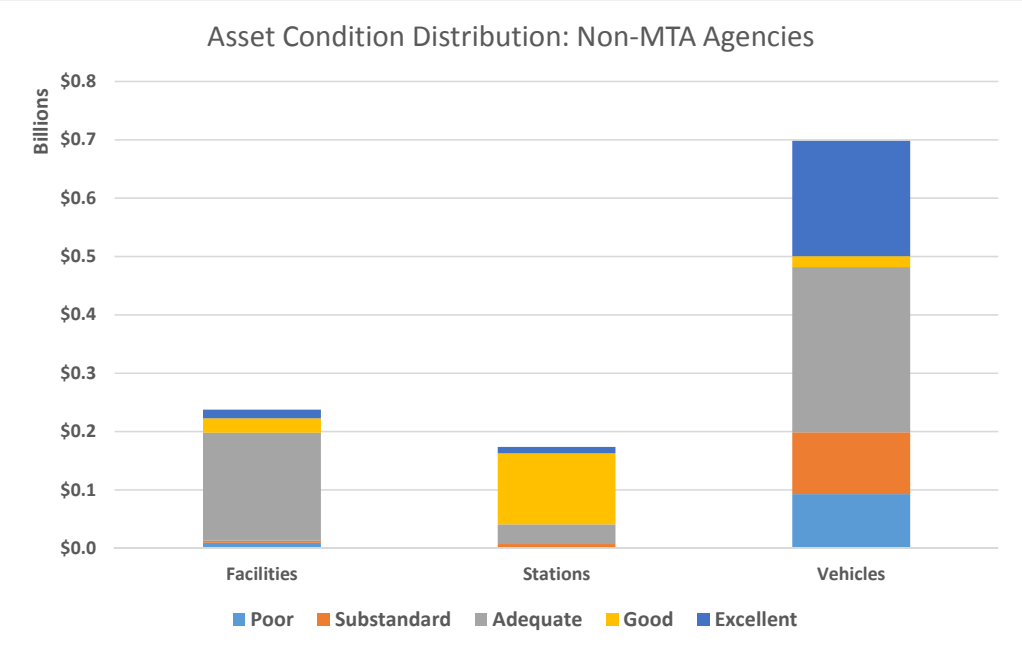



The current condition of public transit assets can also be estimated based on the statewide inventory. The FTA five point rating scale for condition, described in the previous*Transit Analysis Methodology* memo, is shown below in **Figure 2-6** for both MTA and Non-MTA agencies across all asset categories. The resulting condition estimates are based on individual asset ages and replacement values. For MTAs, a majority of vehicles are estimated to be in Excellent condition, whereas 40 percent of stations are estimated to be in Substandard or Poor condition. By comparison, only about a quarter of Non-MTA vehicles are estimated to be in Excellent condition,

while over 75 percent of Stations are in Good or Excellent condition. All assets in Poor condition should be replaced immediately to maintain SGR.

**Figure 2-6. Estimated Public Transit Asset Condition for MTA and Non-MTA Agencies**



Ridership data was provided from the National Transit Database (NTD) to serve as the baseline for projecting public transit demand going forward to 2040[1]. Statewide transit passenger boardings totaled more than 250 million in 2012, with nearly three quarters of all transit trips occurring on MTA bus services (**Figure 2-7**). **Table 2-2** also shows nearly 19 million trips occurred on Non-MTA services, again with most trips on bus routes.

**Figure 2-7. 2012 Annual Boardings by Mode**

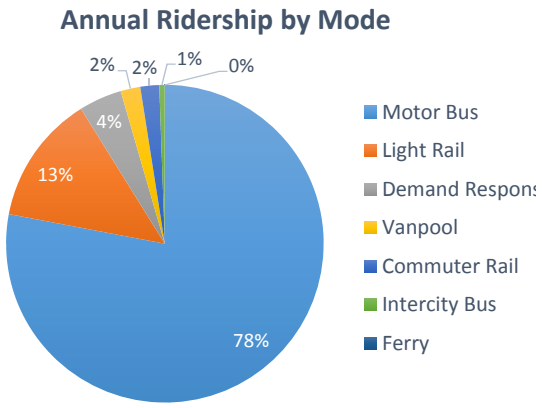



**Table 2-2. 2012 Annual Boardings by Mode**

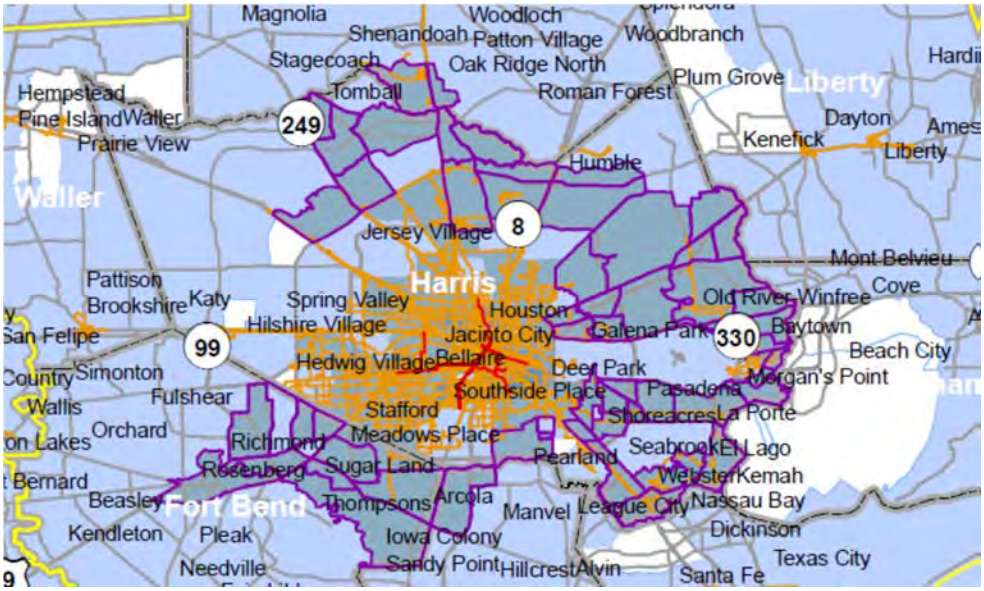
| Mode | MTA | Non-MTA | Total |
|---|---|---|---|
| Motor Bus | 181,640,003 | 13,502,098 | 195,142,101 |
| Light Rail | 32,920,451 | 31,286 | 32,951,737 |
| Demand Response | 7,366,253 | 3,549,918 | 10,916,172 |
| Vanpool | 3,991,280 | 1,025,000 | 5,016,280 |
| Commuter Rail | 4,812,595 | - | 4,812,595 |
| Commuter and Intercity Bus | 551,891 | 817,483 | 1,369,374 |
| Ferry | 52,951 | - | 52,951 |
| **Total** | **231,335,425** | **18,925,785** | **250,261,210** |

Source: NTD 2012

The ridership seen in MTA areas accounts for 92 percent of all public transit trips in Texas. However, there are areas surrounding and nearby these metropolitan centers with lower density development and little or no existing fixed-route transit services. These collar areas are referred to as 'urban gaps' and are described in more detail in Section 3.5 of the *Transit Analysis Methodology* memo. These areas with lower transit service levels than the neighboring MTA service areas are targets for improved service levels over the course of the TTP timeframe. Specifically, the analysis identified urban gap areas (e.g., see the regions sourounded in purple line in **Figure 2-8** below) for the four largest urbanized areas (Houston, Dallas, Austin and San Antonio). Here, the gap area was defined as collar areas expected to undergo increases in population density of more than 2 persons per acre through 2040. The analysis then assessed the expected total population growth in these areas. Finally, the analysis assessed the level of service (and related assets) required to support this new population at a level of service comparable to that provided in regions with similar population densities.

[1] NTD was used as the source for passenger boardings as it segments boardings by mode.

**Figure 2-8. Houston Urban Gap Area with Density Increases of More than 2.0 Persons per Acre**




# 3.0 Unconstrained Needs Determination

## *3.1 Methodology and Assumptions*

The methodology described below is based on the FTA's national-level approach for transit condition and performance reporting, which contributes to the biennial *Congressional Conditions & Performance Report* and *National State of Good Repair Assessment*. This methodology is described in detail in the *Transit Analysis Methodology* memo.

### 3.1.1 Defining "Needs" and State-of-Good Repair

For the purposes of the TTP, transit needs have been divided into three categories of investment:

1. **Preservation:** the capital reinvestment required to maintain existing assets in SGR. Reinvestment needs include rehabilitation and replacement of transit assets, as well as annual capital maintenance (ACM) needs. Preservation also includes the cost of operation and maintenance (O&M) of existing assets for current service levels.
2. **Service expansion:** the capital investments and O&M costs for projected growth in service levels based on projected growth in ridership. Service expansion includes fleet expansion and related facility expansion in response to growth in population and underlying demand. It does not include the addition of services into new geographic areas or addition of new modes of transit.
3. **Major new service:** the capital investments and related O&M costs to significantly improve transit performance via enhancements to core capacity or extension of services into new areas or modes. These projects are generally funded by New Starts or Small Starts grants and are detailed in either a Metropolitan Transportation Plan (MTP) or a Regional Transportation Plan (RTP).

Preservation outcomes are measured by the percentage of assets that are in a "state of good repair" (SGR). For this analysis an asset is in SGR if it does not exceed its useful life and does not require rehabilitation (rehab). If no reinvestment action can be taken for an asset that is due for replacement or rehabilitation as a result of budget constraints, that asset will go into the SGR backlog. This measure captures assets that are above 2.5 on the FTA five-point condition rating scale described above and used in FTA's National State of Good Repair Assessement for transit. See Exhibit 2 in the *Transit Analysis Methodology* memo for a description of asset conditions.

While Preservation is measured by SGR performance, the other two categories of investment are related to growth in ridership. New riders captured by these services are therefore the performance measure for Service Expansion and Major New Services.

### 3.1.2 Predicting Future Performance

To project capital and O&M needs for Preservation and Service Expansion, FTA's Transit Economic Requirements Model (TERM) was customized to model Texas transit asset needs out to 2040. TERM is used to estimate transit investment needs at the federal level, and is available for individual agencies as TERM Lite.

#### Preservation

The customized version, TEX Lite, estimates the total level of reinvestment needed to reach and maintain SGR and includes O&M cost modeling based on the same algorithms used in TERM federal. The O&M costs are based on changes in fleet size over time and baseline O&M cost relationships which are defined by mode.

To project reinvestment needs TEX Lite determines the age and condition of assets in each year of the projection (that is, from current year to 2040) based on FTA's decay curves, which use age as the basis for determining current and future condition. While direct physical evaluation of the condition of an asset provides more accurate condition ratings than age-based estimates, this approach is not feasible for a state-wide project such as the TTP.

TEX Lite uses life cycle profiles to determine if rehabilitation or replacement is needed, and the associated costs. The life cycle of an asset is defined by three components: the useful life, the rehab policy, and the annual capital maintenance needs. The number of rehabs allowed, the age of each rehab and the cost of each have been set to defaults by asset type based on previous FTA research. Finally, ACM greater than zero ensures that a small amount of reinvestment occurs for assets every year of the analysis period.

The replacement cost of assets were taken from the asset inventory from the PTMS database provided by TxDOT. This inventory was then combined with the existing FTA inventory of Texas assets in TERM federal.

### Service Expansion

Service Expansion needs are projected in TEX Lite based on:

1. Ridership growth rates by mode for each individual agency
2. Fleet capacity limitations by mode
3. Relationships between fleet size and associated infrastructure

Ridership growth rates were calculated based on Texas State Data Center projections to 2040 for population growth by county for fixed route services. Demand response services were projected based on a model used in Illinois where 59 percent weight is given to population growth and 41 percent weight is given to growth in the over 65 years of age segment of population. Special services (FTA §5310) are not projected to grow from current levels.

Urban Gap growth rates were identified based on increases in population density in metropolitan/urban areas not currently served by MTA services, as shown in the maps in Section 2. Urban Gap growth rates were identified in four of the MTA areas, with the resulting increases in demand detailed in Table 3-1.

**Table 3-1. Projected Urban Gap Growth Rates**

| Urban Gap Location | Projected Increase Transit Ridership |
|---|---|
| Houston | 30.2% |
| San Antonio | 11.4% |
| Austin | 28.4% |
| Dallas | 28.9% |

The resulting statewide average annual growth in transit demand from the methods described above is 2.3 percent.

### Major New Services

The most recent MTP/RTPs were used to determine the investment needs for Major New Services. In addition, The Texas A&M Transportation Institute (TTI) provided a list of Major New Service projects for State Urban and RTD agencies.

**Table 3-2. Estimated O&M to Capital Invested Ratio for Major New Services**

| Project Mode | O&M/Capital Ratio |
|---|---|
| Bus Rapid Transit | 0.25 |
| Motor Bus | 0.57 |
| Commuter/Heavy Rail | 0.03 |
| Demand Response | 0.71 |
| Ferry | 0.57 |
| Intermodal Facility | 0.01 |
| Light Rail/Streetcar | 0.03 |

Most MPO financial plans do not include the O&M costs related to Major New Service projects. As such, the O&M costs associated with these projects were estimated using the relationship between the capital investment and O&M costs of similar projects by mode or asset type. The resulting ratio of capital to O&M dollars for Major New Services (where expected O&M was not reported) are shown in Table 3-2.

In addition, some assets procured for Major New Services will require rehab and replacement before the end of the 2040 analysis period. Given the 50- to 60-year lifespan of facilities, facility-only projects did not require reinvestment. However, projects involving rail and bus vehicles were estimated to require 40 percent reinvestment of initial project value based on the shorter life of vehicles and related systems. This reinvestment estimate only applies to projects executed in the next five years, as projects beyond that have too much uncertainty related to timing of reinvestment needs.

The estimated project costs in the MTP/RTP and TTI project listings were deflated to 2014 dollars using the reported inflation rate used by the MPO (generally four percent). All other analysis was also performed in 2014 dollars.

### 3.1.3 Selecting Investments

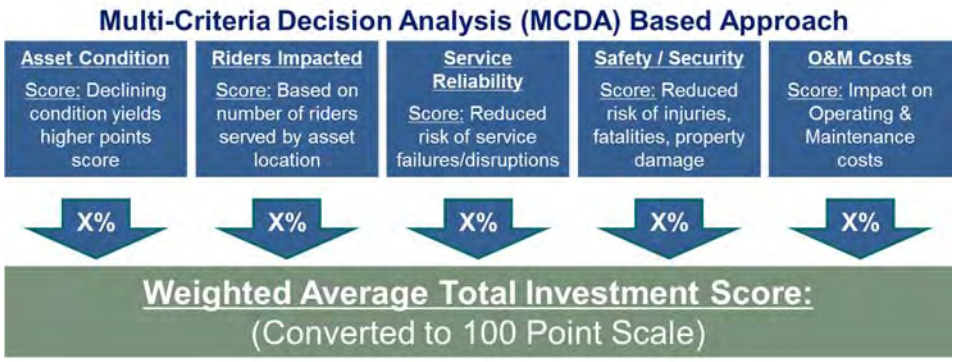
TEX Lite utilizes a prioritization regime to rank reinvestment needs when there is a budget constraint. The Multi-Criteria Decision Analysis (MDCA) approach used by TEX Lite is described in detail in Section 4.1 of the *Transit Analysis Methodology* memo.

**Figure 3-1** provides an overview of the five investment criteria used to score and rank all potential SGR reinvestment actions – including asset condition, number of riders impacted, and the contribution of reinvestment actions to each of service reliability, safety and security, and O&M cost reduction. These criteria for prioritization were developed in conjunction with the Regional Transportation Authority (RTA) in Chicago, and the three operating agencies, Chicago Transit Authority, Metra and Pace, to reflect the priorities of transit in their region. They have since been adopted for use by the FTA in TERM Lite.

The weight placed on each criterion for this analysis is currently set to reflect Preservation priorities for existing assets:

- 65 percent Asset Condition
- 10 percent Impacted Riders
- 15 percent Service Reliability
- 5 percent Safety and Security
- 5 percent O&M Cost Impact

**Figure 3-1. TEX Lite – Investment Prioritization Criteria and Scoring**




Service Expansion investments are prioritized under constrained funding using a separate calculation within TEX Lite. The cost-effectiveness, in terms of new riders per dollar spent, is the only criteria used to prioritize expansion investments in the model. More riders per dollar receive higher ranking. Once assets are acquired for expansion, they are subject to the same prioritization for reinvestment as described above.

Major New Service projects were prioritized based on their identified level of funding and/or stage of planning. If a project was reported as fully funded, or programmed, then it was given highest priority. Partially funded or planned projects ranked second; unfunded or potential projects ranked last.

## *3.2 Unconstrained Needs to 2040*

Based on the methods described above, the unconstrained average annual public transit needs for Texas to 2040 are $3.96 billion. Table 3-3 on the following page details the breakdown of this value by type of expenditure (capital versus operating), type of investment need and agency tier.

For Non-MTA agencies unconstrained needs to 2040 total $8.3 billion, or an average of $309 million per year. This is approximately 8 percent of the statewide public transit needs for the TTP. The remaining 92 percent of needs fall under the MTAs for preservation of existing services and expansion to incorporate increasing populations and transit demands.

The unconstrained needs result in 100 percent SGR for all modes and operators, as all rehabs and replacements have occurred and no asset exceeds its useful life in 2040. Combining Service Expansion with Major New Services, the resulting increase in statewide transit ridership totals just over 190 million trips; about nine million of those trips are taken on Non-MTA services.

As Preservation and Service Expansion needs are both based on the 2013 inventory of transit assets, the resulting needs are dependent on accurate inventory records. While every effort was made to ensure a complete transit inventory for the state, there may be missing records or incomplete records for some agencies.

To address this issue, some 'generated' records have been created to estimate facility and support systems related to known fleet numbers. These records combined with the TERM federal and TxDOT contributions will largely address the complete needs of transit across Texas, but it must be noted that the Preservation and Service Expansion estimates below are likely conservative compared to the reality faced by individual transit agencies.

A larger concern for the unconstrained projection below is the minimal number of Major New Service projects scheduled beyond the next ten years. Of the 132 projects listed for MTAs, only 39 occur past 2024. None of the State Urban or RTD projects occur after 2020. In a truly unconstrained future, there would certainly be an ongoing need to deliver services to new areas and increase the reach of fixed transit routes. The tapering off of Major New Service needs in the numbers represented below certainly underestimates the total need in this area, and underestimates the total potential ridership growth from this type of new service.

**Table 3-3. Unconstrained Public Transit Needs 2014 to 2040 (Millions of $2014)**

| Capital | Type of Investment | MTA | MTA Gap | State Urban | RTD | Special | Intercity Bus | Total | State DR* |
|---|---|---|---|---|---|---|---|---|---|
| Preservation: Existing Assets | Backlog | $3,410 | $0 | $111 | $4 | $16 | $0 | $3,541 | $131 |
| | Normal Rehab/ Replace | $26,035 | $0 | $1,025 | $1,798 | $155 | $2 | $29,014 | $2,979 |
| | *Total* | *$29,445* | *$0* | *$1,136* | *$1,802* | *$171* | *$2* | *$32,555* | *$3,110* |
| Service Expansion | Acquisition | $1,425 | $1,596 | $80 | $95 | $0 | $0 | $3,197 | $176 |
| | Normal Rehab/ Replace | $1,200 | $254 | $128 | $178 | $0 | $0 | $1,760 | $306 |
| | *Total* | *$2,625* | *$1,850* | *$208* | *$273* | *$0* | *$0* | *$4,957* | *$482* |
| Major New Service Projects | Acquisition | $13,339 | $0 | $30 | $29 | $0 | $0 | $13,398 | $59 |
| | Normal Rehab/ Replace | $2,270 | $0 | $10 | $2 | $0 | $0 | $2,283 | $13 |
| | *Total* | *$15,609* | *$0* | *$40* | *$32* | *$0* | *$0* | *$15,681* | *$72* |
| **Total: Capital** | | **$47,679** | **$1,850** | **$1,384** | **$2,107** | **$171** | **$2** | **$53,193** | **$3,664** |
| **Operating** | **Type of Investment** | **MTA** | **MTA Gap** | **State Urban** | **RTD** | **Special** | **Intercity Bus** | **Total** | **State DR*** |
| Preservation | Maintain Service | $30,804 | $0 | $1,801 | $1,688 | $159 | $27 | $34,479 | $3,675 |
| Service Expansion | Natural Growth | $6,845 | $5,884 | $337 | $411 | $0 | $0 | $13,478 | $749 |
| Major New Services | New Mode/ Location | $5,546 | $0 | $166 | $90 | $0 | $0 | $5,802 | $256 |
| **Total: Operating** | | **$43,195** | **$5,884** | **$2,304** | **$2,189** | **$159** | **$27** | **$53,759** | **$4,679** |
| **Grand Total** | | **$90,875** | **$7,734** | **$3,688** | **$4,296** | **$330** | **$28** | **$106,952** | **$8,343** |
| | | | | | | **Annual Average:** | | **$3,961** | |

Notes:
*State DR (designated recipient) excludes MTA and MTA Gap needs.
State Urban major New Services include blended SU/RTD categories.
Numbers may not sum due to rounding

## 4.0 Anticipated Revenues and Funding Gap

Public transit in Texas is funded through multiple sources, from the local, state and federal level. Some of the sources are designated for capital or operating support only, though some allow agencies to use funds as needed. Public transit funding sources in Texas include but are not limited to:

- Farebox revenues;
- Local funds which are from a blend of sales taxes, property taxes and 'other funds' (as reported to NTD in 2009);
- State funds which are from a blend of gas taxes, other taxes and 'other funds' (as reported to NTD in 2009); and
- Federal funds which are divided into formula funding and competitive or one-time funding for projects.

Federal formula funding is presented in **Table 4-1**, including eligibility, uses and state/local match minimum requirements. Eligibility requirements are for the service areas and service types. As such they may not be applied by agency type as some agencies provide services that cross into multiple service areas (for example, some Small Urban agencies can receive § 5311 funding if they provide qualifying services).

In addition to formula funds, agencies can also receive New Starts and Small Starts grants for Major New Service projects and (now under MAP-21) capacity enhancement projects for existing systems. There are other federally funded grant programs that contribute to improvements in systems and vehicles, though those grants tend to be smaller contributions to total funding compared to the sources described above.

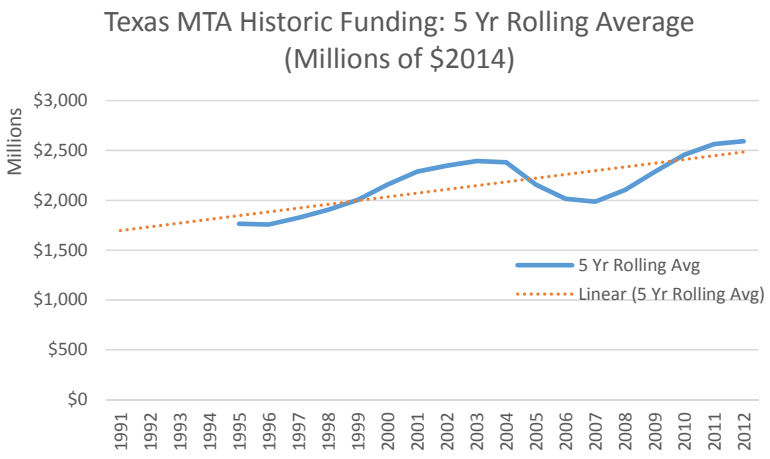
For federal funds allocated to State Urban, RTD and Special services, TxDOT is the "designated recipient" of these funds and allocates them to individual agencies. Since 2004, the TxDOT Public Transportation Division (PTN) has used formulas to allocate state and federal funds for public transportation. Measures of "need" and "performance" have been used to allocate funding since 2007. The details of the funding allocation formula used for subrecipients can be found in the most recent *Texas Transit Statistics* report, published online by TxDOT-PTN.

**Table 4-1. Federal Funding Formula Sources for Public Transit Agencies**

| Federal Funding Source | § 5307 Urban Area | § 5337 State of Good Repair | § 5339 Bus and Bus Facilities | § 5311 Rural | § 5310 Mobility of Seniors & Individuals w/ Disabilities |
|---|---|---|---|---|---|
| Large Urban | ✓ | ✓ | ✓ | | |
| Small Urban (200K to 50K pop) | ✓ | | ✓ | | |
| Rural (under 50K pop) | | | ✓ | ✓ | |
| Special | | | | | ✓ |
| Local Match Requirement | 20% | 20% | 20% | 20% | 20% |
| Designated Uses | Large Urban: Capital and up to 10% for Preventive Maintenance<br><br>Small Urban: Capital and Operating | Capital (reinvestment only) | Capital | Capital and operating | Capital and up to 45% for operating |

Federal funding formulas rely on multiple ratios that compare the services provided by an ageny and the area served by an agency against the rest of the country. The primary factors that drive most allocations are vehicle revenue miles, passenger miles, directional route miles, population, and population density. Large urban agencies in Texas have been increasing their ratios in most of these metrics compared to the rest of the country in recent years. Total funding for the MTAs has therefore been growing in real terms, as seen in **Figure 4-1**.

**Figure 4-1. MTA Funding Trend**

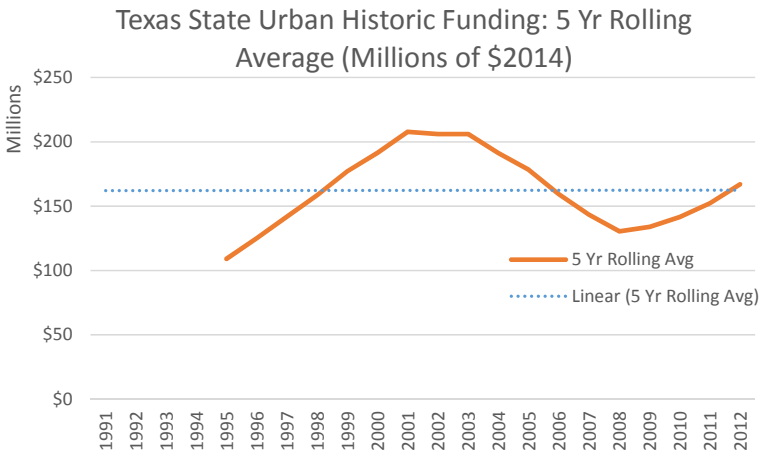



*Source: NTD 2012*

In addition, Texas MTAs currently have five New Starts projects funded. New Starts and Small Starts funding, along with other discretionary grants, create 'bumpy' profiles over time for agencies as they increase funding over normal levels when received. To adjust for these bumps in funding, rolling averages were used to determine historic trends and the proper baseline for growth in funding.

For MTAs, an average funding level for the past 10 years was used as the baseline for 2014 and grown at 1.2 percent in real terms to 2040 to reflect their continuing increases in population and new transit services (**Figure 4-2**). The resulting annual average funding constraint for MTAs is $2.9 billion (in 2014 dollars), including both capital and operating funds. As seen in **Table 4-2**, this results in an annual funding shortfall of about $700 million for MTAs.

**Figure 4-2. Urban Historic Funding Trend**




*Source: NTD 2012*

In addition, the Non-MTA agencies have not seen consistent increases in total funding over time. Based on this historic trend, the average funding for the last 10 years for Non-MTA agencies is held constant to 2040. The result is $227 million per year for State Urban, RTD, Special and Intercity Bus services. This estimate includes both capital and operating funds.

The total funding shortfall compared to unconstrained needs for both MTAs and Non-MTA agencies is approximately $788 million per year. Over the course of the TTP this totals over a $20 billion funding gap.

**Table 4-2. Projected Annual Funding Gap (Millions of $2014 per year)**

| Agency Tier | Average Annual Unconstrained Needs | Average Annual Funding Constraint | Projected Annual Funding Gap |
|---|---|---|---|
| MTA | $3,652 | $2,946 | $707 |
| Non-MTA | $309 | $227 | $82 |
| **Total** | **$3,961** | **$3,173** | **$788** |

Note: Numbers may not sum due to rounding

# 5.0 Fiscally-Constrained Analysis

## *5.1 Project Prioritization*

The following priorities were assigned for allocating constrained funding to the needs identified above:

1. O&M Preservation needs for existing assets – to maintain operation of existing services
2. Fully funded or programmed Major New Service (MNS) projects, both capital and O&M – as funding is already committed to these projects
3. Capital Preservation needs for existing assets (rehab and replacement) – to achieve SGR for existing systems
4. SGR needs for the fully funded/programmed MNS projects (capital reinvestment) – to maintain SGR as new assets are added to the inventory from committed projects
5. Service Expansion needs, both capital and O&M – to meet projected ridership growth
6. Other MNS projects, either partially funded/planned or unfunded/potential

This process of prioritization was done separately for MTAs and Non-MTA agencies under the separate funding constraints noted in Section 4. Within the TEX Lite model, the prioritization routine described in **Section 3.1.3** also prioritizes Preservation and Service Expansion investments when the funding constraint applies. The results of this approach are detailed in the following section.

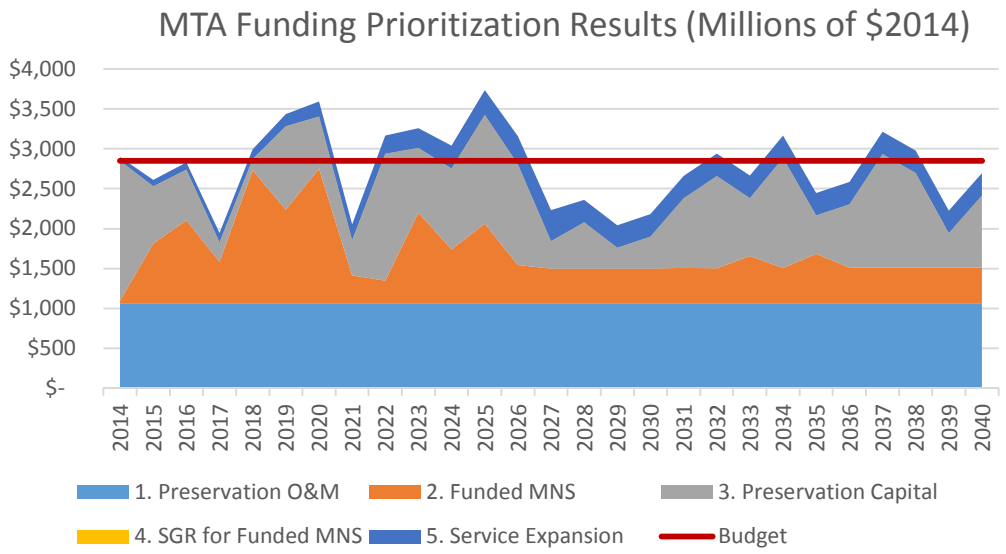
## *5.2 Fiscally-Constrained and Tradeoff Analysis*

Under the funding constraints described above, both the MTA group of agencies and the Non-MTA agencies were allowed to carry over unused budget from one year to the next in this analysis. Carrying over budget allows for more realistic funding outcomes as agencies incur higher costs in years with MNS projects or other procurements for purchase of assets.

**Figure 5-1** illustrates the allocation of funding under the constraint based on the logic described in the preceeding section for MTAs. The effect of carrying over budget can be seen in the bumpiness of the actual needs compared to the annual budget constraint. The $2.9 billion constraint allows the MTAs in this analysis to cover all existing O&M needs, all funded MNS projects, all rehabs and replacements for existing assets (Preservation) and assets purchased as part of MNS projects, and some Service Expansion needs.

Capital expenditures for Service Expansion in this scenario stop in 2027, so fleet expansions to meet growing demand in the MTA areas can only be supported to this year. The remaining years show only O&M needs related to the previously purchased expansion assets.

**Figure 5-1. MTA Funding Constraint and Prioritization Results**

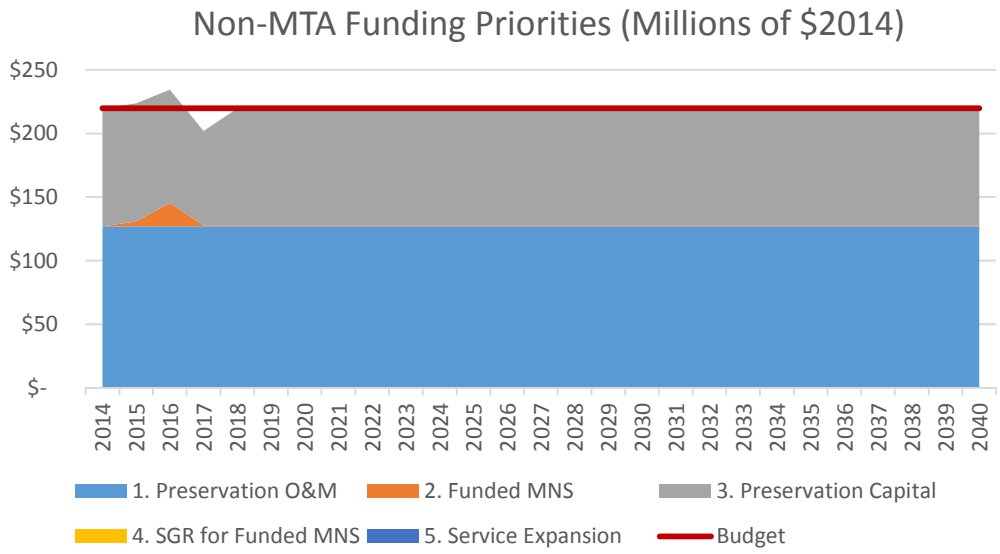



In this scenario for MTAs there is no remaining backlog for transit assets, as all assets are in SGR by 2040.

It is also important to note that the final priority, of partially or unfunded MNS projects, can not be addressed under this budget constraint. The full list projects identified as MNS projects is included in Appendix A, with fully funded projects noted. The list of MNS projects, including funding status, was circulated and verified by the MPOs and some of the agencies involved in planning.

**Figure 5-2** illustrates the results of allocating the budget constraint for the Non-MTA agency needs. The expected funding for these agencies does not cover any expansion beyond the programmed MNS projects. The list of all MNS projects collected by TTI from agencies is also listed in Appendix A.

**Figure 5-2. Non-MTA Funding Constraint and Prioritization Results**




The budget for Non-MTA agencies also does cover all of the Preservation needs for capital rehabs and replacements. Under this funding constraint there is a remaining SGR backlog in 2040 valued at $168 million. The impact of the funding constraint on the Non-MTA SGR backlog over time is illustrated in **Figure 5-3**, where there is an SGR backlog in every year of analysis.

**Figure 5-3. Estimated SGR Backlog for Non-MTA Agencies 2014 to 2040**

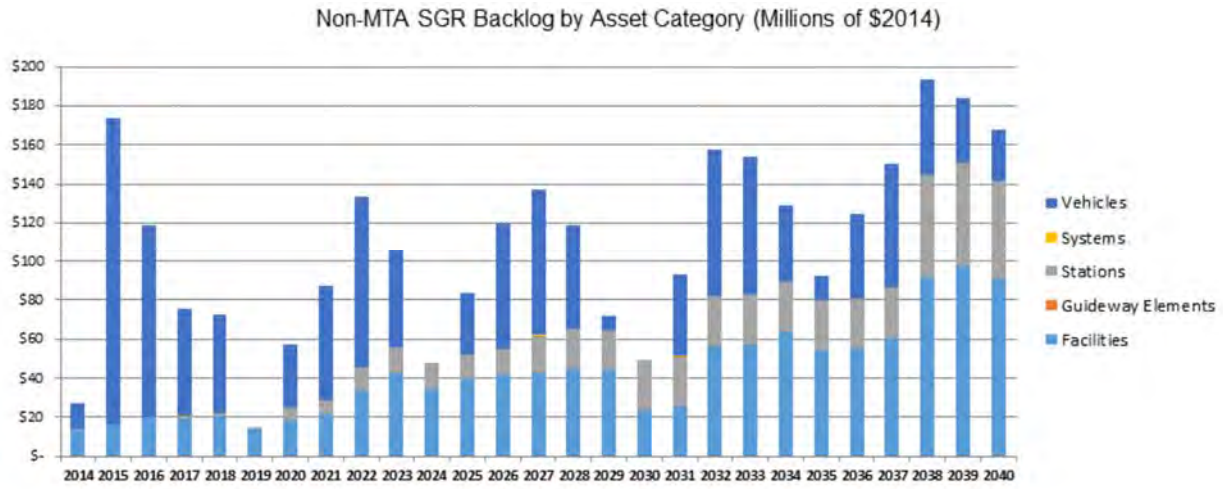


**Table 5-1** summarizes the performance results for both MTA and Non-MTA agencies when applying the prioritization and funding constraints. For MTAs the funding constraint and prioritization approach result in perfect Preservation/SGR results, with moderate growth in ridership. However, not all estimated ridership demand in the MTA areas will be addressed. For the Non-MTAs the result for new ridership is far worse, with little of the estimated growth in demand addressed with the funding available. However, Preservation and SGR results using the priorities listed above are still positive.

**Table 5-1. Summary and Performance Results for Constrained Scenario**

| | Total Invested (M 2014$) | Annual Investment (M 2014$) | 2040 Performance Results |
|---|---|---|---|
| MTA | | | |
| *Budget* | *$ 82,480* | *$ 2,946* | |
| Preservation | $ 55,936 | $ 1,998 | 100% SGR |
| Major New Services | $ 19,843 | $ 709 | 104,682,204 |
| Service Expansion | $ 6,701 | $ 239 | New Trips |
| Non-MTA | | | |
| *Budget* | *$ 6,364* | *$ 227* | |
| Preservation | $ 6,321 | $ 226 | 92% SGR |
| Major New Services | $ 44 | $ 2 | 346,617 |
| Service Expansion | $ - | $ - | New Trips |
| Statewide | | | |
| *Budget* | *$ 88,844* | *$ 3,173* | |
| Preservation | $ 62,257 | $ 2,223 | Over 99% SGR |
| Major New Services | $ 19,887 | $ 710 | 105,028,821 |
| Service Expansion | $ 6,701 | $ 239 | New Trips |

***Public Transit Performance Scales***

| | | | | | |
|---|---|---|---|---|---|
| MTA New Trips | 184,745,661 | 147,796,529 | 110,847,397 | 73,898,264 | 36,949,132 |
| Non-MTA New Trips | 8,871,746 | 7,097,397 | 5,323,048 | 3,548,699 | 1,774,349 |
| **Statewide New Trips** | **193,617,407** | **154,893,926** | **116,170,444** | **77,446,963** | **38,723,481** |
| **Assets in SGR** | **100%** | **86%** | **73%** | **59%** | **45%** |

Note: Totals in the table above may not add up due to rounding.

**Figure 5-4** illustrates the impact of various funding levels on the performance measures for public transit. Again, these curves are based on the inventory and list of projects available for this analysis and may be underestimating the total needs for Preservation and Expansion.

For MTAs, just over $800 million per year spent on reinvestment will result in all assets being in SGR by 2040.

**Figure 5-4. MTA Expenditure Needs for SGR**

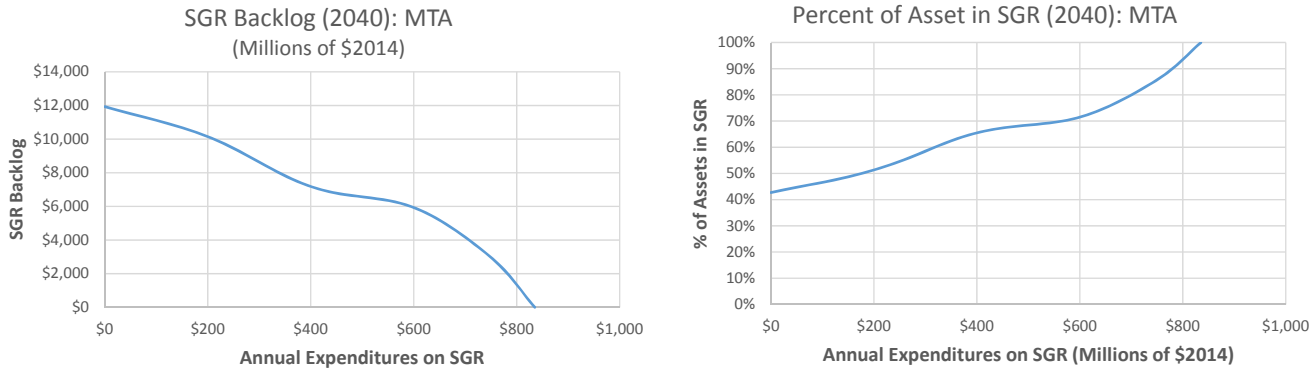
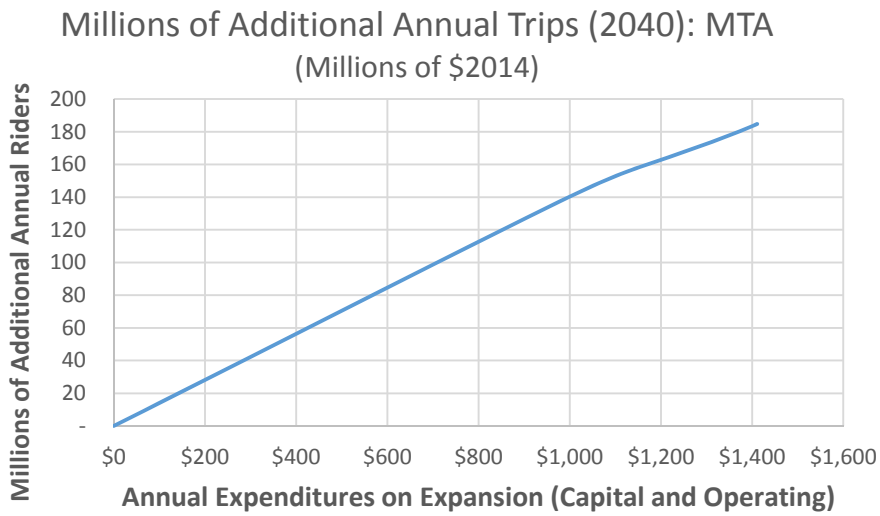


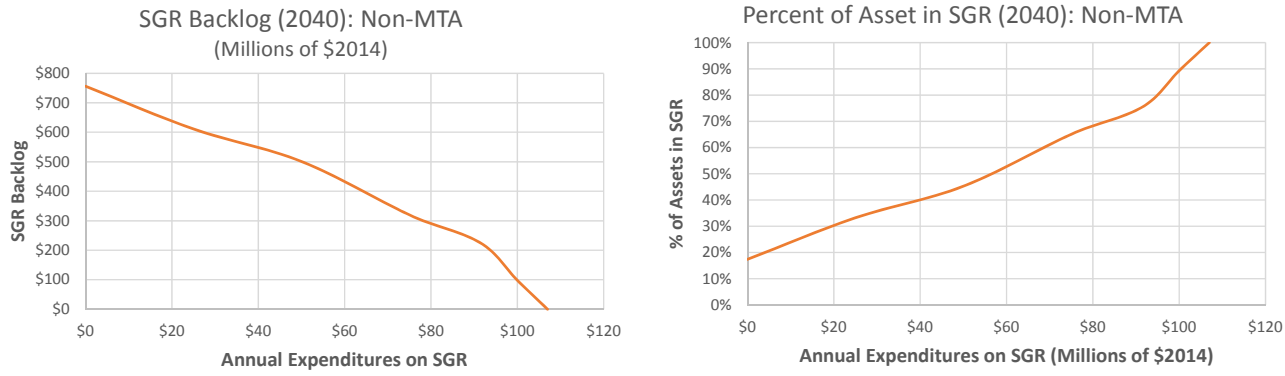

**Figure 5-5** illustrates the annual expenditure needed, in both capital and O&M, for MTAs to meet growing ridership demands at various levels.

**Figure 5-5. MTA Capital and Operating Expenditures for Ridership Growth**



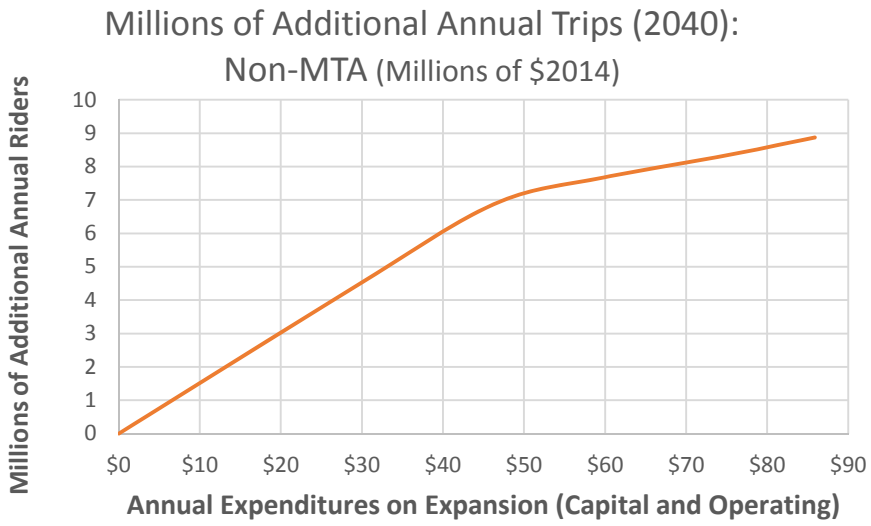

The charts below illustrate the annual expenditure needed to eliminate the SGR backlog for Non-MTA agencies by 2040. In the constrained scenario, about $91 million was available on average for capital investment in Preservation. **Figure 5-6** shows that just over $110 million is needed to address the unconstrained needs for capital investment in this area. If the annual budget for Non-MTA agencies were increased by approximately $20 million per year, from the estimated $227 million to $247 million, then the SGR backlog for these agencies could be eliminated by 2040.

**Figure 5-6. Non-MTA Expenditure Needs for SGR**




However, there would still be some ridership demands unmet with the $247 million in funding. As seen in **Figure 5-7**, the unmet Service Expansion and Major New Service needs would require over $80 million in additional funding per year.

**Figure 5-7. Non-MTA Expenditure Needs for Ridership Growth**



## Appendix A – List of Major New Service Projects

The following mode codes are used in the MTA table: APM = automated people mover, BRT = bus rapid transit, CB = commuter bus, DR = demand response, CR = commuter rail, FB = ferry, IMF = intermodal facility, HSR = high speed rail, LR = light rail, MB = motor bus, RR = commuter/passenger rail, SC = street car

Projects highlighted in orange are given highest priority as they are either reported as fully funded or programmed. Projects highlighted in grey in the MTA list are not considered in this analysis, and are covered in Passenger rail.

| MPO | Mode | Project Name/Cost Description | Capital Cost (YOE$) | Start Year(s) | Funding Source | Fully Funded? | Major New Service? |
|---|---|---|---|---|---|---|---|
| Alamo Area MPO | SC | VIA Metro Transit: Streetcar | $ 231,158,000 | 2017 | TxDOT/COSA/ Bexar County/VIA | No | Yes |
| Corpus Christi | FB | System Expansion: Corpus Christi Dock | $ 2,500,000 | ? | Unfunded (Sect 5309) | No | Yes |
| Corpus Christi | FB | Waterborne Transportation Service: Purchase 2 harbor ferries | $ 2,000,000 | ? | Unfunded (Sect 5309) | No | Yes |
| El Paso | BRT | Alameda Corridor Rapid Transit System (including buses, construction) | $ 37,800,000 | 2015 | Local Funds | Yes | Yes |
| El Paso | BRT | Dyer Corridor Rapid Transit System (design, construct, ITS, etc) | $ 26,348,608 | 2015 | FTA & Local Funds | Yes | Yes |
| El Paso | BRT | Dyer Corridor Rapid Transit System (design, construct, ITS, etc) – Cat 2 | $ 9,168,000 | 2015 | FHWA funds (CAT2) | Yes | Yes |
| El Paso | MB | Far Eastside Transfer Center (PE, ROW, Construction) | $ 4,520,000 | 2016 | FTA & Local Funds | Yes | Yes |
| El Paso | MB | International Mass Transit (BRT/LRT) Juarez and El Paso | $ 79,473,126 | 2021 | FTA & Local Funds | Yes | Yes |
| El Paso | BRT | Mesa Corridor Rapid Transit System (design and construct) | $ 18,970,000 | 2013 | FTA & Local Funds | Yes | Yes |
| El Paso | BRT | Mesa Corridor Rapid Transit System (design and construct) | $ 3,443,000 | 2013 | FHWA funds (CAT2) | Yes | Yes |
| El Paso | BRT | Mesa Corridor RTS (design and construct) | $ 2,686,629 | 2013 | FHWA funds (CAT2) | Yes | Yes |
| El Paso | BRT | Montana Corridor Rapid Transit System (design, construct, ITS, etc) | $ 33,080,000 | 2017 | FTA & Local Funds | Yes | Yes |
| El Paso | BRT | Montana Corridor Rapid Transit System (design, construct, ITS, etc) | $ 9,702,000 | 2017 | FHWA funds (CAT2) | Yes | Yes |
| El Paso | SC | Oregon Street Car Project | $ 118,433,860 | 2020 | FTA & Local Funds | Yes | Yes |
| El Paso | IMF | Northeast Transit Terminal | $ 14,858,000 | 2014 | TIGER & Local | Yes | Yes |
| NCTCOG | RR | Cleburne Line | $ 831,000,000 | 2035 | Local, New Starts, Innovative Financing | ? | Yes |

| MPO | Mode | Project Name/Cost Description | Capital Cost (YOE$) | Start Year(s) | Funding Source | Fully Funded? | Major New Service? |
|---|---|---|---|---|---|---|---|
| NCTCOG | RR | Frisco Line | $ 776,000,000 | 2035 | Local, New Starts, Innovative Financing | ? | Yes |
| NCTCOG | RR | Mansfield Line | $ 1,190,000,000 | 2035 | Local, New Starts, Innovative Financing | ? | Yes |
| NCTCOG | RR | Midlothian Line | $ 587,000,000 | 2035 | Local, New Starts, Innovative Financing | ? | Yes |
| NCTCOG | RR | Speedway Line | $ 984,000,000 | 2035 | Local, New Starts, Innovative Financing | ? | Yes |
| NCTCOG | HSR | East/West Line (Downtown Dallas to Tarrant) | $ 610,000,000 | 2018 | Local, Innovative Financing, Private | ? | Yes |
| NCTCOG | HSR | East/West Line (Downtown Fort Worth to Tarrant) | $ 610,000,000 | 2018 | Local, Innovative Financing, Private | ? | Yes |
| NCTCOG | RR | Waxahachie Line | $ 884,000,000 | 2035 | Local, New Starts, Innovative Financing | ? | Yes |
| NCTCOG | HSR | Regional HSR Rail Connections (MPA boundary, FW, Arlington and Dallas) | $ 807,000,000 | 2018 | Local, Innovative Financing, Private | ? | Yes |
| NCTCOG | LR | Blue Line UNT Extension | $ 422,000,000 | 2018 | Local | Yes | Yes |
| NCTCOG | LR | Cotton Belt | $ 1,241,000,000 | 2018 | Local, New Starts, Innovative Financing | Yes | Yes |
| NCTCOG | LR | Downtown Dallas Second Alignment | $ 1,281,000,000 | 2035 | Local, New Starts | ? | Yes |
| NCTCOG | LR | A-Train (Trinity Mills to Belt Line) | $ 82,000,000 | 2035 | Local | ? | Yes |
| NCTCOG | LR | McKinney Line | $ 518,000,000 | 2035 | Local, New Starts, Innovative Financing | ? | Yes |
| NCTCOG | LR | Orange Line | $ 363,000,000 | 2018 | Local | Yes | Yes |
| NCTCOG | LR | Green Line – Southeast Extension | $ 193,000,000 | 2035 | Local, New Starts | ? | Yes |
| NCTCOG | LR | TEX Rail | $ 959,000,000 | 2018 | Local, New Starts, Innovative Financing | Yes | Yes |

| MPO | Mode | Project Name/Cost Description | Capital Cost (YOE$) | Start Year(s) | Funding Source | Fully Funded? | Major New Service? |
|---|---|---|---|---|---|---|---|
| NCTCOG | LR | Scyene Line (Lanview to Masters) | $ 176,000,000 | 2035 | Local, New Starts, Innovative Financing | ? | Yes |
| NCTCOG | LR | Scyene Line (Masters to Lawson Rd) | $ 1,304,000,000 | 2035 | Local, New Starts, Innovative Financing | ? | Yes |
| NCTCOG | LR | HSR/Airport Connector (Arlington to DFWIA) | $ 200,000,000 | 2018 | Local, Innovative Financing | ? | Yes |
| NCTCOG | SC | Dallas Streetcar (to Oak Cliff) | $ 91,000,000 | 2018 | Local, TIGER grants | Yes | Yes |
| NCTCOG | APM | Las Colinas APM | $ 3,000,000 | 2018 | Local | ? | Yes |
| NCTCOG | APM | Love Field People Mover | $ 49,000,000 | 2018 | Local | ? | Yes |
| NCTCOG | BRT | Ferguson BRT | $ 22,000,000 | 2028 | Local | ? | Yes |
| CAMPO | RR | Lone Star Rail (implement new service Georgetown-San Antonio) | $ 467,000,000 | 2013 | Fed/State/ Local | Yes | Yes |
| CAMPO | CR | Elgin Rail (extension from Austin to Elgin) | $ 327,000,000 | 2015 | Fed/State/ Local | Yes | Yes |
| CAMPO | CR | Round Rock Commuter Rail I (construct new service to Georgetown) | $ 117,000,000 | 2015 | Fed/State/ Local | Yes | Yes |
| CAMPO | CR | Round Rock Commuter Rail II (construct new service to Pflugerville) | $ 111,000,000 | 2015 | Fed/State/ Local | Yes | Yes |
| CAMPO | SC | Urban Rail (implement streetcar circulator service in Austin) | $ 91,000,000 | 2015 | Fed/State/ Local | Yes | Yes |
| CAMPO | SC | Urban Rail – Extension North | $ 272,000,000 | 2020 | Fed/State/ Local | Yes | Yes |
| CAMPO | SC | Urban Rail – Extension Long Center | $ 39,000,000 | 2020 | Fed/State/ Local | Yes | Yes |
| CAMPO | SC | Urban Rail – Extension South | $ 455,000,000 | 2020 | Fed/State/ Local | Yes | Yes |
| CAMPO | BRT | 803 N Burnet S Lamar (implement BRT service) | $ 8,000,000 | 2013 | Fed/State/ Local | Yes | Yes |
| CAMPO | BRT | Slaughter Rapid Bus (implement BRT service) | $ 3,000,000 | 2016 | Fed/State/ Local | Yes | Yes |
| CAMPO | BRT | BR 826 Riverside (implement BRT service) | $ 4,800,000 | 2016 | Fed/State/ Local | Yes | Yes |
| CAMPO | BRT | BR 820 Northeast (implement BRT service) | $ 3,900,000 | 2016 | Fed/State/ Local | Yes | Yes |
| CAMPO | BRT | Central Rapid Bus (implement BRT service) | $ 3,000,000 | 2020 | Fed/State/ Local | Yes | Yes |
| CAMPO | BRT | BR 828 Ben White (implement BRT service) | $ 5,300,000 | 2020 | Fed/State/ Local | Yes | Yes |

| MPO | Mode | Project Name/Cost Description | Capital Cost (YOE$) | Start Year(s) | Funding Source | Fully Funded? | Major New Service? |
|---|---|---|---|---|---|---|---|
| CAMPO | BRT | BR 825 Rundberg/NW (implement BRT service) | $ 9,800,000 | 2020 | Fed/State/ Local | Yes | Yes |
| CAMPO | BRT | BR 880 Oltorf (implement BRT service) | $ 4,900,000 | 2020 | Fed/State/ Local | Yes | Yes |
| CAMPO | BRT | BR 834 Parmer (implement BRT service) | $ 10,400,000 | 2020 | Fed/State/ Local | Yes | Yes |
| CAMPO | CB | 901-South Mapac (CapMetro, implement EB service) | $ 1,700,000 | 2016 | Fed/State/ Local | Yes | Yes |
| CAMPO | CB | 922-Four Points (CapMetro, implement EB service) | $ 2,100,000 | 2020 | Fed/State/ Local | Yes | Yes |
| CAMPO | CB | Bastrop County Connector (CARTS, implement EB service) | $ 2,400,000 | 2020 | Fed/State/ Local | Yes | Yes |
| CAMPO | CB | Bastrop to San Marcos (CARTS, implement EB service) | $ 3,000,000 | 2020 | Fed/State/ Local | Yes | Yes |
| CAMPO | CB | Calwell County Connector (CARTS, implement EB service) | $ 1,600,000 | 2020 | Fed/State/ Local | Yes | Yes |
| CAMPO | CB | Dripping Springs to San Marcos (CARTS, implement EB service) | $ 2,200,000 | 2020 | Fed/State/ Local | Yes | Yes |
| CAMPO | CB | Giddings to Austin (CARTS, implement EB service) | $ 1,900,000 | 2020 | Fed/State/ Local | Yes | Yes |
| CAMPO | CB | Hays County Connector (CARTS, implement EB service) | $ 2,800,000 | 2020 | Fed/State/ Local | Yes | Yes |
| CAMPO | CB | La Grange to Austin (CARTS, implement EB service) | $ 2,800,000 | 2020 | Fed/State/ Local | Yes | Yes |
| CAMPO | CB | Luling to San Marcos (CARTS, implement EB service) | $ 2,000,000 | 2020 | Fed/State/ Local | Yes | Yes |
| CAMPO | CB | Marble Falls to Austin (CARTS, implement EB service) | $ 1,900,000 | 2020 | Fed/State/ Local | Yes | Yes |
| CAMPO | CB | Rte 726 – San Marcos (CARTS, Implement EB service) | $ 2,500,000 | 2020 | Fed/State/ Local | Yes | Yes |
| CAMPO | CB | Williamson County Connector (CARTS, Implement EB service) | $ 2,800,000 | 2020 | Fed/State/ Local | Yes | Yes |
| CAMPO | CB | 1071-Dripping Springs ( Implement EB service) | $ 3,000,000 | 2026 | Fed/State/ Local | Yes | Yes |
| CAMPO | CB | 950-Taylor (CARTS, Implement EB service) | $ 12,000,000 | 2026 | Fed/State/ Local | Yes | Yes |
| CAMPO | CB | 951-Bee Cave (CARTS, Implement EB service) | $ 6,000,000 | 2026 | Fed/State/ Local | Yes | Yes |
| CAMPO | CB | Jarrell Express (CARTS, Implement EB service) | $ 3,000,000 | 2026 | Fed/State/ Local | Yes | Yes |
| CAMPO | CB | Smithville Express (CARTS, Implement EB service) | $ 3,000,000 | 2026 | Fed/State/ Local | Yes | Yes |
| CAMPO | CB | Luling Express (CARTS, Implement EB service) | $ 3,000,000 | 2026 | Fed/State/ Local | Yes | Yes |
| CAMPO | CB | RM 620 Express ( Implement EB service) | $ 9,000,000 | 2026 | Fed/State/ Local | Yes | Yes |

| MPO | Mode | Project Name/Cost Description | Capital Cost (YOE$) | Start Year(s) | Funding Source | Fully Funded? | Major New Service? |
|---|---|---|---|---|---|---|---|
| CAMPO | CB | Taylor Express (CARTS, Implement EB service) | $ 4,000,000 | 2026 | Fed/State/ Local | Yes | Yes |
| CAMPO | CB | Lockhart-San Marcos Express (CARTS, Implement EB service) | $ 3,000,000 | 2026 | Fed/State/ Local | Yes | Yes |
| CAMPO | CB | Liberty Hill Express (CARTS, Implement EB service) | $ 2,000,000 | 2026 | Fed/State/ Local | Yes | Yes |
| CAMPO | CB | 360-Loop 360 (CapMetro, Implement EB service) | $ 300,000 | 2026 | Fed/State/ Local | Yes | Yes |
| CAMPO | CB | 953-Lockhart (CARTS, EB service to) | $ 4,000,000 | 2026 | Fed/State/ Local | Yes | Yes |
| CAMPO | CB | 952-San Marcos (CARTS, EB service to) | $ 10,000,000 | 2026 | Fed/State/ Local | Yes | Yes |
| CAMPO | CB | 1081-Bastrop (CARTS, EB service to) | $ 3,000,000 | 2026 | Fed/State/ Local | Yes | Yes |
| Houston Galveston | ? | Fort Bend County: Acquire 6 large transit vehicles (phase 2) for express services b/t FM 521 P&R from Arcola-Sienna P&R | $ 6,855,684 | 2024 | ? | Yes | Yes |
| Houston Galveston | DR | Fort Bend County: Acquire 12 small to medium transit vehicles for county-wide DR services | $ 1,115,262 | 2016 | ? | Yes | Yes |
| Houston Galveston | ? | Fort Bend County: Construct second O&M facility to support expanded services | $ 3,000,000 | 2025 | ? | Yes | Yes |
| Houston Galveston | CR | Fort Bend County: Southwest Commuter Rail Line | $ 345,000,000 | 2025 | ? | Yes | Yes |
| Houston Galveston | LR | Island Transit: Galveston Rail Trolley – extend to Stewart Beach | $ 7,043,380 | 2016 | ? | Yes | Yes |
| Houston Galveston | MB | Gulf Coast Center: Leasing vehicles for new FR bus service in Texas City | $ 261,007 | 2023 | ? | Yes | Yes |
| Houston Galveston | LR | Metro: East End Corridor LR transit extension to SE corridor at Gulfgate | $ 300,000,000 | 2035 | ? | Yes | Yes |
| Houston Galveston | BRT | Metro: Inner Katy Corridor Guided Rapid Transit | $ 420,000,000 | 2025 | ? | Yes | Yes |
| Houston Galveston | MB | Metro: Future Signature Bus Service | $ 10,000,000 | 2031 | ? | Yes | Yes |
| Houston Galveston | MB | Metro: Future Signature Bus Service | $ 4,750,000 | 2015 | ? | Yes | Yes |
| Houston Galveston | MB | Metro: Future Signature Bus Service | $ 10,000,000 | 2021 | ? | Yes | Yes |
| Houston Galveston | MB | Metro: Future Signature Bus Service | $ 10,000,000 | 2026 | ? | Yes | Yes |
| Houston Galveston | MB | Metro: Future Signature Bus Service | $ 2,802,000 | 2013 | ? | Yes | Yes |
| Houston Galveston | MB | Metro: Future Signature Bus Service | $ 2,000,000 | 2016 | ? | Yes | Yes |

| MPO | Mode | Project Name/Cost Description | Capital Cost (YOE$) | Start Year(s) | Funding Source | Fully Funded? | Major New Service? |
|---|---|---|---|---|---|---|---|
| Houston Galveston | MB | Metro: Future Signature Bus Service | $ 2,000,000 | 2017 | ? | Yes | Yes |
| Houston Galveston | MB | Metro: Future Signature Bus Service | $ 2,000,000 | 2018 | ? | Yes | Yes |
| Houston Galveston | MB | Metro: Future Signature Bus Service | $ 2,000,000 | 2019 | ? | Yes | Yes |
| Houston Galveston | MB | Metro: Future Signature Bus Service | $ 2,000,000 | 2020 | ? | Yes | Yes |
| Houston Galveston | MB | Metro: Future Signature Bus Service | $ 1,332,000 | 2013 | ? | Yes | Yes |
| Houston Galveston | MB | Metro: Future Signature Bus Service | $ 13,201,000 | 2013 | ? | Yes | Yes |
| Houston Galveston | MB | Metro: Signature bus express service routes (incl shelters and signage) | $ 15,000,000 | 2015 | ? | Yes | Yes |
| Houston Galveston | LR | Metro: North LRT from Northline commons to IAH | $ 1,000,000,000 | 2023 | ? | Yes | Yes |
| Houston Galveston | LR | Metro: Southeast Corridor LRT extension to Hobby/Hinmann P&R (8 stations) | $ 233,730,000 | 2020 | ? | Yes | Yes |
| Houston Galveston | LR | Metro: Southeast Corridor LRT extension to Sunnyside | $ 252,000,000 | 2024 | ? | Yes | Yes |
| Houston Galveston | ? | Metro: Northwest Corridor Uptown Galleria line extension to Hempstead intermodal termsin | $ 60,000,000 | 2023 | ? | Yes | Yes |
| Houston Galveston | RR | Metro: SH 288 Almeda Guided Rapid Transit | $ 250,000,000 | 2033 | ? | Yes | Yes |
| Houston Galveston | ? | Metro: Metro solutions University Corridor | $ 1,000,000,000 | 2016 | ? | Yes | Yes |
| Houston Galveston | ? | Metro: Metro solutions uptown corridor | $ 625,000,000 | 2020 | ? | Yes | Yes |
| Houston Galveston | CR | Metro: SW CR Line (4 stations | $ 400,000,000 | 2017 | ? | Yes | Yes |
| Houston Galveston | ? | City of Conroe: Purchase transit vehicles | $ 1,000,000 | 2014 | ? | Yes | Yes |
| Houston Galveston | ? | City of Conroe: Construct conroe college terminal/mixed use dev | $ 16,000,000 | 2025 | ? | Yes | Yes |
| Houston Galveston | ? | City of Conroe: Construct downtown terminal | $ 12,000,000 | 2025 | ? | Yes | Yes |
| Houston Galveston | ? | City of Conroe: Construct P&R facility | $ 1,000,000 | 2013 | ? | Yes | Yes |
| Houston Galveston | ? | City of Conroe: Construct conroe tech park transit terminal | $ 9,000,000 | 2017 | ? | Yes | Yes |
| Houston Galveston | CR | Galveston CR transit (7 stations) | $ 210,000,000 | 2024 | ? | Yes | Yes |

Non-MTA MNS projects, which include some "Enhancement" projects deemed to address existing capacity constraints.

| Agency | Name and Description of Project | Category of Project | Status of Project | Capital Costs (yoe$) | Annual O&M Costs | Funding source(s)? | Start Year |
|---|---|---|---|---|---|---|---|
| City Transit Management Company, Inc. (Lubbock) | Restore 30 minute mid-day service to routes 5,6,9,12 in one to three years. | Enhancement of existing | Potential | $0 | $400,000 | City of Lubbock | 2016 |
| City Transit Management Company, Inc. (Lubbock) | Restore 30 minute service to mid-day routes 1, 2, 7, 14, 19, and 34. | Enhancement of existing | Potential | $0 | $350,000 | City of Lubbock | 2016 |
| Community Action Council of South Texas | CACST is partnering with Valley Metro and STC to connect Starr County with Hidalgo County | Major new service | Planned | $561,005 | $306,094 | STC Match/ TxDOT Grant(s)& TDCs | 2015 |
| East Texas Council of Governments | East Texas United: fixed routes connecting cities in East Texas | Major new service | Potential | | | | 2017 |
| East Texas Council of Governments | Operate flex routes in cities of Athens, Palestine, Rusk, and Henderson | Major new service | Potential | | | | 2017 |
| East Texas Council of Governments | Seamless fares and fare payment along with public information campaign | Enhancement of existing | Potential | | | | 2018 |
| Fort Bend County – Public Transportation Department | Expand Job Access service – Rosenberg, Texas | Enhancement of existing | Programmed | $75,000 | $100,000 | JARC | 2015 |
| Fort Bend County – Public Transportation Department | Construct Administrative and Operating Facility | Major new service | Programmed | $20,000,000 | | $6,000,000 Local, balance Federal | 2016 |
| Fort Bend County – Public Transportation Department | Commuter Service to Downtown Houston | Major new service | Potential | $4,900,000 | $1,600,000 | | 2016 |
| Galveston Island Transit | Start new seawall tourist service, pending comprehensive plan completion | Enhancement of existing | Planned | $450,000 | $723,840 | Federal | 2015 |
| Gulf Coast Center | Establish local route and park & ride service serving City of Kemah | Major new service | Programmed | $1,000,000 | $750,000 | CMAQ, Parking and Fare Revenues | 2015 |
| Gulf Coast Center | Pearland Park & Ride. Commuter service to/from the Texas Medical Center and Houston Central Business District. (Funds have been programmed for both operating and some capital) | Major new service | Planned | $7,500,000 | $850,000 | CMAQ, JARC, Farebox, Land donation, local share | 2016 |
| Gulf Coast Center | Construct and operate administrative facility and park & ride in Texas City | Major new service | Planned | | | TBD | 2015 |

| Agency | Name and Description of Project | Category of Project | Status of Project | Capital Costs (yoe$) | Annual O&M Costs | Funding source(s)? | Start Year |
|---|---|---|---|---|---|---|---|
| Gulf Coast Center | Dickinson Park & Ride. Commuter service to/from Texas Medical Center & Houston CBD | Major new service | Planned | | | TBD | 2017 |
| Lower Rio Grande Valley Development Corporation | Regional Transit Service | Enhancement of existing | Planned | $15,000,000 | $3,000,000 | 5307, 5310, 5311, 5337 | 2016 |
| Lower Rio Grande Valley Development Corporation | Harligen/San Benito Fixed Route and ADA Paratransit | Enhancement of existing | Planned | $1,250,000 | $1,500,000 | 5307, 5310, Local and TDCs | 2015 |
| Midland Odessa Transit District | Multimodal Facility | Enhancement of existing | Planned | $3,000,000 | $100,000 | 5307 | 2016 |
| Midland Odessa Transit District | Plan and implement improved route alignments and services | Enhancement of existing | Potential | $2,500,000 | $500,000 | 5307 | 2017 |
| Midland Odessa Transit District | Administrative Building | Major new service | Programmed | $2,300,000 | $40,000 | 5307 | 2015 |
| Public Transit Services | Construct new maintenance facility, construct park & ride facility, and add fixed route services to program | Enhancement of existing | Potential | $2,000,000 | $50,000 | 5311, 5307 | 2016 |
| Senior Center Resources and Public Transit, Inc | Connection to DFW for public transportation | Enhancement of existing | Planned | $420,000 | $400,000 | local match through inkind | 2016 |
| SPAN Inc. | SPAN studying needs in rural Denton County, expects some need for services in the future | Major new service | Potential | | | TBD | 2020 |
| SPCAA SPARTAN Public Transportation | Anticipate partnership with major employers for commuter services for employees (major construction project is awaiting approval from the EPA) | Major new service | Potential | $300,000 | $300,000 | | 2015 |
| STAR Transit | Establish/improve transit center, maintenance/operations hub, and fixed routes in/near Terrell area | Enhancement of existing | Planned | $3,000,000 | $500,000 | FTA TXDOT local | 2016 |

# Texas Transportation Plan

## Tech Memo 7: Freight Modal Profile

September 23, 2014

## Acknowledgements

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## 1.0 Introduction

The Texas Transportation Plan 2040 (TTP) is the State's long-range transportation plan which covers the size and scope of the Texas transportation system, including all modes of freight transportation. This memo documents the existing conditions, current and future demand and needs identified to enhance freight mobility and support economic development throughout the state. The material contained in this memo is taken from the current output produced from the Texas Freight Mobility Plan (TFMP) and additional sources including publicly available planning documents. The TFMP project is being conducted simultaneously with the TTP but on a slightly different schedule. The TFMP is led by the consultant CDM Smith, Inc. in cooperation with the freight planning team from Texas DOT.

The TFMP inventory and conditions analysis focuses on the identified Primary and Secondary Texas Freight Transportation Networks that include highway, rail, and waterways. Current and forecast freight volumes are identified through the study to assess impact to the modal gateway facilities such as rail hubs, ports, airports, and pipeline terminals; as well as connections to major freight generators, defined by warehousing and distribution centers, and industry clusters. The border crossing facilities are also included in the study. The Inventory is organized based on the modes by which freight travels in Texas. The results of the TFMP will focus on improvements to corridors identified as having the most benefit to freight mobility.

The TFMP is based on widespread stakeholder and agency outreach and includes the direction and active participation of the Texas Freight Advisory Committee (FAC). The FAC is a group of public sector officials and leaders from the private sector firms engaged in transportation in the state including carriers, shippers, and auxiliary service providers. The role of the FAC is to advise TxDOT on freight issues, priorities, projects and funding needs for freight improvements, and elevate freight transportation as a critical component of the state's economic vitality and competitiveness.

## 2.0 Overview of Existing Conditions

Texas operates the nation's largest highway network, largest interstate network, and has the one of the highest volumes of vehicle traffic in the United States. Texas also has the nation's largest rail network. The state's ports handle nearly 20 percent of the nation's total maritime cargo. Two of the nation's top ten busiest commercial airports are in Texas. The pipeline system in Texas is vast due to the concentration of the energy and chemical industries in the state. The state's pipeline network covers 374,000 miles. Due to the proximity of Mexico and the length of the border the Texas rail and truck infrastructure handle the most US to Mexico trade crossings of any state. Infrastructure in Texas is critical to business locally, nationally and globally. Understanding the current and future trends and issues influencing this system is critical to maintaining capacity and efficiency in this network so that Texas freight transportation continues to be an asset to the state's citizens and economy.

**Exhibit 1. Texas Freight Tons by Mode in 2010 Summary**

Source: USDOT Research & Innovative Technology Administration, State Transportation Statistics, 2012 and Texas Railroad Commission, 2012

## *2.1 Inventory of Freight Facilities and Freight Generators*

In addition to the analysis of trends and issues, the TFMP includes an inventory to identify the freight assets that are currently utilized and projected to be utilized, in order to verify the capabilities of the freight infrastructure. The information presented here and included for the TTP is based on this inventory of assets. An examination of the infrastructure has been used to determine the current conditions for freight and to identify existing and future major freight corridors and freight movements in Texas. The inventory includes projected freight volumes and connections to modal gateway facilities, such as rail facilities, water ports, airports, and pipeline terminals, as well as connections to major freight generators, such as warehousing and distribution centers, industry clusters and the border crossing gateways.

The condition and performance analysis for the TFMP focuses on highway and rail conditions and performance, with particular attention to defining key corridors and intermodal connectivity. The assessment relies on existing data sources and analyses to provide a snapshot of current conditions and performance considerations associated with three of the TFMP goal areas:

- Asset Management – Documentation of the conditions/state of good repair for the Texas Freight Highway Network (TFHN) and Texas Freight Rail Network (TFRN)

- **Mobility and Reliability** – Identification of highway and freight bottlenecks that cause delay and unreliability in freight movements
- **Safety** – Identification of various highway and rail safety considerations including truck crash rates, truck rollovers, and at grade rail crossings

## *2.2 Highway*

The Texas Freight Highway Network (TFHN) begins with the tiered roadway system adopted by the Federal Highway Administration (FHWA) and TxDOT then adds additional roads with particular significance to the freight community. The TFHN identifies connections to freight gateways and generators to include railroads, water ports, airports, pipeline terminals, border crossings, warehousing and distribution centers, and intermodal terminals.

As Texas is developing their TFHN, FHWA is designating a National Highway Primary Freight Network. The National Highway Primary Freight Network will be reviewed and considered as it relates to the TFHN. Further, MAP-21 specifies that states are to identify Critical Rural Freight Corridors (CRFC) defined to be non-Interstate routes that are characterized by high freight volumes. Texas' CRFC's will be identified and incorporated within the TFHN. Exhibit 2 shows the primary and secondary networks along with the facilities for the connection points for water, rail, and air. The forecast of freight tonnage for 2040 is shown in Exhibit 3 as it will flow over the highway network. These forecasts and related flow assignments were developed from the application of Global Insight's TRANSEARCH data base.

## Exhibit 2. Texas Freight Primary and Secondary Networks

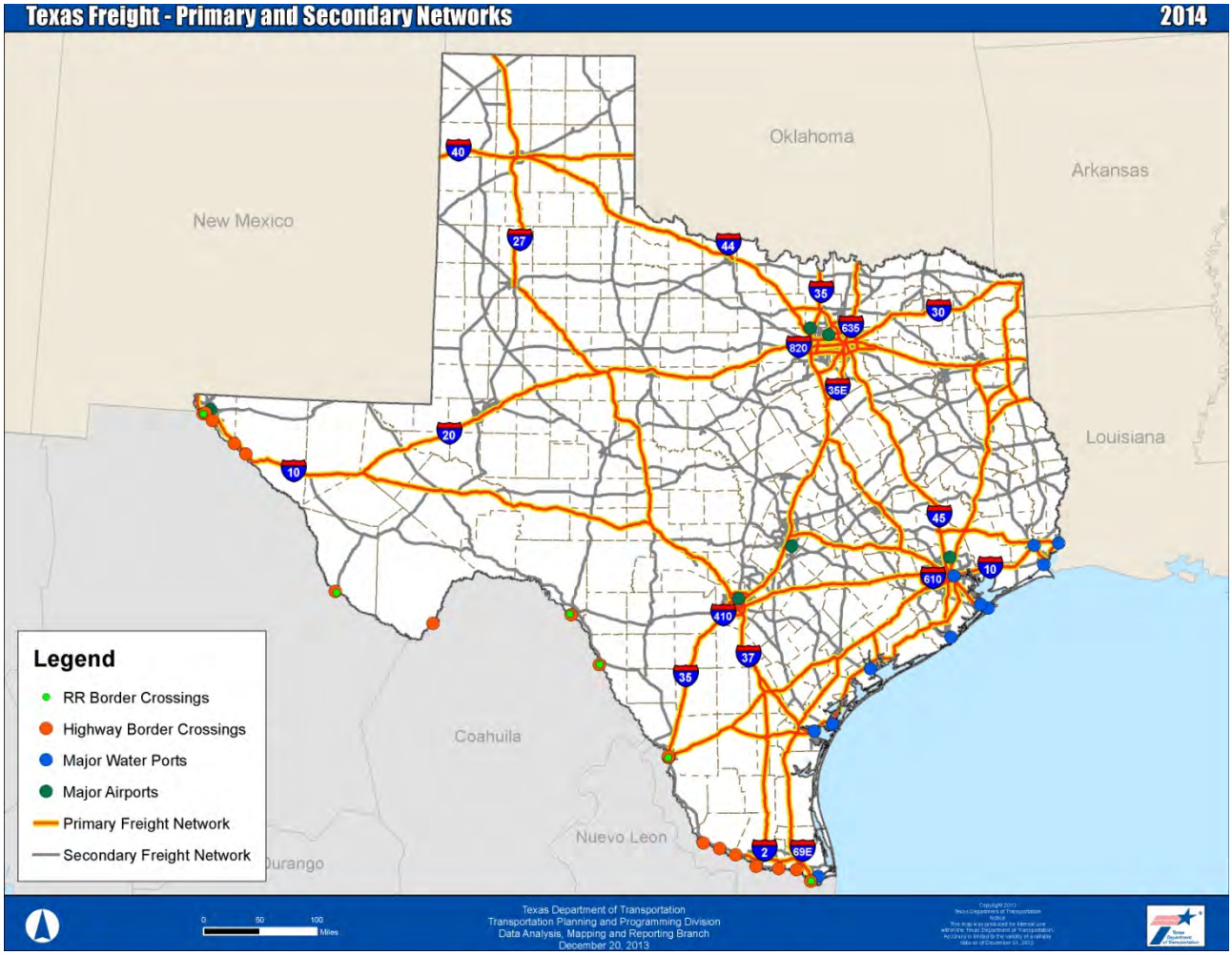
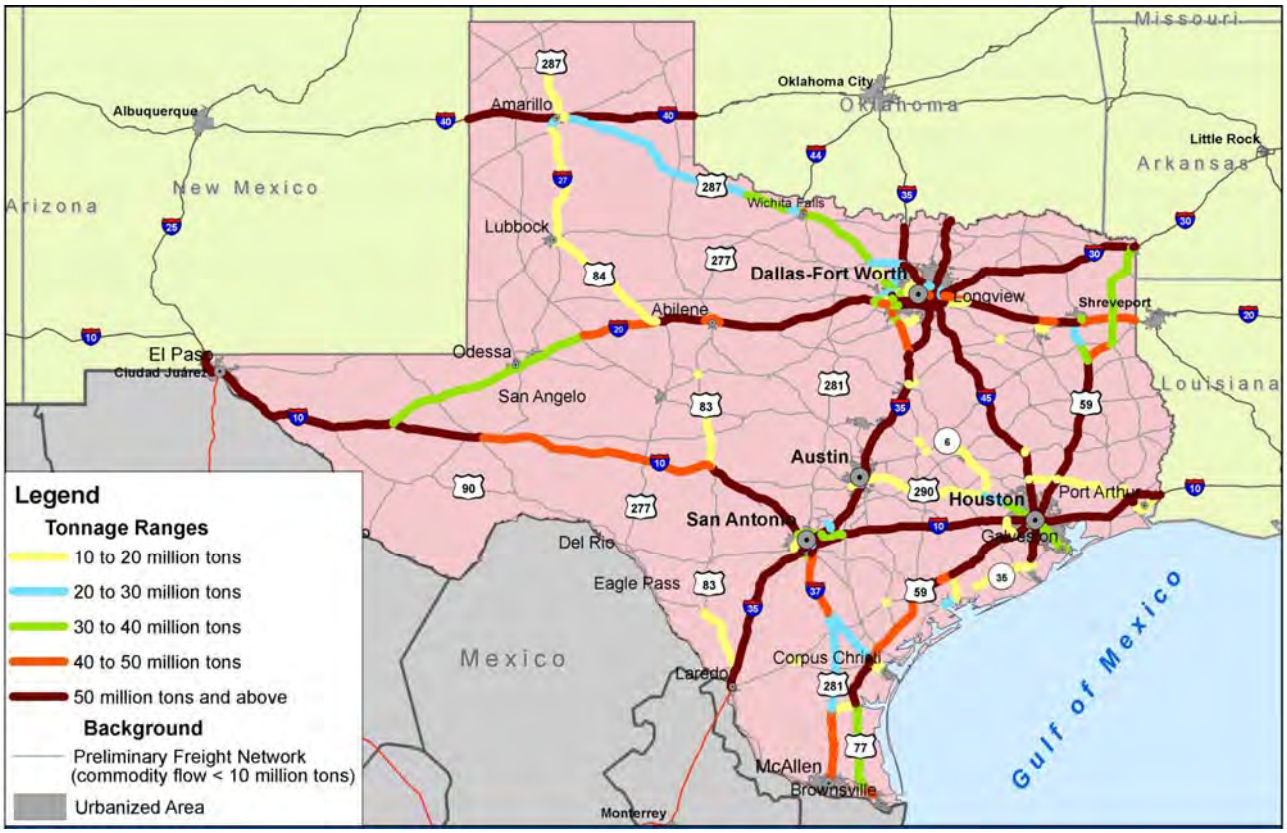


**Exhibit 3. Projected 2040 Total Truck Tons**




Source: TRANSEARCH, 2010

## 2.2.1 Highway Capacity

Freight travels on the same highway network as passenger vehicles. Congestion on these highways increases the time it takes goods to travel, which increases the costs of getting these goods to market. Highway congestion levels are measured by Level-of-Service (LOS).

The following charts in **Exhibit 4** illustrate the LOS as a percent of roadway mileage on the Interstate mainlanes, the US and State Highways which are included in the TFHN.

**Exhibit 4. Texas Freight Network Level-of-Service, 2013**

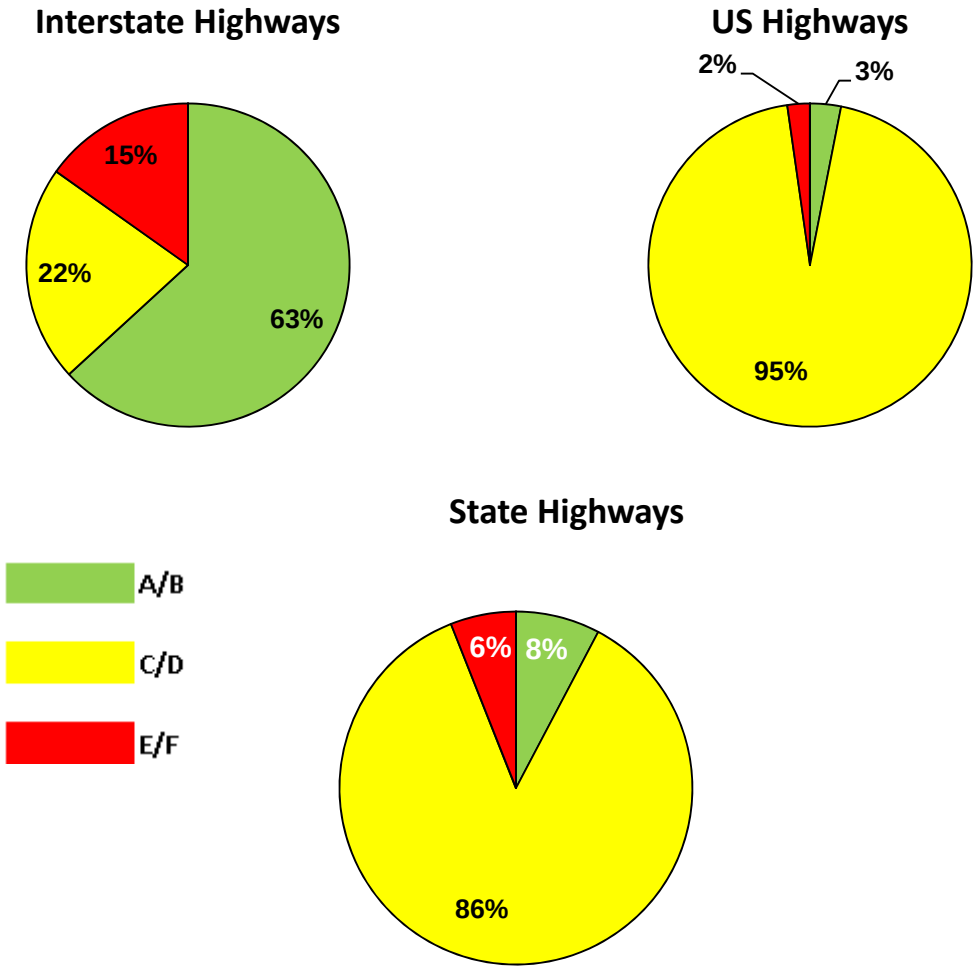


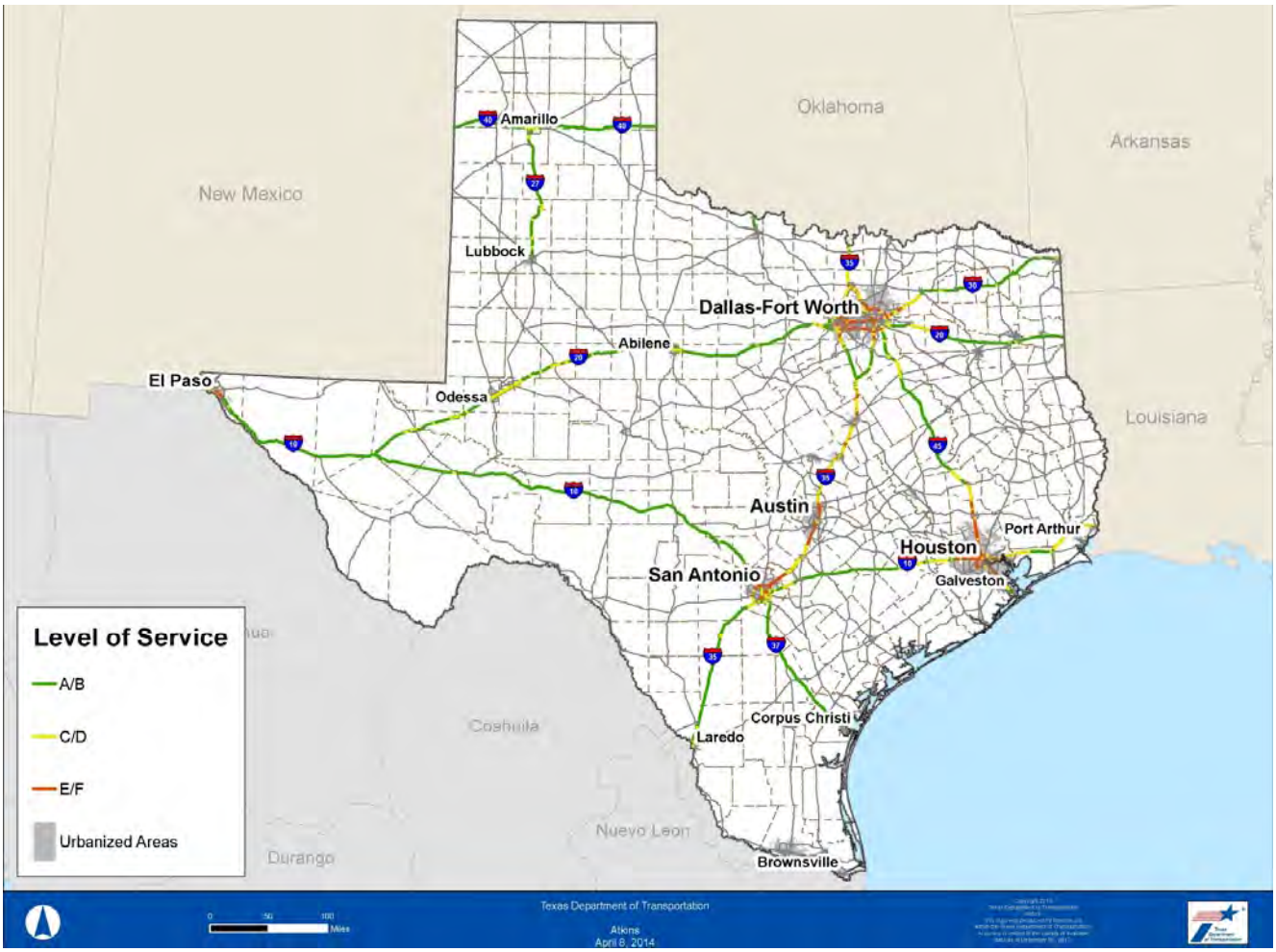

Exhibit 5 shows the statewide average percentage of traffic comprised of trucks which was calculated for the segments of the TFHN roadways with LOS E and F. This exhibit indicates that on average, the majority of traffic on the congested sections of roadway are passenger vehicles.

**Exhibit 5. Average Percent Trucks on Freight Network Sections with LOS E and F, 2013**

| | Percent Truck Traffic (2011) | |
|---|---|---|
| | E | F |
| Interstates | 10.5% | 6.9% |
| US Highway | 4.6% | 4.8% |
| State Highways | 4.5% | 3.8% |

Source: TxDOT RHiNO Database, 2013

**Exhibit 6. Level-of-Service – Freight Network Interstate Mainlanes, 2013**




Source: TxDOT RHiNO Database

As seen in **Exhibit 6** above, most of the miles of Interstate in Texas operate at LOS A or B. These are located along the rural portions of the Interstates, while the Interstates in the urban areas exhibit LOS of E or F. These areas of lower LOS are where the freight movements experience more interaction with passenger vehicles. A majority of the US Highways on the TFHN operate at LOS C or D. As with the Interstates, LOS on the US Highways degrades within the urban areas, but there is much less occurrence of LOS E and F than on the Interstates indicating there may be opportunities for freight movements to shift to these routes. The State Highways in the TFHN operate at a LOS C or D, again with concentrations of LOS E and F in the urban areas. Many State Highways in the urban areas are essential parts of the roadway network, but less so in rural areas. As the volumes of movement on the Interstates and US highways continue to increase and trucks seek alternate routes, rural State Highways may become a more integral part of the freight network. More

resources may be required to develop and maintain the rural highways in order to support the additional traffic.

### 2.2.2 Highway Restrictions

Truck traffic is often restricted on highways due to low clearances at bridges and also at weight restricted bridges and roadways. Current limits for vehicular traffic to travel on TxDOT roadways without oversize or overweight permits are as follows:

- Width – 8'6"
- Height – 14'
- Gross Weight - 80,000 pounds maximum.

Bridges crossing the TFHN with clearances less than 14 feet were identified from the National Bridge Inventory database, and load restricted roadways were identified from TxDOT's RHiNO database. These facilities are included in **Exhibit 8**.

There are only five bridges crossing the TFHN which are less than 14 feet (trucks over 14 feet require permits in Texas). Four of the five are railroad bridges crossing the roadway and two (one railroad and one roadway bridge) are at the same location on the I-37 frontage road. These locations are indicated in **Exhibit 8** by yellow triangles and are listed in **Exhibit 7**. Bridges between 14 and 16 feet were also identified as many of these structures may cause impediments for trucks. There are 175 bridges crossing the TFHN within this range.

**Exhibit 7. Bridges with Less than 14 Feet Clearance**

| Crossing | Bridge Facility | Location |
|---|---|---|
| IH 37 WFR | UP RR | 0.1 MI W OF IH 37 |
| IH 37 WFR | SH 234 | |
| BUS LP 10 | SP RR | 0.6 MI E OF RM 1111 |
| US 67 NB | KCS RAILROAD | 0.2 MI W OF US 82 |
| US 67/90 | SP RR | 0.3 MI W OF FM 1703 |

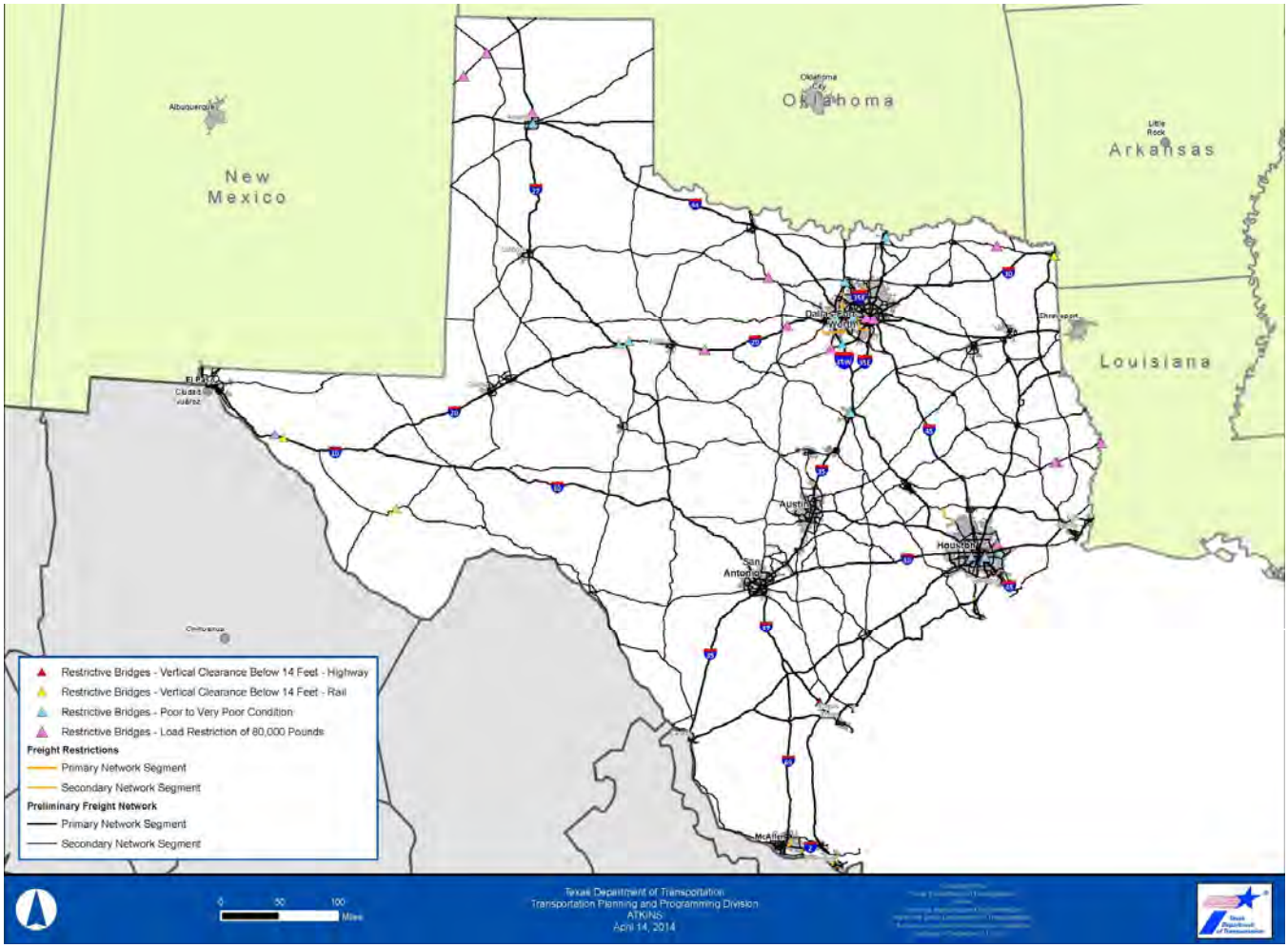
Source: National Bridge Inventory, 2013

Truck routes are restricted by roadways and bridges which cannot accommodate the federal commercial vehicle maximum weight of 80,000 pounds for freight transport. The National Bridge Inventory identifies 87 bridges in Texas with weight restrictions of less than 80,000 pounds. Of these 16 have been identified on the TFHN and are indicated by pink triangles in **Exhibit 8**. One load restricted bridge is on I-20 west of Abilene. There are ten load restricted bridges on the US highways in Texas. These structures along the TFHN are being evaluated in the TFMP to determine the bridges which are projected to carry the most truck traffic, or are connected to emerging

commodity centers and, therefore, have the most potential impact on freight movement and the greatest need for improvement. These bridges are identified by pink triangles in **Exhibit 8**.

Additionally, there are portions of roadways in the state that are restricted to less than 80,000 pounds. These routes are shown in orange in **Exhibit 8**. These segments are generally in the urban areas, where alternate routes may be available.

**Exhibit 8. Highway and Bridge Restrictions, 2013**




Source: TxDOT RHiNO Database, 2013; National Bridge Inventory, 2013

## 2.2.3 Border Crossings, Ports of Entry (POEs)

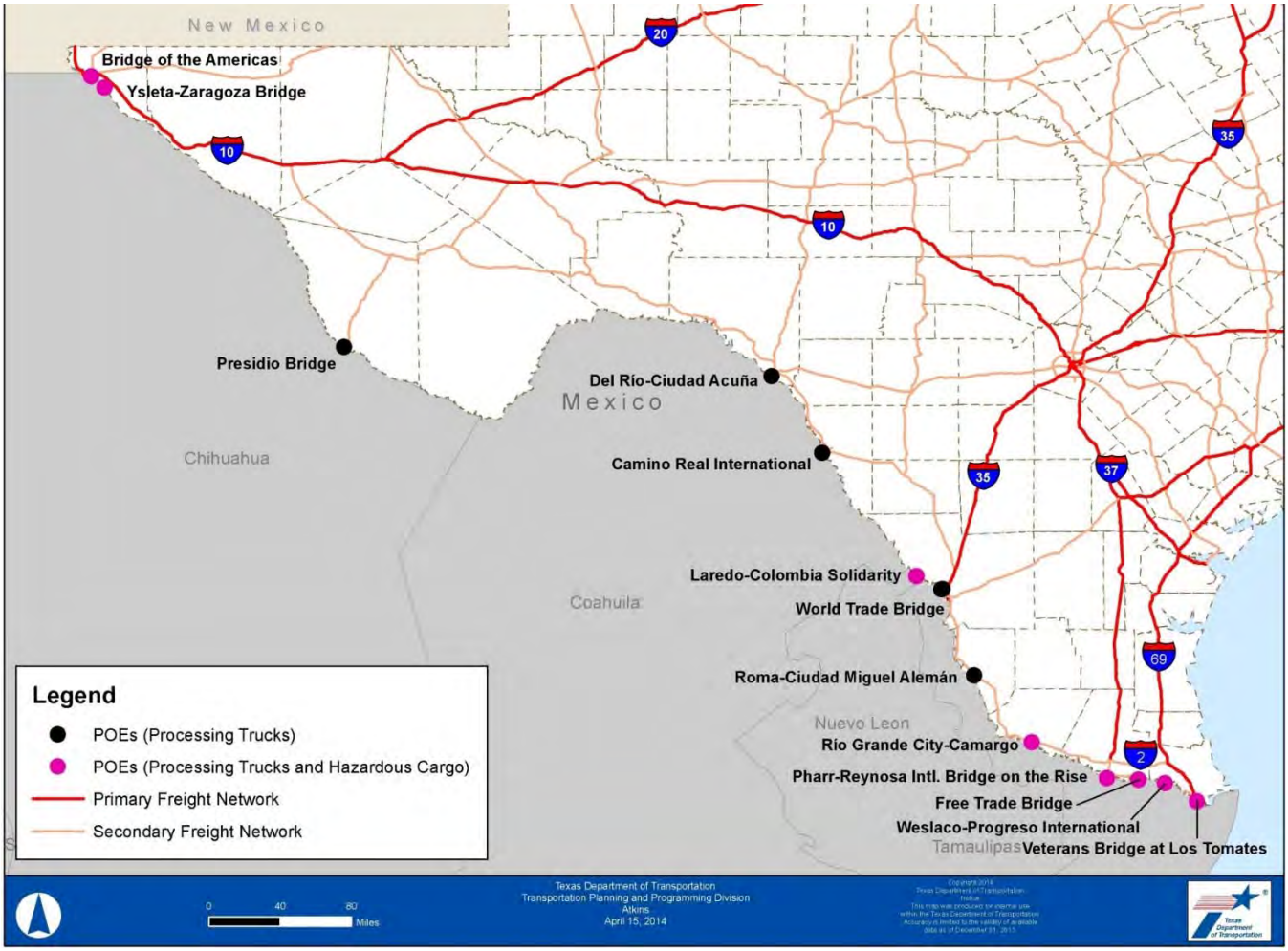
Thirteen of the 27 bridges which connect the U.S. to Mexico along the 1,254 mile Texas border carry truck traffic. The remaining bridges each carry different combinations of auto, rail, and pedestrian traffic. Some bridges are dedicated to certain travel modes. The volume of freight crossing northbound from Mexico into the U.S. included 3.5 million trucks and 7,800 trains in

2012. The crossings are located over the entire length of the Texas-Mexico border but are concentrated in or near the three major metropolitan areas of El Paso, Laredo and Brownsville.

Currently, crossing and wait times at many of the high volume ports of entry are considered to be deterrents to free trade between the U.S. and Mexico. The average 'Wait Time' and bridge 'Crossing Time' for trucks at different times-of-day is a key statistic for TxDOT, FHWA and the Customs and Border Patrol (CBP) in their efforts to determine the relative effectiveness of different investment strategies designed to reduce truck delays at border crossings.[1]

**Exhibit 9** depicts all the POEs that process trucks and hazardous cargo. **Exhibit 10** depicts all of the train POEs. The rail crossing in Presidio is currently closed as a result of flood damage.

**Exhibit 9. Texas – Mexico Truck POEs, 2012**




[1] Commercial Border Crossing and Wait Time Measurement at the Pharr-Reynosa International Bridge, Texas Transportation Institute, November, 2010, pp. 1-2

## Exhibit 10. Texas – Mexico Rail POEs, 2012

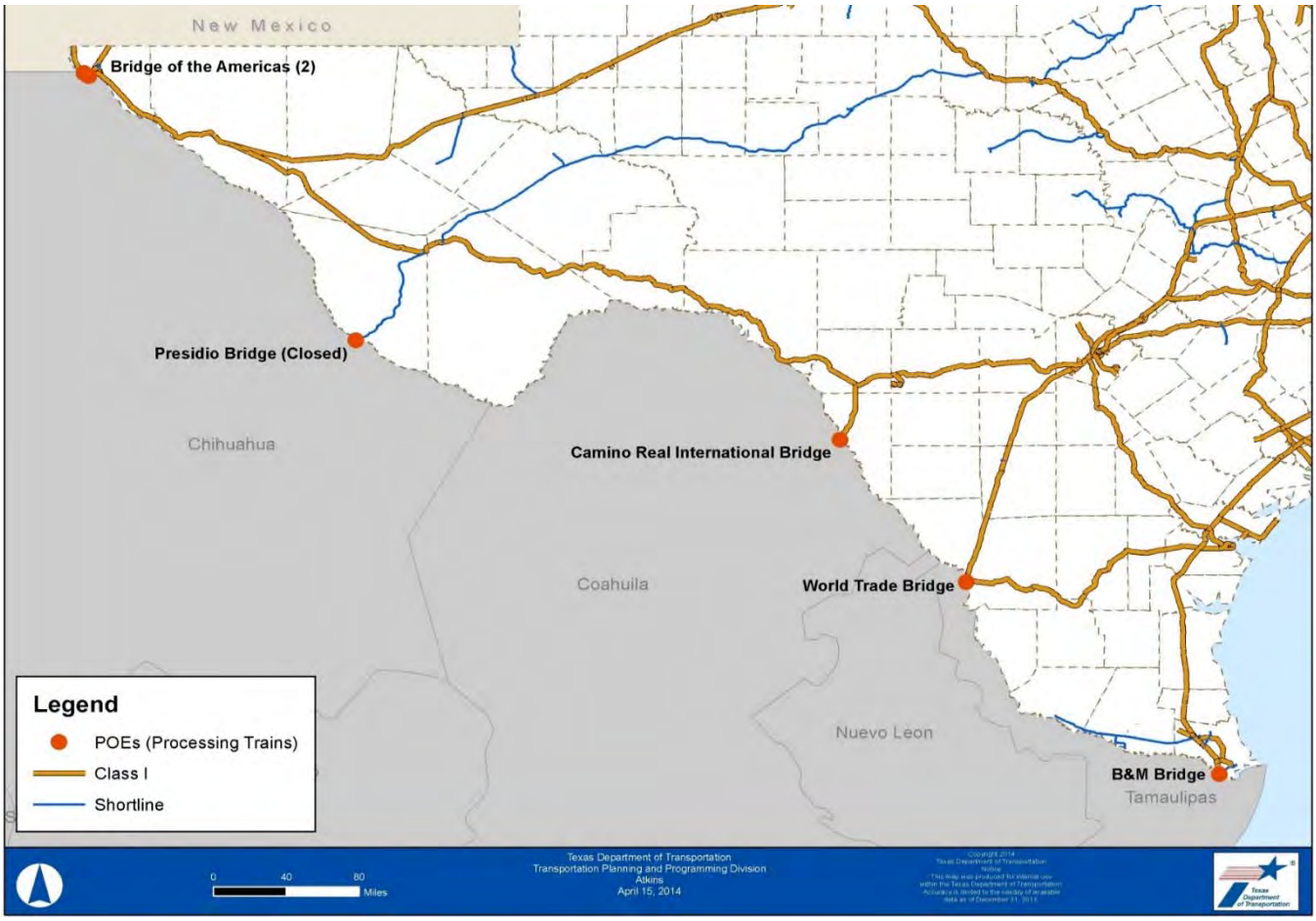


**Exhibit 11. Texas – Mexico POEs, 2012**

| Region | City (Nearest) | Bridge Name | Total Traffic | % Trucks | Freight Crossing Vehicle Types |
|---|---|---|---|---|---|
| | | | Trucks | | |
| El Paso – Presidio | El Paso | Ysleta-Zaragoza Bridge | 3,334,819 | 12% | Trucks |
| | | | 409,930 | | |
| | El Paso | Paso Del Norte Bridge | 2,076,684 | 0% | |
| | | | 0 | | |
| | El Paso | Bridge of the Americas | 3,605,947 | 9% | Trucks, Rail |
| | | | 314,730 | | |
| | El Paso | Fabens-Caseta Bridge | 237,929 | 0% | |
| | | | 0 | | |
| | El Paso | Fort Hancock-El Porvenir Bridge | 65,868 | 0% | |
| | | | 0 | | |
| | Presidio | Presidio Bridge | 582,392 | 2% | Trucks, (Rail Closed) |
| | | | 11,286 | | |
| Del Rio – Laredo | Del Rio | Del Río-Ciudad Acuña International Bridge | 1,290,504 | 5% | Trucks |
| | | | 65,210 | | |
| | Del Rio | Lake Armistad Dam Crossing | 42,846 | 0% | |
| | | | 0 | | |
| | Eagle Pass | Camino Real International Bridge | 1,297,206 | 9% | Trucks, Rail |
| | | | 116,843 | | |
| | Eagle Pass | Eagle Pass Bridge I | 1,094,970 | 0% | |
| | | | 0 | | |
| | Laredo | Juárez-Lincoln Bridge | 3,392,917 | 0% | |
| | | | 0 | | |
| | Laredo | Gateway to the Americas Bridge | 895,779 | 0% | |
| | | | 0 | | |
| | Laredo | World Trade Bridge | 1,399,068 | 100% | Trucks, Rail |
| | | | 1,399,068 | | |
| | Laredo | Laredo-Colombia Solidarity Bridge | 572,480 | 67% | Trucks |
| | | | 382,401 | | |
| McAllen – Brownsville | Falcon Heights | Lake Falcon Dam Crossing | 68,387 | 0% | |
| | | | 0 | | |
| | Roma | Roma-Ciudad Miguel Alemán Bridge | 625,464 | 1% | Trucks |
| | | | 7,130 | | |
| | Rio Grande City | Río Grande City -Camargo Bridge | 336,532 | 9% | Trucks |
| | | | 29,160 | | |
| | Mission | Anzaldúas International Bridge | 1,073,968 | 0% | |
| | | | 0 | | |

**Exhibit 11. Texas – Mexico POEs, 2012**

| Region | City (Nearest) | Bridge Name | Total Traffic | % Trucks | Freight Crossing Vehicle Types |
|---|---|---|---|---|---|
| | | | Trucks | | |
| McAllen – Brownsville (continued) | Donna | Donna International Bridge | 487,617 | 0% | |
| | | | 0 | | |
| | Hidalgo | McAllen-Hidalgo International Bridge | 2,572,150 | 0% | |
| | | | 0 | | |
| | Pharr | Pharr-Reynosa International Bridge on The Rise | 1,747,965 | 27% | Trucks |
| | | | 479,530 | | |
| | Progresso | Weslaco-Progreso International Bridge | 510,845 | 9% | Trucks |
| | | | 44,300 | | |
| | LOS Indios | Free Trade Bridge | 445,575 | 6% | Trucks |
| | | | 27,300 | | |
| | Brownsville | B&M Bridge | 1,294,961 | 0% | Rail |
| | | | 0 | | |
| | Brownsville | Veterans International Bridge at LOS Tomates | 1,466,154 | 13% | Trucks |
| | | | 190,204 | | |
| | Brownsville | Gateway International Bridge | 1,223,130 | 0% | |
| | | | 0 | | |

Note:
Texas-Mexico International Bridge and Border Crossings Existing and Proposed 2013
Sources: Texas Department of Transportation, 2035 State Long Range Transportation Plan, 2010

## *2.3 Freight Movement Generators*

The freight supply chain describes how goods move from their origins through processing to the market and consumer. These goods may originate in Texas or they may travel through many gateways to enter the TFHN. Gateways include water ports, airports, rail terminals and border crossings. Freight generators are also an important link in the supply chain within Texas' borders. Generators include industry clusters and warehousing/distribution centers. The freight network is comprised of the links among all of the various freight facilities.

### 2.3.1 Industry Clusters

Industry cluster information for the TFMP was obtained from the Texas Workforce Commission. The industries were selected based on the available data and the top commodities, by ton, projected within Texas annually by 2040.

As expected, most of the industries in Texas tend to cluster in and around the urbanized areas of the state, with some locations scattered in the rural areas. Location throughout the state is partially dependent upon the industry type and related to where products are produced and consumed.

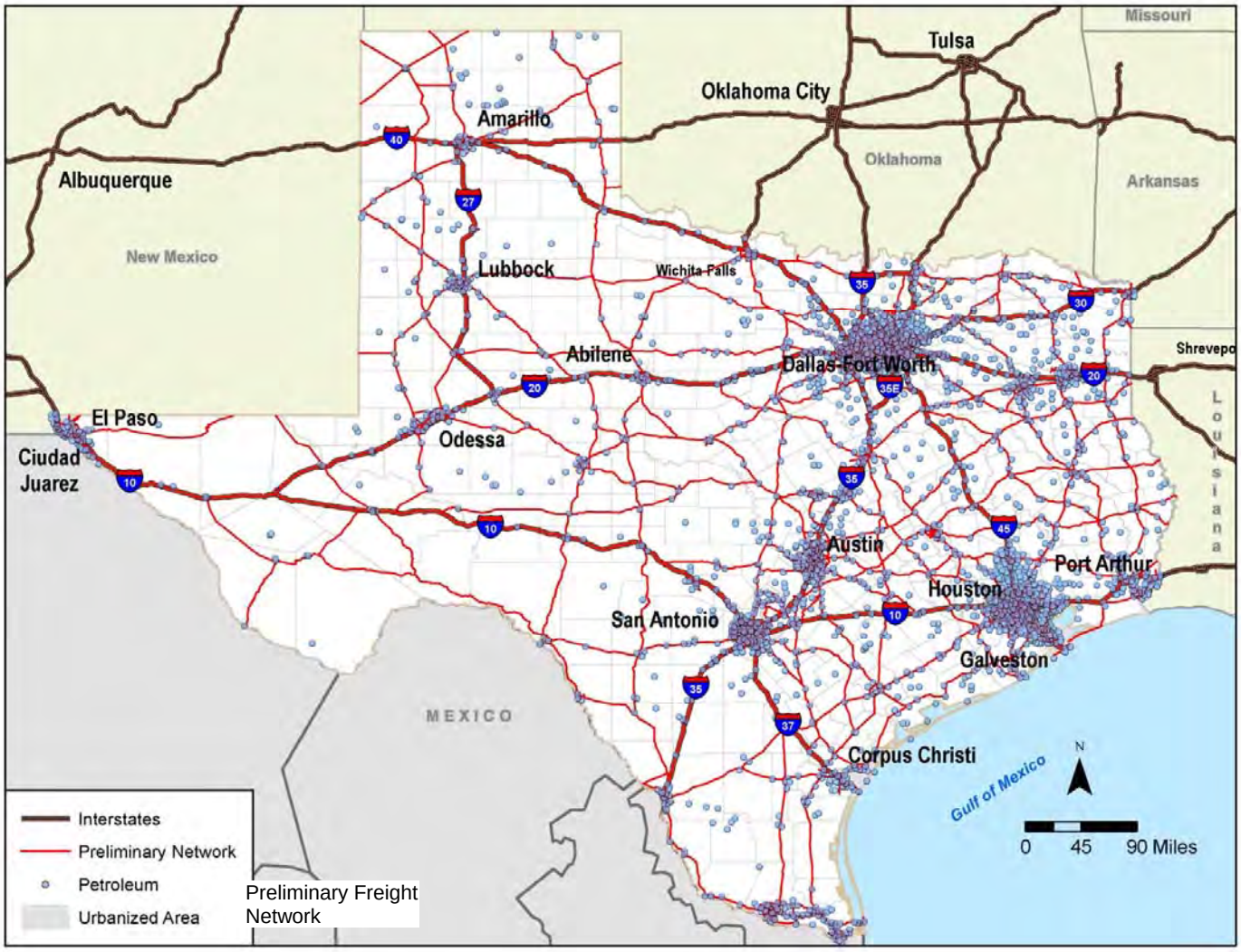
Transportation equipment and electronics are the industries which are most densely clustered in the urban areas. This would indicate that these industries depend upon the population in the urban areas for production. A majority of the locations not around the urban areas are still along the TFHN which provides industry access to the urban centers, and across the state.

Heavy construction and production support are also concentrated around the urban areas, but the clusters are larger and broader, indicating that much of these industries are located not only in the urban cores but in the suburban areas of these cities. There are also more rural locations of heavy construction and production support industries than for transportation equipment and electronics. The heavy construction industry particularly has more locations throughout northeast Texas, while production support is scattered through the eastern part of the state as well as in the western portion of the panhandle.

The agriculture, petroleum (**Exhibit 12**), and energy-mining industries, show some concentrations in the urban areas, but are much more widely distributed throughout the state and in the rural areas. These industries are largely dependent upon the geography, geology, and other environmental factors for their production and are not merely selected. Support services for these industries will still develop in urban areas which have ample access to the TFHN.

The location of industry concentrations are important to Texas as the goods and raw materials these industries produce have to be transported either to the next phase of production for that material or to the consumer. The reliability and convenience of this transport affects both the producer and the consumer.

**Exhibit 12. Petroleum Industry, 2012**

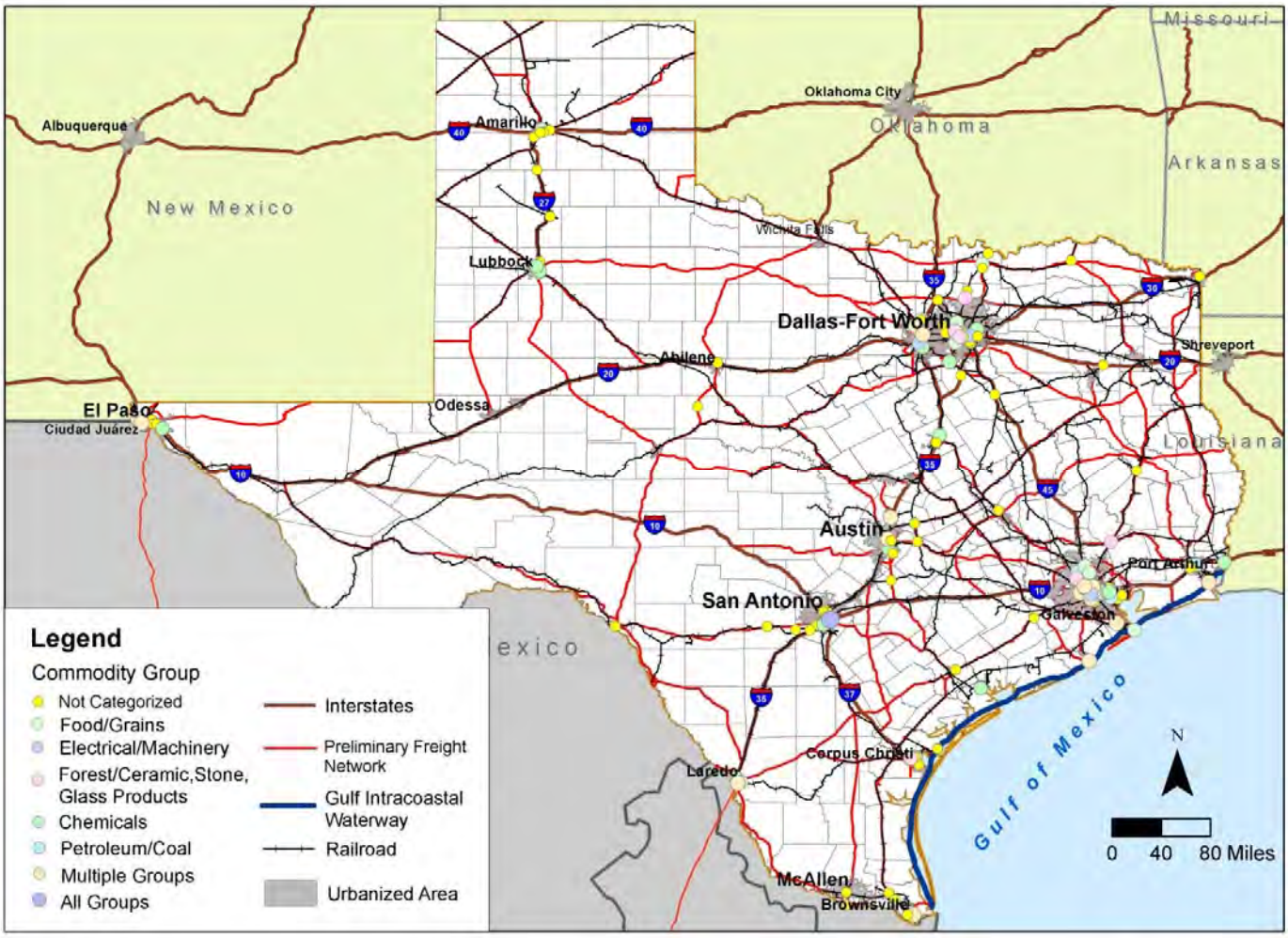



Source: Texas Workforce Commission, www.texasindustryprofiles.com, 2012

## 2.3.2 Warehousing and Distribution Center Facilities

Warehousing and distribution centers provide a vital link between goods and the consumer. Items from a distribution center often are distributed to retailers, wholesalers or even directly to the consumer as is often the case with internet shopping. Warehouse facilities are usually located near major market areas and in proximity to major roadway facilities. Exhibit 13 displays the major warehousing facilities by commodity group in Texas. As expected, the facilities are clustered in and around the urban areas of the state and are along the TFHN, to allow better and faster access to the consumer. Especially in today's marketplace, where two-day, next day, and even same day delivery are becoming commonplace, the ability to reach the consumer efficiently is paramount in the supply chain.

**Exhibit 13. Major Warehousing and Distribution Center Facilities, 2013**



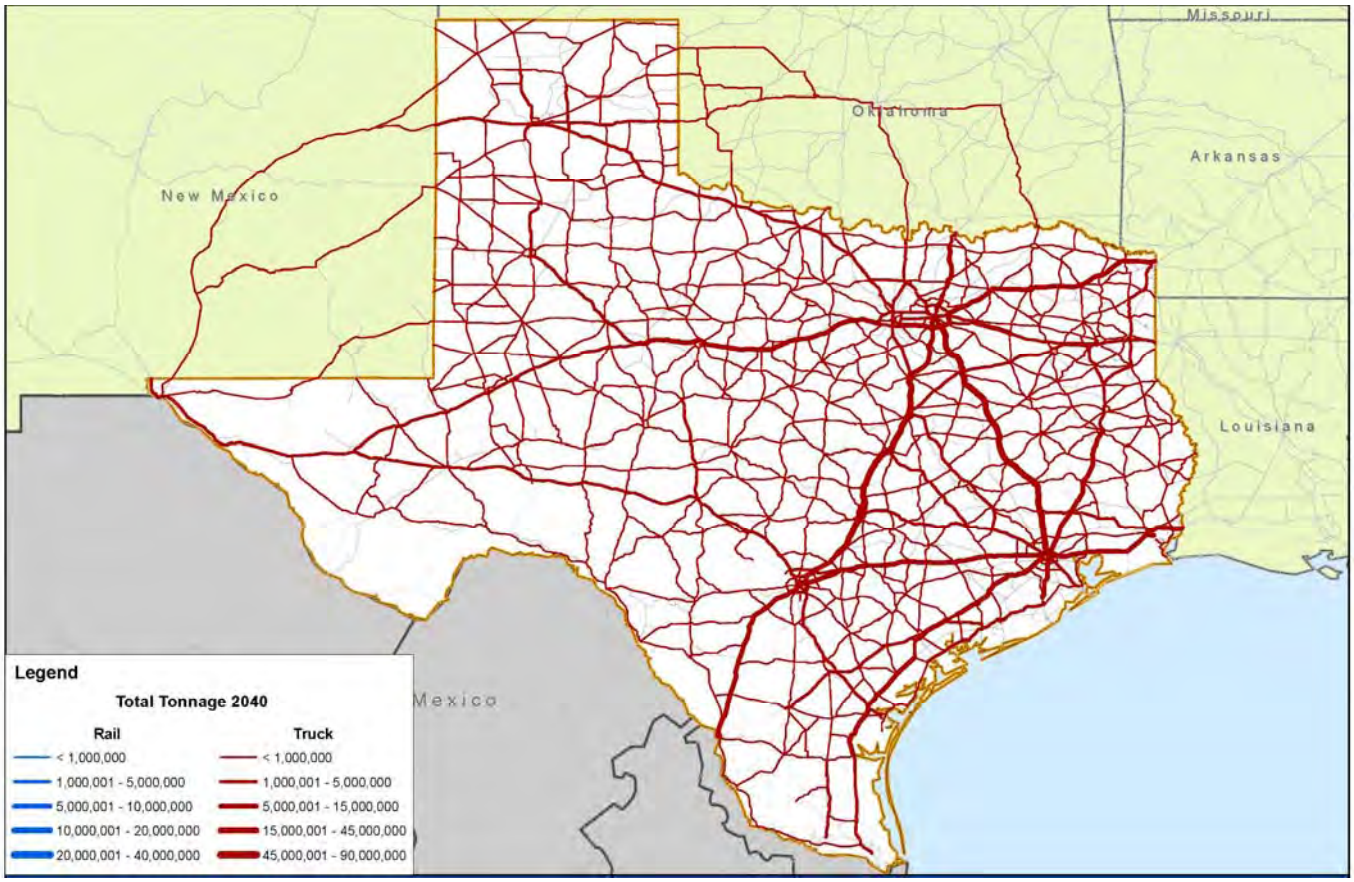

Source: Bureau of Transportation Statistics, 2013

## 2.3.3 Commodity Flow

The TFHN is the network by which goods reach the consumer. Based on the locations of industry clusters, generators, gateways, and the consumer, individual commodities often utilize different links in the freight network. **Exhibit 14** shows the most heavily utilized highway facilities for those freight commodities in Texas projected to total over 200 million tons by 2040. Actual 2010 tonnage and projected 2040 tonnage are depicted so that growth trends may be evaluated. For all commodities, trucks carried more tonnage than rail in 2010 and that relationship holds for the forecast in 2040. In all cases, the increased tonnage projected between 2010 and 2040 occurs on the Interstates and some US highways, with the remainder of the highway network remaining about the same.

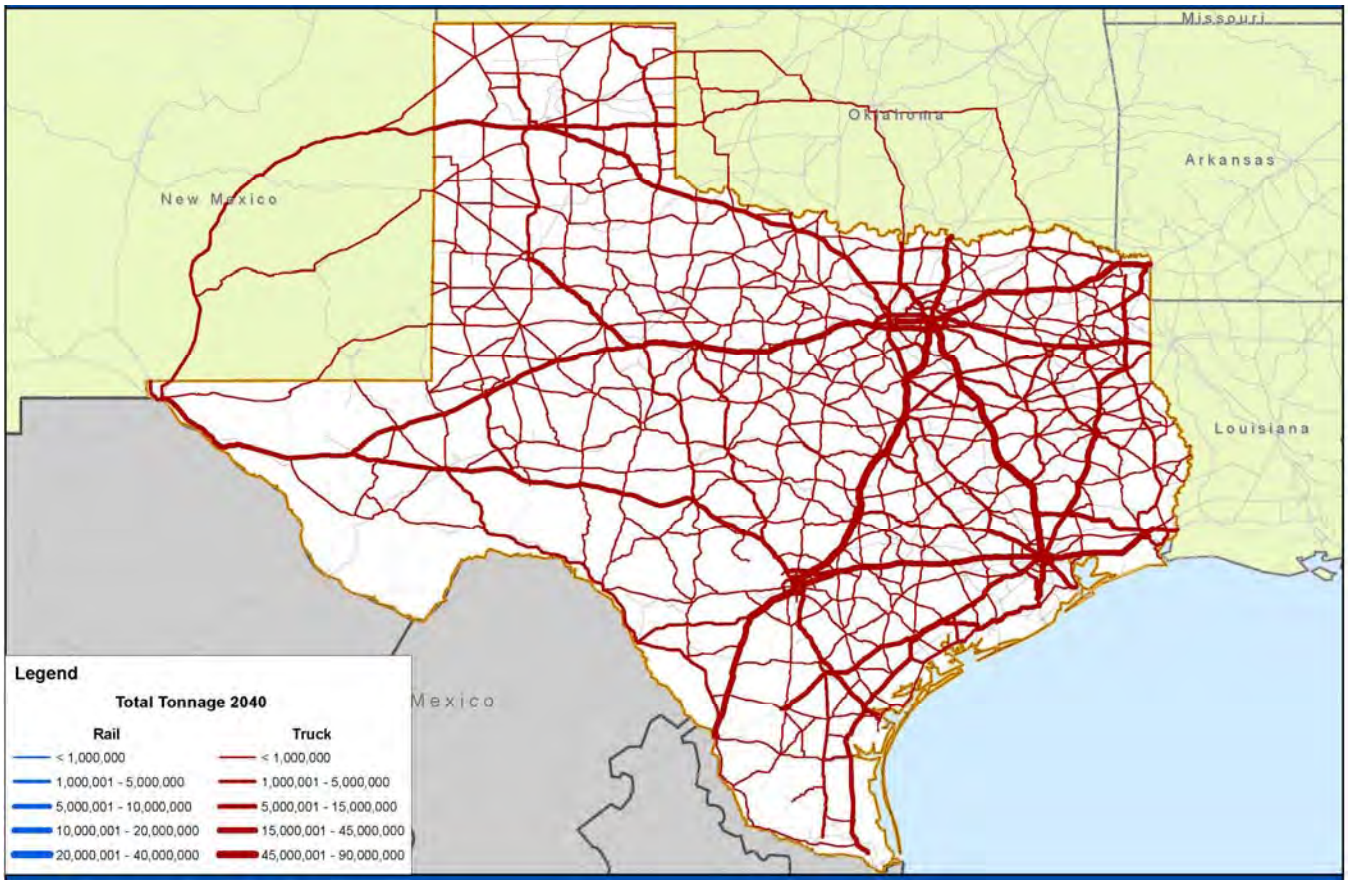
Secondary traffic, which includes movements between warehousing and retail locations, comprises most of the tonnage on the roadways and little to no movements on the railroads in the State. **Exhibit 14** and **Exhibit 15** show the total tonnage of secondary traffic for 2010 and 2040. Rail lines do not appear on these two exhibits, as there are no rail lines that carried secondary traffic in 2010 or are projected to carry secondary traffic in 2040. These movements between warehousing and retail are often quick turnaround routes that are not usually suitable for rail transport. The routes may be travelled weekly if not daily dependent upon the goods, for example perishable goods may need to be transported daily while a store may receive non-perishable items in weekly shipments from a warehouse. The Interstates within Texas are most heavily utilized for these movements for 2010 and 2040, as most of the warehousing (**Exhibit 13**) and retail consumers are located within the urban areas connected by these facilities.

**Exhibit 14. Total Truck Tonnage 2010 (Secondary Traffic)**




Source: TRANSEARCH, 2010

**Exhibit 15. Total Truck Tonnage 2040 (Secondary Traffic)**




Source: TRANSEARCH, 2010

## 2.4 Railroad Operations and Capacity

Rail is a major component of freight movement throughout Texas. Texas has 10,425[2] total rail miles, the most of any state. In 2010, 24% of the freight tonnage and 27% of the total value of freight in Texas was carried by the rail system[3]. In 2011, Texas led the nation in total rail tons terminated, at 202.4 million tons and was fifth in total rail tons originated at 89.3 million[11]. The rail industry stratifies its network into three categories: Class I, II, and III. The TFMP utilizes these classifications as the basis to define the rail network. The rail assets in Texas are discussed based on these classifications and the connections to freight gateways and to generators.

## 2.5 Railroad Classification

Railroad classification is determined by the U.S. Surface Transportation Board (STB) based on annual revenue dollars. In 2012 dollars, a railroad with operating revenues greater than $433.2 million for at least three consecutive years is considered a Class I railroad. Similarly, a

[2] https://www.aar.org/keyissues/Documents/Railroads-States/Texas-2010.pdf

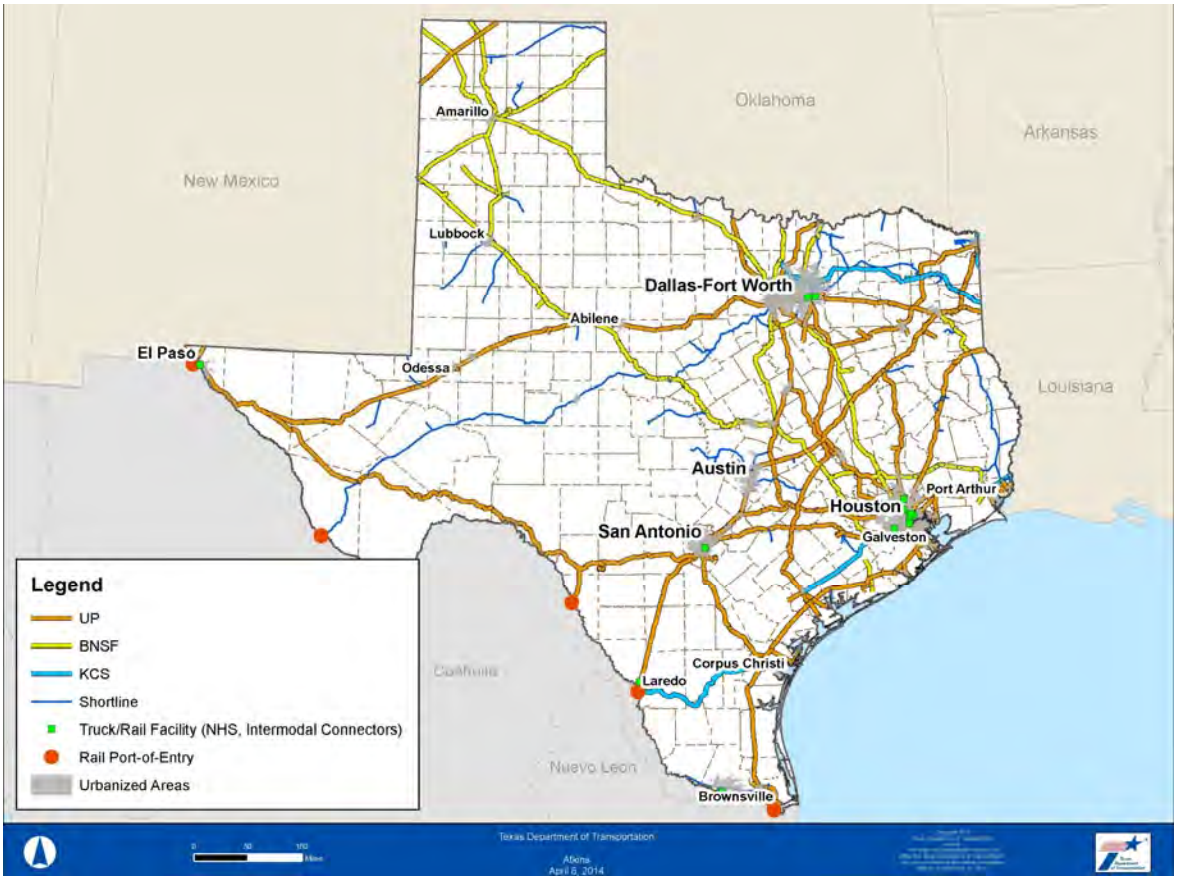
[3] IHS Global Insight TRANSEARCH

railroad with revenues greater than $34.7 million, but less than $433.2 million[4], is considered a Class II railroad: Such railroads are commonly referred to as "regional" railroads.

A railroad not within the Class I or II categories is considered a Class III railroad, also known as a "short line". As the name indicates, short lines operate over a relatively short distance. Short lines serve the larger railroads by collecting and distributing railcars to individual industrial and agricultural shippers and receivers. They provide a critical service, particularly in lower-density rail corridors and markets where the larger railroads cannot operate cost-effectively. From a historical standpoint, many of the nation's short lines operate on branches previously owned and operated by the Class I railroads. The Texas rail network is shown below in **Exhibit 16**.

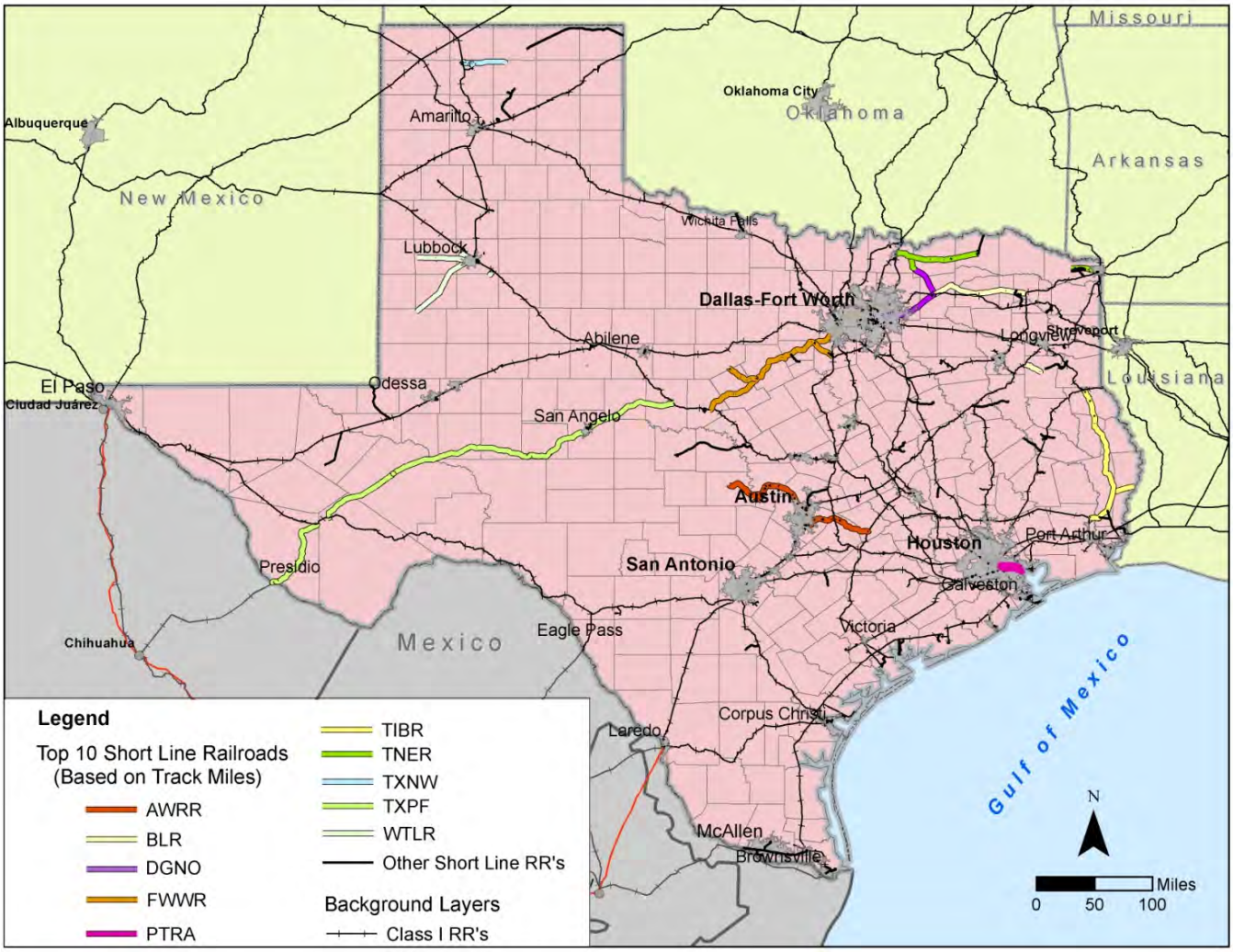
Short line railroads connect Class I railroads and commodity shippers and receivers. A total of 43 short line railroads serve Texas. These systems include a total of 2,479 track miles, ranging from 337 to 0.59 track miles per operator. The top ten short line freight systems (based on track miles) are shown in **Exhibit 17**.

**Exhibit 16. Texas Rail Lines, 2013**




[4] http://www.aslrra.org/about_aslrra/faqs/

## Exhibit 17. Texas Freight Short Line Rail Lines, 2013



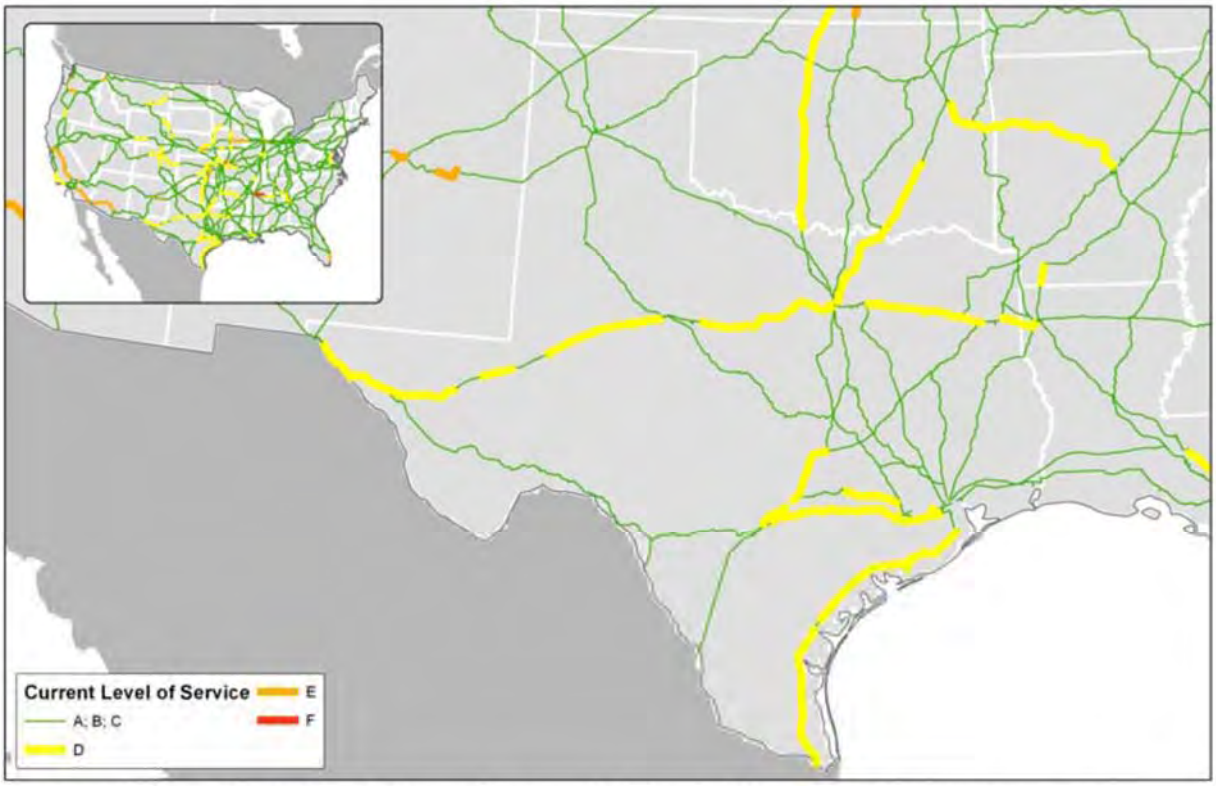

Source: National Transportation Atlas, Bureau of Transportation Statistics, 2013

## 2.6 *Railroad Operations and Capacity*

### 2.6.1 Texas Rail Plan November 2010

The rapid growth in overall rail freight volumes will have a dramatic effect on the Texas rail system. **Exhibit 18** illustrates the level-of-service (LOS), based on volume-to capacity ratios (V/C) at which the rail system operated based on 2007 data. Green lines indicate relative free-flow through much of the state at a V/C of 0.7 or less, although some capacity issues exist on rail lines parallel to the I-20 corridor, the I-10 corridor, the I-35 corridor, and the US-59 corridor near the Gulf Coast. These corridors are operating near capacity, with V/C between 0.7 and 0.8.

**Exhibit 18. Freight Rail Level-of-Service (2007)**




Source: National Rail Freight Infrastructure Capacity and Investment Study prepared for the Association of American Railroads by Cambridge Systematics, Inc.

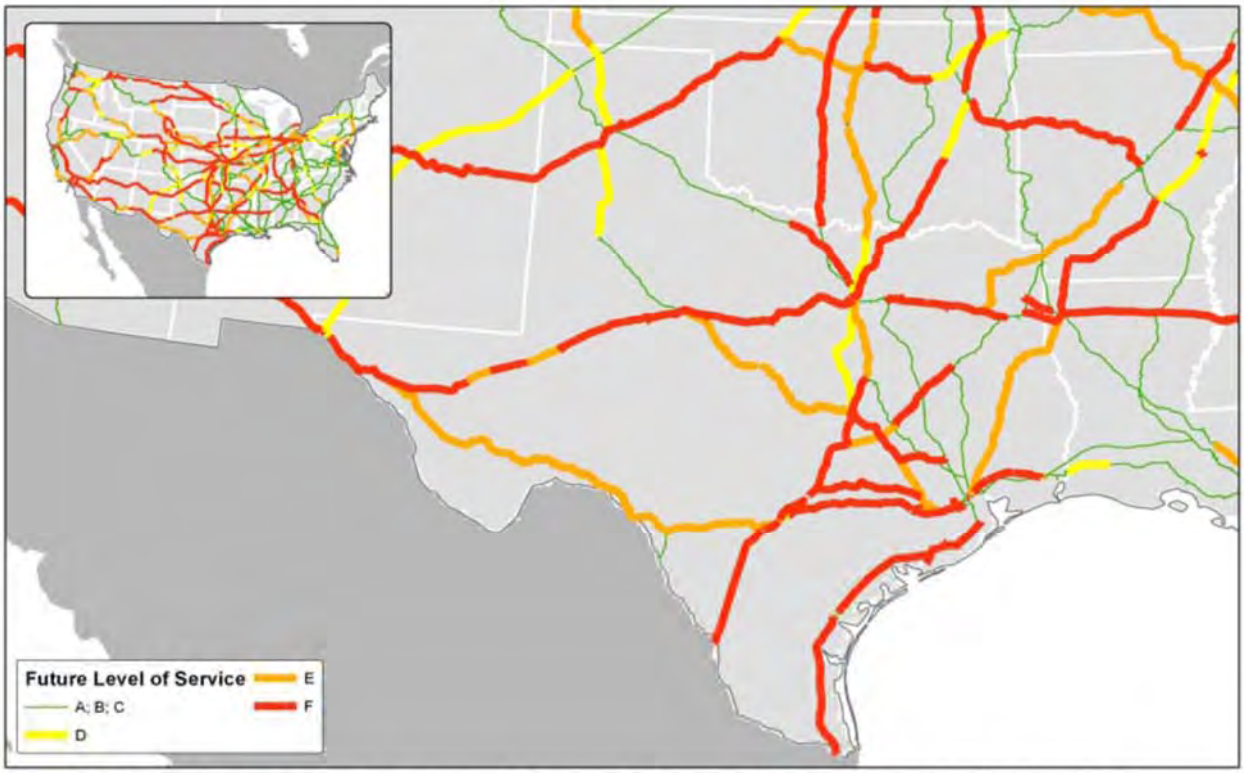
Source: Association of American Railroads, National Rail Freight Infrastructure Capacity and Investment Study

Exhibit 19 looks ahead to 2030, and assumes no dramatic improvement or expansion to the rail system. This also assumes no additional passenger rail beyond what currently exists. As a result, the statewide rail LOS drops significantly. Though there are still projected segments of the rail system operating at a fairly free-flowing LOS A, B, or C, a majority of rail miles will operate in congested conditions, particularly along the currently constrained corridors identified above. LOS E represents at- or near-capacity conditions of V/C of 0.8 to 1.0. LOS F indicates conditions with volume exceeding capacity.

## *2.7 Railroad Connectivity*

Railroads serve as important connections to sea ports and land POE. Much of the freight carried by rail comes into Texas through these POE. Rail is often utilized for shipment of bulk goods and not typically a suitable, direct-to-consumer mode of transport. The capacity of rail to transport shipments from POE to intermodal terminals, transshipment terminals, and warehouse and distribution centers is integral to supply chain operations in Texas, nationally and globally.

**Exhibit 19. Freight Rail Level-of-Service in 2030, No Improvements**




Source: National Rail Freight Infrastructure Capacity and Investment Study prepared for the Association of American Railroads by Cambridge Systematics, Inc.

Source: Association of American Railroads, National Rail Freight Infrastructure Capacity and Investment Study, 2007

### 2.7.1 Rail Ports of Entry

Each of the major freight sea ports in Texas is served by at least one Class I railroad, as shown in **Exhibit 20**. The land POEs with rail crossings are fairly evenly distributed across Texas' border with Mexico. **Exhibit 21** lists the Land POE with rail connections. These connections are also illustrated in **Exhibit 16**. Of the five land POE with rail connections, four are Class I railroads, while Presidio is served by the short line Texas Pacifico Transportation (TXPF) railroad. TXPF leases the South Orient Rail Line from TxDOT. The rail bridge in Presidio has been closed since it was damaged by fire in February 2008.

**Exhibit 20. Texas Ports and Connecting Railroads, 2010**

| Port | Connecting Railroads |
|---|---|
| Beaumont | KCS, UP, BNSF |
| Brownsville | Brownsville & Rio Grande International switching with UP, BNSF, KCS |
| Corpus Christi | KCS, UP, BNSF |
| Freeport | UP |
| Galveston | UP, BNSF |
| Houston | UP, BNSF, KCS (via trackage rights) |
| Orange | UP, BNSF |
| Port Arthur | KCS, UP, BNSF(via trackage rights and switching) |
| Port Lavaca- Point Comfort | Port Lavaca via UP, Point Comfort via Point Comfort & Northern |
| Texas City | UP, BNSF |
| Victoria | UP |

Source: Texas Rail Plan, TxDOT, 2010

**Exhibit 21. Texas Land Ports of Entry with Rail Connections, 2013**

| Class I Rail line | Connects to Port of Entry | | | | |
|---|---|---|---|---|---|
| | El Paso | Presidio | Eagle Pass | Laredo | Brownsville |
| UP | X | | X | X | X |
| BNSF* | X | | X | | X |
| KCS | | | | X | |
| TXPF Shortline | | X | | | |

Note:
*Via shared line operating agreement with UP

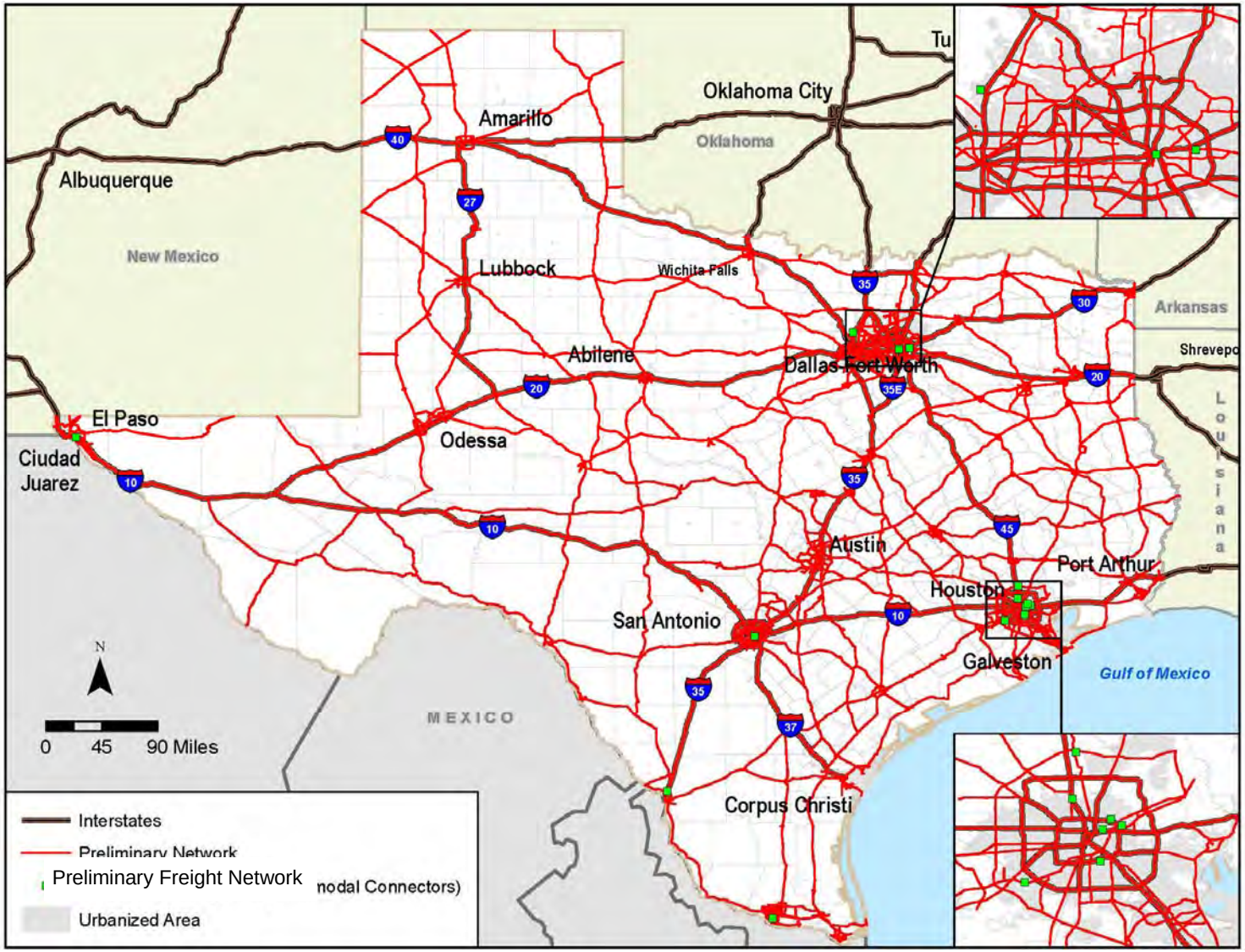
Source: Bureau of Transportation Statistics, 2013

### 2.7.2 Intermodal Facilities

Intermodal connectors serve an important function in the freight network. They are the points at which freight transfers from one mode to another for example from rail to truck or port to rail. They serve to connect freight movements at origins or destinations as those first or last mile transit and they can allow for freight to move from one mode to another or across regions for the same mode to facilitate the continued movement of goods along the supply chain. Exhibit 22 depicts the NHS intermodal connectors that serve as truck/rail intermodal terminals where goods transfer to and from highway and rail.

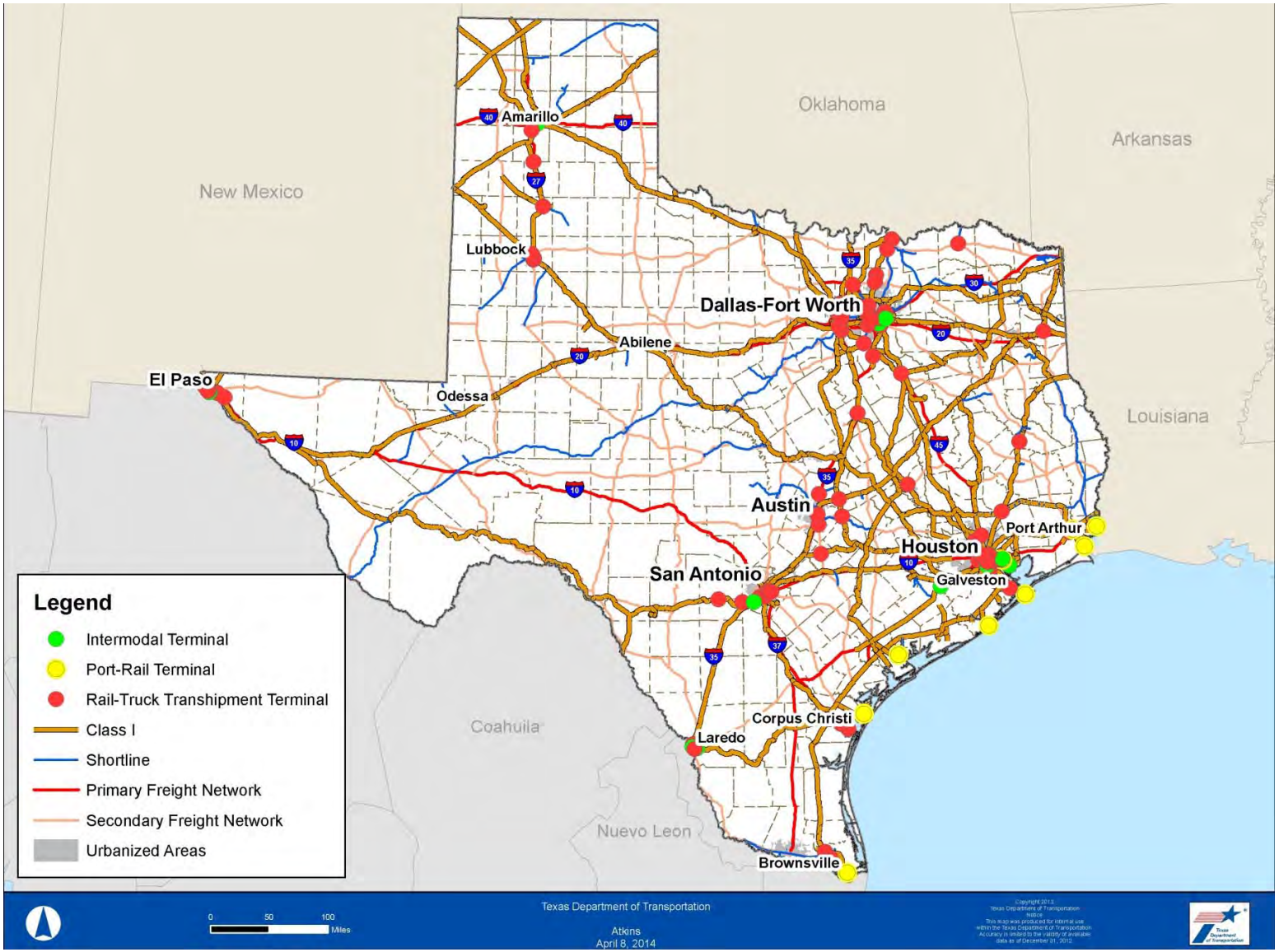
Exhibit 23 illustrates the numerous transshipment terminals located throughout Texas. Beyond the NHS intermodal connectors, there are facilities around the state which allow for the transfer of goods from rail to other modes. Most of these terminals are located near the major urban centers and along the freight network which allows for the most efficient shipment of goods. Many major warehousing and distribution centers have adjacent sidings will allow for direct rail access to their facilities.

**Exhibit 22. NHS Truck/Rail Intermodal Connectors, 2013**




Source: FHWA, 2013

## Exhibit 23. Rail Connections, 2013



## 2.8 Gulf Intracoastal Waterway (GIWW)

Texas' Gulf Coast provides several freight gateways through its sea ports. Eleven Texas ports were ranked among the top 150 in the nation in 2011 based on total tonnage, with seven among the top 50[5]. Ports in Texas and beyond are connected via the Gulf Intracoastal Water Way (GIWW), a navigable inland waterway along the south coast of the US with an average depth of 12 feet. The GIWW was completed in 1949 and is primarily meant to serve barge traffic. The Waterway Freight Network including the GIWW is discussed in this section. Unless otherwise noted, port specific information was obtained from the website maintained by each port.

The Gulf Intracoastal Waterway (GIWW), depicted in **Exhibit 24**, is a 1,300-mile man-made canal, which runs along the Gulf of Mexico coastline from Brownsville to St. Marks, Florida. The GIWW, primarily meant to serve barge traffic, connects Texas ports to one another as well as to the other Gulf ports in the country. Within Texas, the GIWW is approximately 425 miles long with authorized channel depth of 12 feet and a width of 125 feet. It is often a challenge to maintain this channel to these dimensions. Approximately five million cubic yards of material is dredged from the Texas portion of the channel annually. In 2011, over 112 short tons of cargo moved through the GIWW, with more than 74 million (66%) travelling through the Texas portion[6]. The GIWW handles commercial navigation traffic equivalent to the fourth largest port in the US[7].

[5] US Army Corps of Engineers (USACE) Navigation Data Center

[6] USACE Waterborne Commerce Statistics Center

[7] USACE

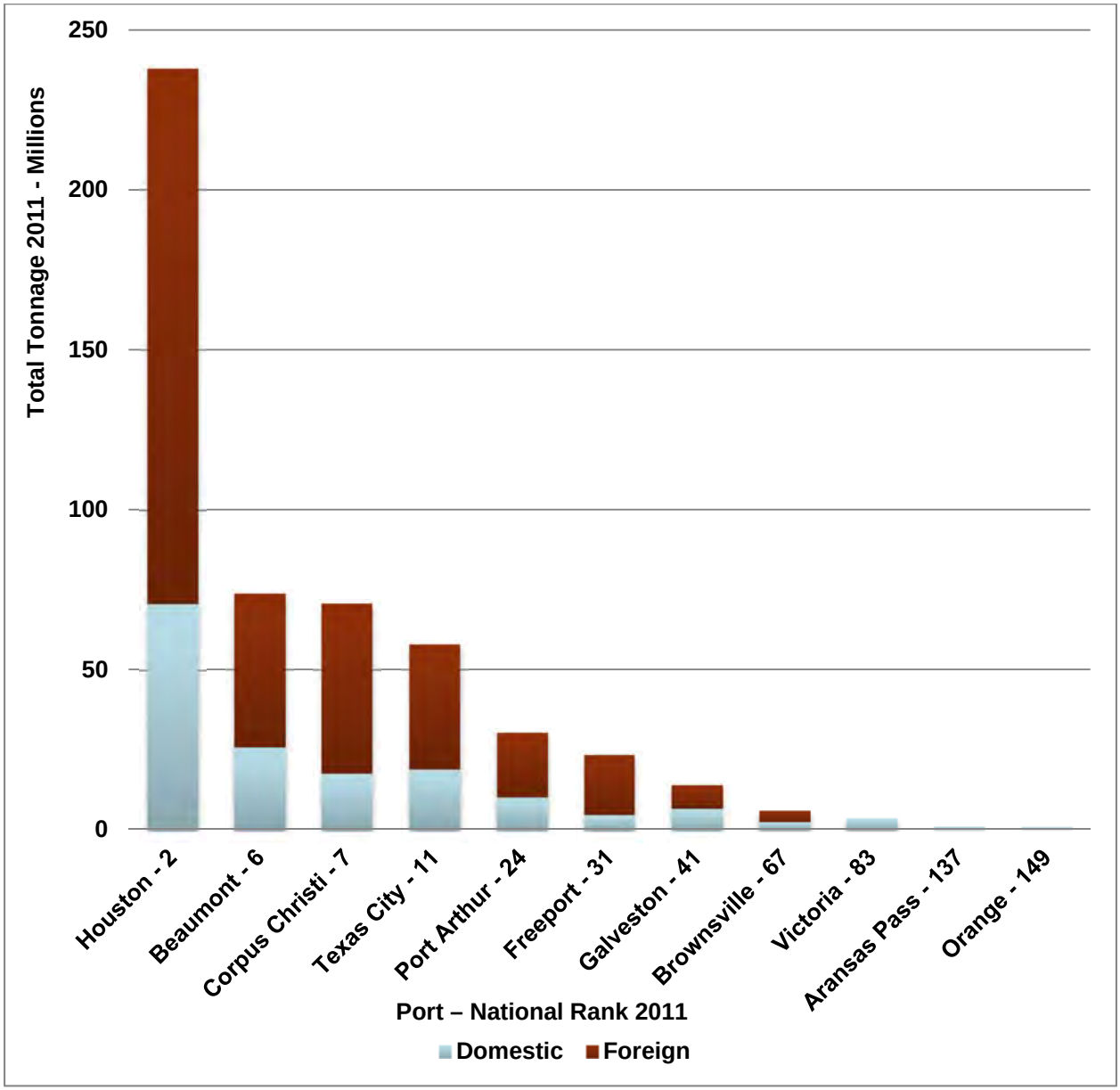
**Exhibit 24. Gulf Intracoastal Waterway, 2013**

Source: National Transportation Atlas, Bureau of Transportation Statistics, 2013

## 2.9 Texas Ports

Ports are integral to the Texas economy and connections to other transportation modes at the port facilities are necessary to provide connectivity to markets in Texas and beyond. **Exhibit 25** shows the total tonnage of freight shipped through those Texas ports that fall within the top 150 US ports in 2011. The chart shows the overall U.S. ranking, and gives a breakdown by domestic and foreign tonnage. The Port of Houston ranks second nationally in total tonnage, handling nearly 238 billion tons in 2011. **Exhibit 26** includes the channel length, depth, and width for each of these ports.

**Exhibit 25. Top Texas Water Ports 2011 Tonnage**




Source: U.S. Army Corps of Engineers, 2013

**Exhibit 26. Port Channel Information, 2012**

| Port/City Name | Channel | Length (miles) | Depth (feet) | Width (feet) |
|---|---|---|---|---|
| Houston | Houston Ship Channel | 52 | 45 | 530 |
| Beaumont | Sabine Neches Ship Channel [(a)] | 42 | 40 | 400 |
| Corpus Christi | Corpus Christi Ship Channel | 34 | 45 | 500 |
| Texas City | Texas City Ship Channel [(a)] | 9.4 | 45 | 500 |
| Port Arthur | Sabine Neches Ship Channel | 42 | 40 | 400 |
| Freeport | Freeport Harbor Channel [(a)] Harbor Channel | 8.5 | 45 | 400 |
| Galveston | Galveston Channel [(a)] | 9.3 | 45 | 1,200 |
| Brownsville | Brownsville Ship Channel [(a)] | 17 | 42 | 1,200[(b)] |
| Victoria | Victoria Barge Canal [(a)] | 35 | 12 | 125 |
| Aransas Pass | Aransas Pass Channel [(a)] | 7 | 14 | 125 |
| Orange | Sabine Neches Ship Channel | 42 | 40 | 400 |

Notes:

[a] Direct access to the GIWW – Texas portion (423 miles, 12 foot depth, 125 foot width)
[b] Turning basin width

Source: Report from the Panama Canal Stakeholder Working Group, 2012

Exhibit 26 includes major roadway and Class I railroad connections to these major ports. It is significant to note that several of these top US ports are not adjacent to the Interstate or US Highway system. This highlights the importance of the secondary roadway network in the state to the movement of freight. They ultimately connect the ports to the major highways and rail terminals.

## *2.10 Air Cargo*

The Federal Aviation Administration (FAA) categorizes public use airports into the following categories: Primary Commercial Service Airports, Non-Primary Commercial Service Airports, Reliever Airports, and General Aviation Airports. Primary Commercial Service Airports are further broken down into subcategories of Large Hub, Medium Hub, Small Hub, and Non-Hub, depending on their percentage of total U.S. passenger enplanements. Commercial Service Airports are those with at least 2,500 annual passenger enplanements and regularly scheduled commercial airline traffic.

The quantity of air cargo moving between origin and destination points, and also the amount of cargo transferring via an airport, is often closely related to airport infrastructure capacity. Texas' busiest cargo airports are located near major metropolitan areas that produce consistent passenger and air cargo traffic. Consequently, these facilities must be able to support large aircraft capable of accommodating market demand. The state's smaller airports, generally located near Texas' medium sized metro areas, have infrastructure capable of supporting smaller-scale air cargo

operations. These airports can be, and often are, used to move cargo traffic to larger airports and airports outside of the state.

Texas was home to five of the top cargo airports in North America in terms of total tonnage in 2012, shown in **Exhibit 27**.

**Exhibit 27. Texas' Top Freight Airports**

| ID | Airport Name | Associated City | 2002 Total Cargo Tonnage | 2012 Total Cargo Tonnage | 2002-2012 CAGR* | North American Rank 2012 | Global Rank 2012 |
|---|---|---|---|---|---|---|---|
| DFW | Dallas/Fort Worth International | Dallas-Fort Worth | 738,890 | 664,749 | -1.05% | 11th | 36th |
| IAH | George Bush Intercontinental | Houston | 363,529 | 483,226 | 2.89% | 14th | 46th |
| AFW+ | Fort Worth Alliance+ | Fort Worth | 176,429 | N/A | N/A | | |
| SAT | San Antonio International | San Antonio | 133,441 | 129,167 | -0.33% | 36th | 131st |
| ELP | El Paso International | El Paso | 88,426 | 94,146 | 0.63% | 47th | 168th |
| AUS | Austin-Bergstrom International | Austin | 142,919 | 77,796 | -5.90% | 54th | n/a |

Source: Airports Council International – North America (ACI NA)
*CAGR = Compound Annual Growth Rate
+ AFW ACI-NA data not available for 2012

These five airports handled nearly 1.45 million tons of total air cargo in 2012, which represents a decrease of -0.09% annually since 2002. In this same timeframe, Texas' fastest growing airports by total tonnage were George Bush Intercontinental (IAH) at 2.88% annually and El Paso International at 0.67% annually. Austin-Bergstrom International, Dallas/Fort Worth International, and San Antonio International all experienced losses in total air cargo from 2002 to 2012.

Connections between the cargo airports and the highway and rail networks are integral to the movement of freight from these gateways. **Exhibit 28** identifies the Interstate Highways and Class I railroads that are within 90 miles of these major air cargo airports in Texas. Although the Interstates may be the most heavily travelled routes for freight to and from the airports, the local and regional roadways around the airports serve as important connection to local warehousing facilities and other local freight destinations. There are over 160 PHFN roadway facilities within 90 miles of these top cargo airports in Texas. Many of these secondary routes are important connections for locally bound freight such as SH 114 in Dallas and SH 71 in Austin.

**Exhibit 28. Interstates and Class I Rail in Proximity to Cargo Airports, 2012**

| | DFW | IAH | AFW | SAT | ELP | AUS |
|---|---|---|---|---|---|---|
| Interstates | | | | | | |
| I-10 | | X | | X | X | X |
| I-20 | X | | X | | | |
| I-25 | | | | | X | |
| I-30 | X | | X | | | |
| I-35E | X | | X | | | |
| I-35W | X | | X | | | |
| I-35 | | | | X | | X |
| I-37 | | | | X | | |
| I-45 | X | X | X | | | |
| I-69 | | X | | | | |
| I-410 | | | | X | | |
| I-610 | | X | | | | |
| I-635 | X | | X | | | |
| I-820 | X | | X | | | |
| Class I Rail | | | | | | |
| UP | X | X | X | X | X | X |
| BNSF | X | X | X | | | X |
| KCS | X | X | X | | | |

Source: http://governor.state.tx.us/files/ecodev/Logistics_Report.pdf, 2012

## *2.11 Pipeline Freight Network*

The Pipeline and Hazardous Material Safety Administration (PHMAS), an agency of the U.S. Department of Transportation (USDOT), is the office responsible for regulating pipeline transport. In Texas, the state agency responsible for pipeline permitting and operations is the Railroad Commission of Texas (RRC). Approximately 294,000 miles of onshore gas transmission pipelines and 164,000 miles of onshore hazardous liquid pipelines move natural gas, crude oil, and petroleum products throughout the U.S. every day[8]. Pipelines are a relatively safe and inexpensive means to transport gas, oil, and petroleum. The National Transportation Safety Board indicates that pipeline transportation has a lower accident rate than other modes.

Pipeline transportation includes the gathering, transmission, or distribution of gas, oil, or other commodities by pipeline. The pipeline network is composed of the following three different line types:

[8] https://www.npms.phmsa.dot.gov/. Accessed November 7, 2013

- A transmission line is a pipeline that transports gas/liquid from a gathering line or storage facility to a distribution center, storage facility, or upstream large volume customer, or transports gas within a storage field.
- A gathering line is a pipeline that transports gas from a production facility to a transmission line.
- A distribution line is a pipeline other than a gathering or transmission line.

The network of transmission lines will be the focus of the pipeline information for the TFMP.

### 2.11.1 Pipeline Operations in Texas

In 2013, Texas contained of 374,318 total pipeline miles, which includes interstate and intrastate, and regulated and non-regulated miles[9]. In the region, these pipelines are mainly used for natural gas distribution followed by products like crude oil, liquefied petroleum, and refined products (**Exhibit 29**). The highest percentages of pipeline miles are in Harris County (5.6%), Brazoria County (3.5%), Jefferson County (2.8%), and Nueces County (2.2%)[10], which are areas of the state where there are numerous refining facilities.

The statewide transmission pipeline network includes pipelines with a diameter greater than or equal to 16 inches as depicted in **Exhibit 30**. Over 1700 companies operate pipelines in Texas. Of these companies, DCP Midstream (7.9%), Enterprise Products Operating (6.6%), Energy Transfer Company (4.8%), and Targa Midstream Services (2.6%) operate the highest percentages of pipeline miles in Texas[11].

[9] http://www.rrc.state.tx.us/data/gasservices/vitalstats/mileage.php Accessed November 7, 2013

[10] https://www.npms.phmsa.dot.gov/. Accessed November 7, 2013

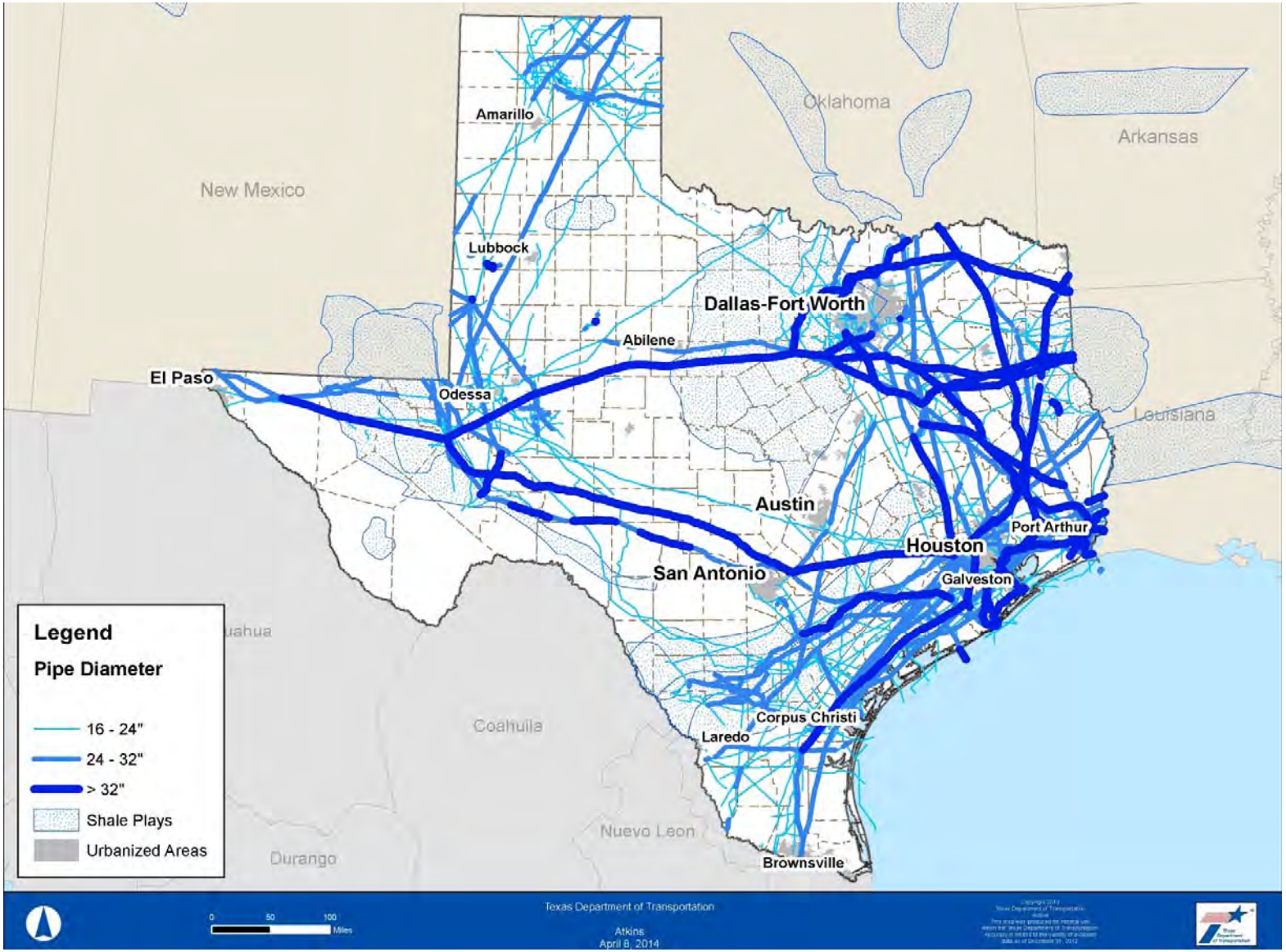
[11] https://www.npms.phmsa.dot.gov/. Accessed November 7, 2013

**Exhibit 29. Texas Pipeline Transmission Mileage by Commodity, 2011**

| Commodity | Pipelines Miles | Percentage |
|---|---|---|
| NG – Natural Gas | 63,162 | 50.1% |
| CRD – Crude Oil | 14,108 | 11.2% |
| LPG – Liquefied Petroleum Gas HVL (Highly Volatile Liquid) | 12,229 | 9.7% |
| PRD – Refined Products | 12,132 | 9.6% |
| NGL – Natural Gas Liquids HVL (Highly Volatile Liquid) | 10,473 | 8.3% |
| OHV – Other HVL (Highly Volatile Liquid) | 6,173 | 4.9% |
| EPL – Empty Liquid | 3,075 | 2.4% |
| $CO_2$ – Carbon Dioxide | 1,554 | 1.2% |
| OTG – Other Gas | 1,458 | 1.1% |
| HG – Hydrogen Gas | 897 | 0.7% |
| EPG – Empty Gas | 257 | 0.2% |
| AA – Anhydrous Ammonia HVL (Highly Volatile Liquid) | 197 | 0.1% |
| PG – Propane Gas | 89 | <0.1% |
| HVL – Highly Volatile Liquid | 29 | <0.1% |
| SG – Synthetic Gas | 28 | <0.1% |
| ETH – Ethylene HVL (Highly Volatile Liquid) | 15 | <0.1% |
| **Total** | **125,876** | **100%** |

Source: http://primis.phmsa.dot.gov/comm/reports/safety/TX_detail1.html
Report generated on December 15, 2013, data as of 2011

**Exhibit 30. Statewide Transmission Pipeline Network, 2013**




Source: The Railroad Commission of Texas, 2013

## 2.12 Intermodal Truck/Pipeline Terminals

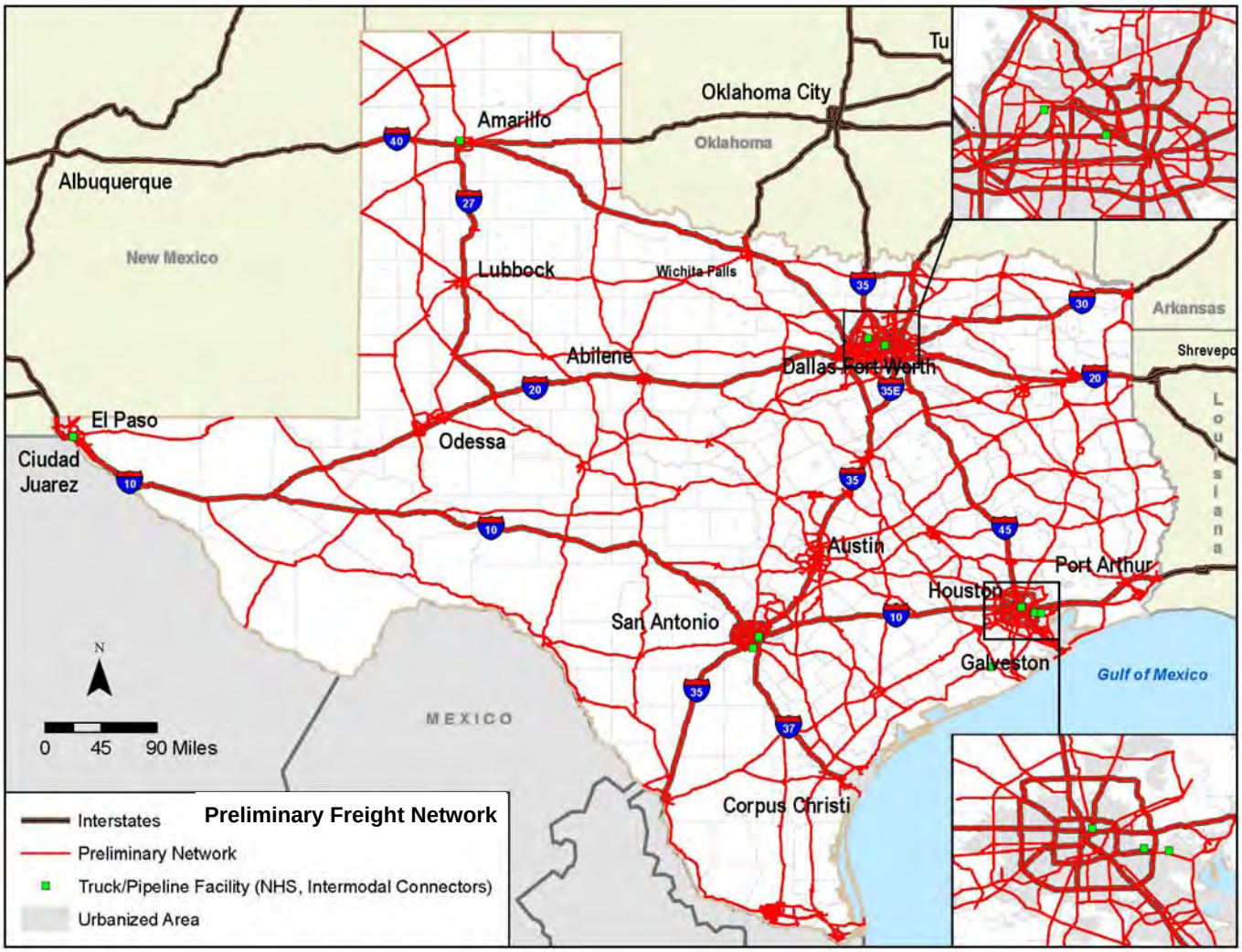
While the locations of the transmission pipelines are an important part of the Texas Freight Network, the pipelines connect to the TFHN at truck/pipeline terminals. It is at these facilities where the product being transported via the pipeline is transferred to trucks for further transport as needed. While there are many NHS truck intermodal connectors in Texas, there are only a few that handle pipeline products. Exhibit 31 identifies the NHS truck/pipeline intermodal terminals in Texas according to FHWA. These terminals are also depicted in Exhibit 32.

**Exhibit 31. Texas Truck/Pipeline Terminals, 2013**

| Intermodal Facility |
|---|
| Alameda Cluster |
| Chevron Refinery (El Paso) |
| Coastal States Terminal (San Antonio) |
| Deerpark Cluster |
| Diamond Shamrock Corp. Bulk Fuel Facility (DFW) |
| Diamond Shamrock Terminal (San Antonio) |
| Diamond Shamrock/Phillips (Amarillo) |
| Exxon Baytown Refinery |
| Exxon Bulk Fuel Facility (DFW) |
| Galena Park Cluster |
| GATX Terminals Corp. |
| Jacinto Port Cluster |
| Koch Refining Company (San Antonio) |
| Phillips Petroleum Sweeny Complex, Houston |
| Phillips Pipeline Co. |
| Shell Deer Park Chemical Plant & Refinery, Houston |
| Star Enterprise/Texaco |

Source: http://www.fhwa.dot.gov/planning/national_highway_system/intermodal_connectors/texas.cfm, 2013

## Exhibit 32. NHS Truck/Pipeline Intermodal Terminals, 2013




Source: FHWA, 2013

## 3.0 Key Trends and Issues

**Exhibit 33. Results of TxFAC Opinion Survey of Key Trends and Issues**

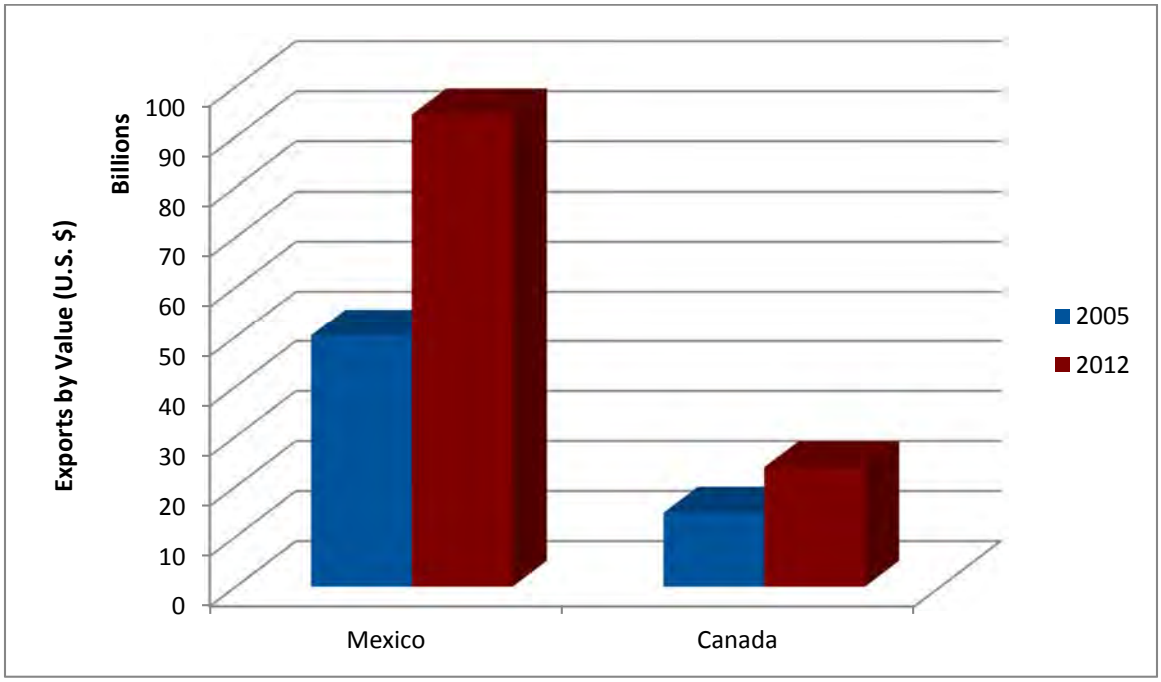
| Most Influential Trends/Issues | Most Influential (Count) | Least Infuential (Count) |
|---|---|---|
| **Economic Trends and Issues** | | |
| NAFTA Trade | 5 | 0 |
| Emerging Markets | 6 | 2 |
| Panama Canal | 2 | 3 |
| Port and Border Security/Efficiency | 3 | 1 |
| **Demographic Trends and Issues** | | |
| Population Growth, Mega-regions | 6 | 1 |
| **Infrastructure Preservation** | | |
| Port and Waterway Maintenance | 3 | 0 |
| Highway & Bridge Maintenance | 10 | 0 |
| Modal Productivity | 5 | 2 |
| Domestic Oil Production | 1 | 0 |
| **Environmental Trends and Issues** | | |
| Alternative Energy | 2 | 5 |
| Alternative Fuels | 4 | 2 |
| Air Quality | 1 | 2 |
| **Technology Trends and Issues** | | |
| Dedicated Freight Infrastructure | 5 | 1 |
| 3D Printing | 0 | 11 |

Members of the TxFAC also suggested the following as additional trends and issues to consider:

- **Resurgence of Mexico:** Current investment in the country's infrastructure and by private industry will substantially increase the flow of trade through the NAFTA corridor.
- **The value of US Currency:** Inflation and the future purchasing power of US consumers could have substantial impacts on future imports.
- **Workforce development:** This is a growing issue impacting logistics (i.e., truck drivers)

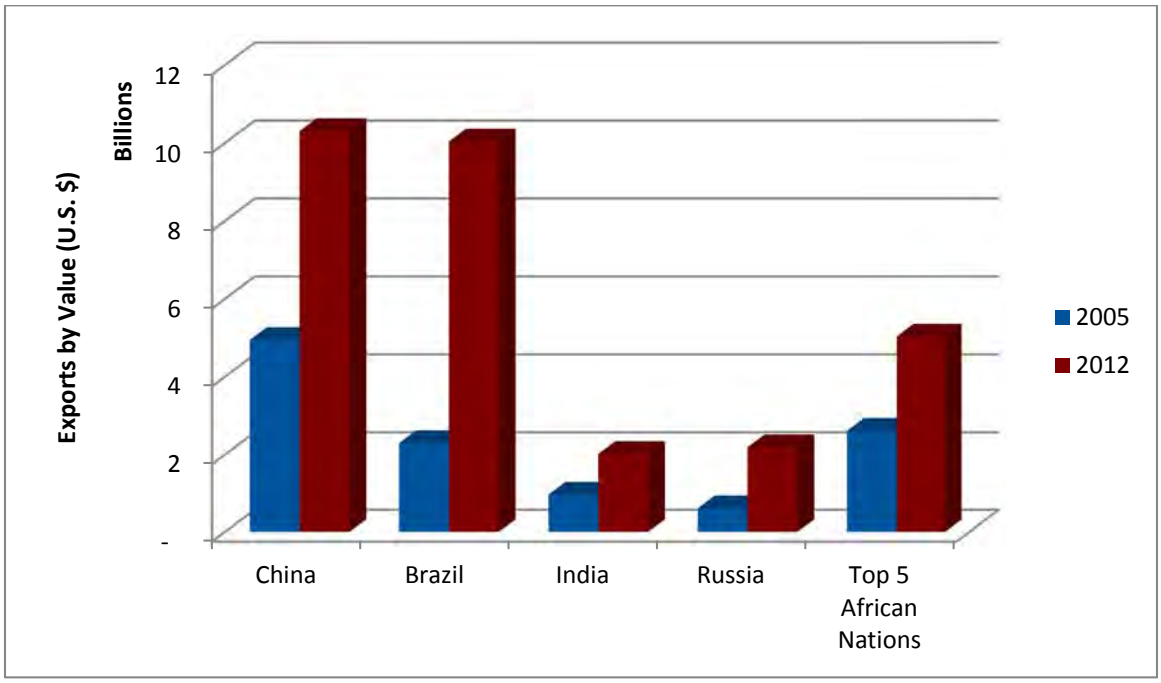
## 3.1 Economics

**Exhibit 34. Texas Exports to Mexico and Canada 2005 and 2012**




Source: International Trade Administration, US Department of Commerce

**Exhibit 35. Texas Exports to Emerging Nations 2005 and 2012**




Source: International Trade Administration, US Department of Commerce

## 3.2 Panama Canal

The expansion of the canal has spurred interest across the country. In 2012, the Texas Panama Canal Working Group studied the expansion's impact on the state and had three principal findings:[12]

1. The Panama Canal expansion…represents opportunities to expand Texas' position as a global gateway for the nation. By providing a low-cost, reliable, safe, secure, multimodal, and environmentally sustainable supply chain, the state can increase its global trade, create new jobs, and expand the economy of the state and nation.

2. As the leading goods export state in the country, Texas is well positioned to take advantage of the Panama Canal expansion and other opportunities to increase the export of dry bulk; liquid bulk; general and break bulk cargo; and containers to existing and new markets. Commodities in these general categories include agricultural produce; coal; value added manufacturing products; petrochemical and chemical products; military cargo; paper products; consumer goods; and other products. The emerging Liquid Natural Gas (LNG) export market resulting from energy developments in the state represents a major opportunity.

3. To increase global trade and economic development, Texas must develop processes that provide a transportation system focused on commerce, including Texas ports, the Gulf Intracoastal Waterway (GIWW), the roadway system, the rail system, and the pipeline network. It is critical that Texas accelerate investments in freight transportation infrastructure to grow commerce and increase the tax base of the state.

## 3.3 Port and Border Security

Border crossing security and efficiency are increasingly important issues for Texas due to US trade with Mexico. Security processing is often identified as a key reason for delays at the border and delays at points of entry, which are costly both economically and environmentally. Port security is also important due to containerized imports and hazardous materials (such as petrochemicals) that are handled at Texas ports.

A number of efforts have been introduced at the federal level to increase efficient border security, including the Container Security Initiative (CSI), the Secure Freight Initiative, and the Customs Trade Partnership against Terrorism (C-TPAT). CSI works with foreign governments to examine high-risk containers at foreign ports before departing for the US Currently 58 ports are participating accounting for nearly 85 percent of all US bound container traffic.[13] The Secure Freight Initiative builds on CSI to specifically address potential nuclear threats.[14] The C-TPAT partners with over

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[12] Report from the Panama Canal Stakeholder Working Group, November 2012

[13] U.S. Department of Homeland Security. Container Security Initiative Ports. Web. <http://www.dhs.gov/container-security-initiative-ports>.

[14] U.S. Department of Homeland Security. Secure Freight Initiative. Web. <http://www.dhs.gov/secure-freight-initiative>.

10,000 stakeholders around the world to pre-screen cargo entering the country; the participants represent over 50 percent of US imports by value.[15]

Texas has developed its own program, the Border Safety Inspection Facility (BSIF) program which consists of funding and construction of temporary and permanent border inspection facilities at locations all along the Mexican border. The goal of these facilities is to provide an efficient method of inspecting and weighing commercial vehicles entering the U.S. There are eight sites are included in the BSIF Program:

- Bridge of the Americas, El Paso
- Ysleta-Zaragoza Bridge, Ysleta
- Camino Real International Bridge, Eagle Pass
- Laredo-Colombia Solidarity Bridge, Laredo
- World Trade Bridge, Laredo
- Pharr-Reynosa International Bridge on the Rise, Pharr
- Free Trade Bridge, LOS Indios
- Veterans International Bridge at LOS Tomates, Brownsville

Trusted shipper programs allow carriers meeting pre-determined criteria to register and receive less scrutiny at the border. Programs like the Free and Secure Trade (FAST) lanes are used by C-TPAT to expedite border crossings and reward safe, known carriers. Research conducted by the Texas A&M Transportation Institute (TTI) found trusted shipper programs are successful at reducing wait times, but some carriers are reluctant to join and share data.[16] The US and Mexico have worked collaboratively on border initiatives founded on co-responsibility and collaboration between customs agencies, and expanding trusted shipper programs. For example, C-TPAT's FAST lane program works with Mexico's New Program of Certified Companies. [17]

Texas convenes a Border Trade Advisory Committee to provide a forum between TxDOT, the governor, Metropolitan Planning Organizations (MPO), ports of entry, universities, and city and county officials, among others, to evaluate the effect transportation choices have on border trade and communities. This Committee produces reports, the most recent in 2012, detailing the status of current programs, opportunities and threats to the system, funding issues and future outlook of border trends.[18] Texas realizes the importance of border capacity, efficiency and security on the economic vitality of border communities as well as the state and nation. It is critical to continue

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[15] U.S. Customs and Border Protection. Customs-Trade Partnership Against Terrorism (C-TPAT). Web. <http://www.cbp.gov/linkhandler/cgov/trade/cargo_security/ctpat/ctpat_program_information/what_is_ctpat/ctpat_overview.ctt/ctpat_overview.pdf>.

[16] Trotter, Bob, Brenda Manak, et al. Texas A&M Transportation Institute. Assessment of Multiple Layers of Security Screening of Trucks by Customs Border Protection in El Paso, Texas. Web. <http://d2dtl5nnlpfr0r.cloudfront.net/tti.tamu.edu/documents/TTI-2013-6.pdf>.

[17] "Mexico-U.S. Border Cooperation Lauded by U.S. Official." IIP Digital. 19 Sept 2013. Web. <http://iipdigital.usembassy.gov/st/english/inbrief/2013/09/20130922283297.html

[18] Texas. Department of Transportation. Border Trade Advisory Committee Report 2012. Web. <http://ftp.dot.state.tx.us/pub/txdot-info/tpp/misc/btac_2012.pdf>.

collaborative efforts with Mexico and invest in capacity, technology and security upgrades where appropriate to ensure trade thrives and freight of all modes is able to freely and efficiently move across the border, throughout the state and beyond.

Using technology at border crossings and ports is one way to enhance both security and efficiency without having to build large, expensive capacity improvements or other costly infrastructure. Federal security programs like the Secure Freight Initiative already employ technology that can scan and detect radioactive material in real-time, ensuring no nuclear material is traveling inappropriately.[19]

Texas' BSIF program uses Intelligent Transportation Systems (ITS) strategies like weigh-in-motion (WIM) and dimension-in-motion (DIM) components so trucks do not have to stop, dynamic messaging signs to inform drivers, and a flow manager to ensure traffic flows smoothly.[20] The entire system is synthesized into one software system for efficient and effective management by employees. Depending on if the truck passes or fails certain points of inspection, the software diagrams their route and what steps are to be taken to rectify the issue. Cameras are installed at various points and accessible from the software as well.

Port security uses a wide array of technologies including X-ray and Radiation Portal Monitors (RPM), intelligent video systems, crane-mounted sensors, and Radio Frequency Identification (RFID) tags, among others.[21] Ports are also beginning to use strategies similar to how the Federal Aviation Administration (FAA) monitors all US air traffic, using an integrated coastal radar system to better understand and protect the borders as well as increase maritime safety in case of an emergency.

# 4.0 Unconstrained Needs Determination

## *4.1 Methodology and Assumptions*

### 4.1.1 Defining "Needs"

Several tasks in the TFMP were directed toward the collection of information to document the state's freight assets in a comprehensive inventory, to ascertain their current condition and develop a needs assessment based on meeting future demand. Use of the TRANSEARCH database for current and forecast freight volumes was a critical element of the analysis. Data from TRANSEARCH was enhanced by interaction with both public and private sector participants including:

- Stakeholder engagement
  - Listening sessions
  - Motor carrier surveys

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[19] U.S. Department of Homeland Security. Secure Freight Initiative. Web. <http://www.dhs.gov/secure-freight-initiative>.

[20] Sturgeon, Purser, and Darin Parish. Texas. Department of Transportation. ITS and Border Safety Inspection Facilities in Texas. 2009. Web. <http://itstexas.org/sites/itstexas.org/files/presentations/ITS_Texas_2009_Session2B_Parish.pdf>.

[21] Stone, David. "Port Security: Top Threats and Technology Trends." Security Info Watch. 06 Mar 2006. Web. 23 Oct. 2013. <http://www.securityinfowatch.com/article/10558823/port-security-top-threats-and-technology-trends>.

  - Roadside Truck Driver Origin/Destination (O/D) Interviews
  - Inventory and assessment of freight transportation assets
- Analysis of the condition and performance of the freight system.

Participants in the extensive outreach program identified highway congestion, delays due to accidents, lane merge difficulties, and inadequate highway capacity to be the most problematic issues. Roughly 24% listed Texas' expansive road network as an economic strength. However, a greater proportion (34%) listed the quality of the road network as one of Texas' weaknesses.

The most common areas of congestion included I-35 and I-10 along with the areas surrounding all major cities, and specifically near Dallas/Fort Worth, Austin, and Houston.

The overall freight transportation needs were identified in 10 categories:

1. System Capacity
2. System Operations
3. Safety/Security
4. Intermodal Connectivity
5. Rural Connectivity
6. NAFTA and Border/Ports-of-Entry
7. Energy/Environment
8. Education/Public Awareness
9. Public/Private Sector Coordination
10. Funding/Financing

Exhibit 36 identifies types of needs and issues associated with the each of the 10 broader needs categories.

**Exhibit 36. Key Freight Network Needs**

| System Capacity | Energy/Environment |
|---|---|
| Reduce rail capacity constraints | Reduce cost of alternative fuel sources |
| Increase number of alternate corridors/redundancy | Streamline environmental review process |
| Reduce congestion on key freight corridors | Understand the impact of expanded shale production on infrastructure |
| Reduce bottlenecks at interchanges on key freight corridors | |
| Improve merging lanes at interstate interchanges | |
| System Operations | Education and Public Awareness |
| Update and maintain aging infrastructure | Promote a better understanding of the impact of re-shoring on freight volumes and Texas infrastructure |
| Address oversize/overweight/over dimensional trucks issues (e.g., permitting and routes) | Communicate importance of freight movement to the public |
| Enhanced comprehensive statewide incident management | Improve communication between public-private sectors |
| Define a statewide priority freight network | Improve understanding by the public of commercial vehicle operational needs |
| Identify dedicated heavy weight truck corridors | Improve the understanding of role and responsibilities of private and public sector in funding and maintaining infrastructure |
| Designate and identify truck-only lanes | |
| Safety/Security | Public/Private Sector Coordination |
| Improve truck parking (including overnight/rest stops) | Connect to neighboring states' infrastructure |
| Reduce the number of at-grade rail crossings | Increase political/legislative support for freight issues |
| Improve rail connectivity in rural areas | improve internal and external communication within public agencies |
| Improve and update roadway geometrics | Increase coordination on technology between public and private sectors |
| Increase education/awareness of public about commercial vehicle needs | Improve collaboration to accommodate varying planning horizons |
| Intermodal Connectivity | Increase understanding of agencies to market conditions that impact long-term efforts |
| Identify regional corridors | Coordinate on real-time travel conditions with neighboring states |
| Improve port-rail connections | |
| Increase the number of intermodal connection points | |
| Rural Connectivity | Funding/Financing |
| Improve north-south connectivity to the border | Focus on funding on high priority freight corridors |
| Increase connectivity between western and eastern railroads | Balance existing transportation funding needs |
| Increase rural access to existing freight network | Create alternative measures for allocating funding |
| NAFTA and Border/Ports of Entry | Explore alternative funding mechanisms |
| Reduce congestion at the border | Promote importance of freight transportation to elected officials |
| Reduce customs processing time | |

**Exhibit 36. Key Freight Network Needs**

| System Capacity | Energy/Environment |
|---|---|
| Address border crossing staffing issues | |
| Increase and implement cross-border technology applications | |
| Promote public awareness of changing policies in Mexico (legislative, economic, funding, etc.) | |
| Connect U.S. Interstate to Mexico's infrastructure | |
| Impact of Mexican infrastructure improvements on U.S. | |

## *4.2 System Capacity*

Congestion and bottlenecks were identified as important issues with regard to the state's freight transportation system. Key congested corridors as well as those with significant bottlenecks in major urban areas identified include: I-35 in Austin; I-35 north of San Antonio; I-10, I-610, US 59 in Houston; I-35, and 635 in Dallas. Congestion at border crossings present significant freight bottlenecks.

Most of the freight rail lines in the state are single track which creates choke points in the system and affect overall rail system capacity. One of the key rail bottlenecks identified is the single track railroad bridge of the Neches River in Beaumont which handles over 50 trains a day. Additional rail lines are needed around the Port of Houston. Improvements to existing lines are needed where rail conflicts are causing highway bottlenecks such as around Corpus Christi.

The identified ports and waterway need was to deepen the Gulf Intracoastal Waterway to allow for more freight flows through Texas ports. Roadways such as I-10, I-20, Interstate 35, I-69, US-281, and US-83 were identified as some of the roadways in the state experiencing congestion and encroachment problems.

More pipelines across the state were also identified as a need to meet the demands of the energy sector activities. Additional pipeline capacity would reduce the number of trucks carrying crude oil.

## *4.3 System Operations*

The lack of a comprehensive statewide incident management program was identified as a need related to systems operations. Improved incident management to detect, respond, and clear incidents on roadways faster as part of a robust statewide incident management program would improve reliability help in maximizing the existing infrastructure.

The need for a comprehensive statewide traffic management center was identified. The lack of real-time traveler information alerting drivers to incidents, construction, roadway conditions, etc. was noted as a critical need for facilitating efficient movement of freight throughout the state.

Updated and proper signage is also important in the efficient movement of freight. Design standards were identified as an issue needing to be addressed, specifically signal timing and placement, inadequate turning radii, and acceleration and deceleration lanes.

There is a need for a statewide freight network to support the efficient movement of freight throughout the state. This includes the need for designated truck routes, oversize/overweight truck corridors, and hazardous material routes. A dedicated freight network will promote opportunities for connectivity throughout the state, improve the efficiency of the entire transportation system, and enhance global competitiveness.

## *4.4 Safety/Security*

Safety is a major focus of TxDOT and private sector stakeholders. A key priority should be to operate effectively and efficiently and maintain safety standards. Key safety needs include:

- Lack of safe truck parking
- Numerous at-grade rail crossings particularly in urban areas
- Poor roadway design and geometrics
- Lack of public education and awareness of commercial vehicle operations

In addition to congestion, vehicular crashes also create delays for freight and can result in significant damage to cargo and personal injury. This includes heavy truck crashes on highways and crashes at highway-rail grade crossings.

## *4.5 Intermodal Connectivity*

Modal availability is measured in varying degrees by the regions throughout the state, though all agree the lack of strong connectivity between the modes reduces their efficient and productive use. A system with adequate and available access points, e.g. truck-rail facilities, promotes the use of alternative modes beyond truck. Without these access points, supply chain decision makers rely on trucks rather than rail, water, or air transport. This lack of access contributes to the capacity concerns on highways. Without better intermodal connectivity, the combination of higher forecasted volumes of trade and reliance on truck transport will lead to increased congestion. The lack of connectivity among modes hinders the future growth of the Texas economy.

## *4.6 Rural Connectivity*

The TFMP outcomes should promote operational capacities and modal diversity to rural regions. This expansion will promote economic development and manage the future volumes of trade. Currently, 109 out of 253 counties in Texas are classified as rural as defined by the US census. The south and west regions have typically not been afforded access to modes beyond truck. Access to rail transport is frequently identified as a site selection criteria for new investment by manufacturers or distributors. Without modal alternatives, these regions are placed at an economic disadvantage. Farm-to-Market (FM) roads are seeing increased traffic with rural production and the state needs to ensure the system is maintained and expanded. The west Texas region has been

identified as a potential site for future space-centric activities, without appropriate rail and air cargo capacities, transport will be limited to trucks, something which may impact the economic potential.

## 4.7 NAFTA and Border/Ports-of-Entry

Texas is the number one US trading partner with Mexico. Texas shares a common border with Mexico and as such is subject to not only the direct exchange of freight, but also a significant amount of pass-through freight as well. The increasing role of the Mexican economy within global trade has dramatically impacted Texas border crossings. Foreign investors, including China, have invested in Mexican freight infrastructure, such as Federal Highway 2 that runs along the Mexico–US border, and Port Lazaro-Cardenos, which is the largest Mexican seaport. Mexican manufacturing centers, known as maquilas, have raised the level of trade between the US and Mexico. Many of these investments are ongoing and will continue to impact trade volumes.

Activities impacting supply chain decisions by US and foreign organizations have promoted a redirection of manufacturing, assembly, and raw material processing to Mexico from Asian markets. Robotics, reducing the impact of labor wages, additive and regional manufacturing, duty-free and tariff-free material and equipment importation, and fuel-transportation costs have collectively fostered an increase of goods moving from Mexico into the US

Areas surrounding border crossings are subject to extreme traffic congestion. As trade increases and congestion worsens, the resulting situation may promote other methods of transportation for import and export traffic with Mexico. The inability to productively process trade at the international bridges and border crossings may foster alternative modal use or redirect trade volumes to crossings with other states other than Texas. Redirecting trade volumes to other states could have a negative impact on the economy.

## 4.8 Energy/Environment

There is a great deal of focus on exploring alternative fuel sources, particularly liquid natural gas and compressed natural gas. However, many alternative fuel sources are not financially viable options and often are not suitable for transporting hazardous materials or overweight loads. Additionally, there is a need to streamline the environmental regulatory review process to be more efficient.

## 4.9 Education/Public Awareness

Effective freight planning is dependent upon public awareness of key freight issues. Stakeholders stressed the importance of public education on the benefits of freight. In particular it was noted that the public needs to be made aware of the economic benefits and quality of life improvements that are supported by freight mobility including job creation and global economic competitiveness. Educating the public on safety issues related to freight is also a focus. Stakeholders believe that the general public is not aware of the challenges that the trucking industry faces. This lack of understanding can lead to safety problems.

## 4.10 Public/Private Sector Coordination

Planning activities often occur within the silo of a specific agency or organization, resulting in less than satisfactory implementation. Without the cooperation of other agencies and integration with other TxDOT and external agency plans, TxDOT implementation efforts may not meet the goals of the individual plan. In an effort to alleviate these shortcomings, TxDOT should form cooperative partnerships to provide efficient and economy-of-scale efforts to achieve successful implementation. Stakeholders noted that the public and private sector need to work together to create a safe, reliable, and efficient freight network in Texas.

## 4.11 Funding/Financing

The majority of transportation funds come from the federal gas tax which has not been raised since 1993. This has put a severe strain on the transportation sector to find alternative funding sources for transportation projects. There is a need to identify innovative and alternative funding sources.

## 4.12 Performance

In section 2 the primary needs of the TFHN were classified into three categories; asset management, mobility and reliability, and safety. Current conditions and future expectations for increasing freight volume direct the need for investment.

### 4.12.1 Asset Management

Adequately maintaining the condition of Texas' highways, bridges, and rail networks, particularly those associated with the TFHN is critical to freight movement.

Most roadways on the TFHN are currently in good condition (84 percent). This overall average, however, conceals some major concerns. Texas interstate highways, the most important part of the highway network, have a smaller percentage of sections in good condition and a larger percentage in very poor condition when compared to overall TFHN averages. The Dallas area has the most miles of roadways with pavement conditions of poor and very poor.

The 2040 traffic forecasts and pavement condition grades were used to identify the top 25 roadway segments that should be prioritized for improvement. The sections, on average, are in the poorest condition for the anticipated future truck volumes. These 25 roadway sections are presented in Exhibit 37. Five of these sections are on interstates, nine are on US highways, six are on state highways, and five of these segments are on farm-to-market (FM) roadways. These sections are prioritized because they are in very poor condition and are anticipated to carry high truck volumes in the future.

**Exhibit 37. Prioritized Texas Preliminary Freight Network – Pavement Condition**

| Control Section | Roadway | Length | District |
|---|---|---|---|
| 0675-04 | IH 45 | 9.9 | Bryan |
| 0261-02 | US 67 | 5.7 | Dallas |
| 2552-03 | SL 375 | 14.4 | El Paso |
| 1890-01 | FM 1976 | 13 | San Antonio |
| 0374-02 | US 62 | 8 | El Paso |
| 0259-05 | BU 67 | 5.6 | Fort Worth |
| 0264-06 | US 277 | 5.8 | San Angelo |
| 0255-07 | US 281 | 5.4 | Pharr |
| 0371-01 | US 77 | 7.9 | Yoakum |
| 0271-15 | IH 610 | 6.1 | Houston |
| 0271-14 | IH 610 | 6.1 | Houston |
| 0441-09 | IH 10 | 8.7 | Odessa |
| 0272-04 | US 190 | 6.2 | Brownwood |
| 0306-03 | SH 87 | 6.9 | Beaumont |
| 0264-05 | US 277 | 5.8 | San Angelo |
| 0275-07 | IH 40 | 6.4 | Amarillo |
| 0389-12 | BS 146 | 8.3 | Houston |
| 2452-03 | SL 1604 | 14.2 | San Antonio |
| 0400-02 | SH 154 | 8.4 | Paris |
| 0339-05 | SH 105 | 7.4 | Beaumont |
| 2681-02 | FM 2499 | 14.8 | Fort Worth |
| 1802-02 | FM 3461 | 12.8 | Pharr |
| 0254-01 | US 281 | 5.3 | Corpus Christi |
| 1064-01 | FM 676 | 11 | Pharr |
| 1890-01 | FM 1976 | 13 | San Antonio |

Source: TxDOT Pavement Management Information System and Statewide Analysis Model v.3

**Bridge Conditions.** Based on analysis using the Federal Highway Administration's (FHWA's) National Bridge Inventory condition rating system, the vast majority of bridges in Texas are in good condition and less than 1 percent of bridges are in poor or very poor condition. Substructures and culverts, however, are generally in worse condition than other bridge elements.

The 25 bridges in very poor condition are presented in **Exhibit 38**. Four of these bridges are on interstates, twelve are on US highways, eight are on state highways, and one is on the FM roadway network. The bridges in very poor condition with low traffic volumes are already posted with warnings and limitations. Other bridges are in very poor condition because of their high traffic volumes and importance in the highway system.

**Exhibit 38. Texas Preliminary Freight Network Bridges with Lowest Sufficiency Ratings**

| Bridge | Intersected Feature | City (nearest) | Sufficiency Rating |
|---|---|---|---|
| IH 35 | Road (travels under) | Dallas | 228 |
| US 82 | Waterway | Texarkana | 330 |
| US 190 | Waterway | Lufkin | 341 |
| US 190 | Waterway | Lufkin | 341 |
| SH 310 | Road (travels over) | Dallas | 347 |
| US 84 | Waterway | Longview | 351 |
| SH 35 | Waterway | Houston | 351 |
| US 77 | Waterway | Corpus Christi | 355 |
| US 287 | Waterway | Wichita Falls | 356 |
| US 87 | Road (travels over) | Amarillo | 360 |
| US 87 | Road (travels over) | Amarillo | 360 |
| IH 45 | Road (travels over) | Houston | 378 |
| SH 183 | Road (travels over) | Fort Worth | 389 |
| SH 87 | Waterway | Beaumont | 392 |
| SH 105 | Waterway | Bryan | 398 |
| FM 720 | Waterway | Dallas | 403 |
| SH 35 | Waterway | Corpus Christi | 408 |
| SH 183 | Rail (travels over) | Fort Worth | 412 |
| US 190 | Waterway | Lufkin | 341 |
| IH 20 | Waterway | Abilene | 425 |
| IH 35 | Waterway | Fort Worth | 430 |
| US 84 | Road (travels under) | Abilene | 437 |
| US 67 | Waterway | Odessa | 438 |
| US 281 | Waterway | Fort Worth | 443 |
| SH 73 | Waterway | Beaumont | 450 |
| IH 35 | Road (travels under) | Dallas | 228 |
| US 82 | Waterway | Texarkana | 330 |
| US 190 | Waterway | Lufkin | 341 |
| US 190 | Waterway | Lufkin | 341 |
| SH 310 | Road (travels over) | Dallas | 347 |
| US 84 | Waterway | Longview | 351 |

**Track Quality.** The PTFRN is the most extensive state rail system in the United States. While these rail facilities are owned by private companies, including Union Pacific, BNSF, and Kansas City Southern, track maintenance has a direct impact on operation speeds and weight capacity. Most of Union Pacific's system is approved for heavy axle rail cars that can handle up to between 286,000 lbs. and 315,000 lbs. of gross weight. BNSF provides weight restriction maps for 4-axle cars based on their length.

Nearly all railroad lines in Texas are single-track; there are four segments of multi-track rail lines. The longest multi-track rail line runs from the New Mexico border northeast through Amarillo to the Oklahoma border. There are three shorter multi-track segments in urban environments: one line between northeast San Antonio and New Braunfels; one line between Fort Worth and Dallas; and a third line, which runs within Houston. Additionally the railroad system includes 72 railroad bridges that cross waterways.

## *4.13 Mobility*

The mobility of a freight transportation network is largely determined by the number and severity of "bottlenecks." Identification and ranking of the top freight highway bottlenecks is primarily based on the FHWA Office of Freight Management and Operations' annual Freight Performance Measures (FPM) analysis, which assesses the level of truck-oriented congestion at 250 locations on the national highway system, and results from a Texas Transportation Institute (TTI) study on freight bottlenecks to validate the results. As **Exhibit 39** indicates, Texas is responsible for five of the top ten truck bottlenecks in the nation. Half of the 16 bottlenecks in Texas saw their national ranking increase between 2010 and 2012, while the other half saw improvement in relative congestion.

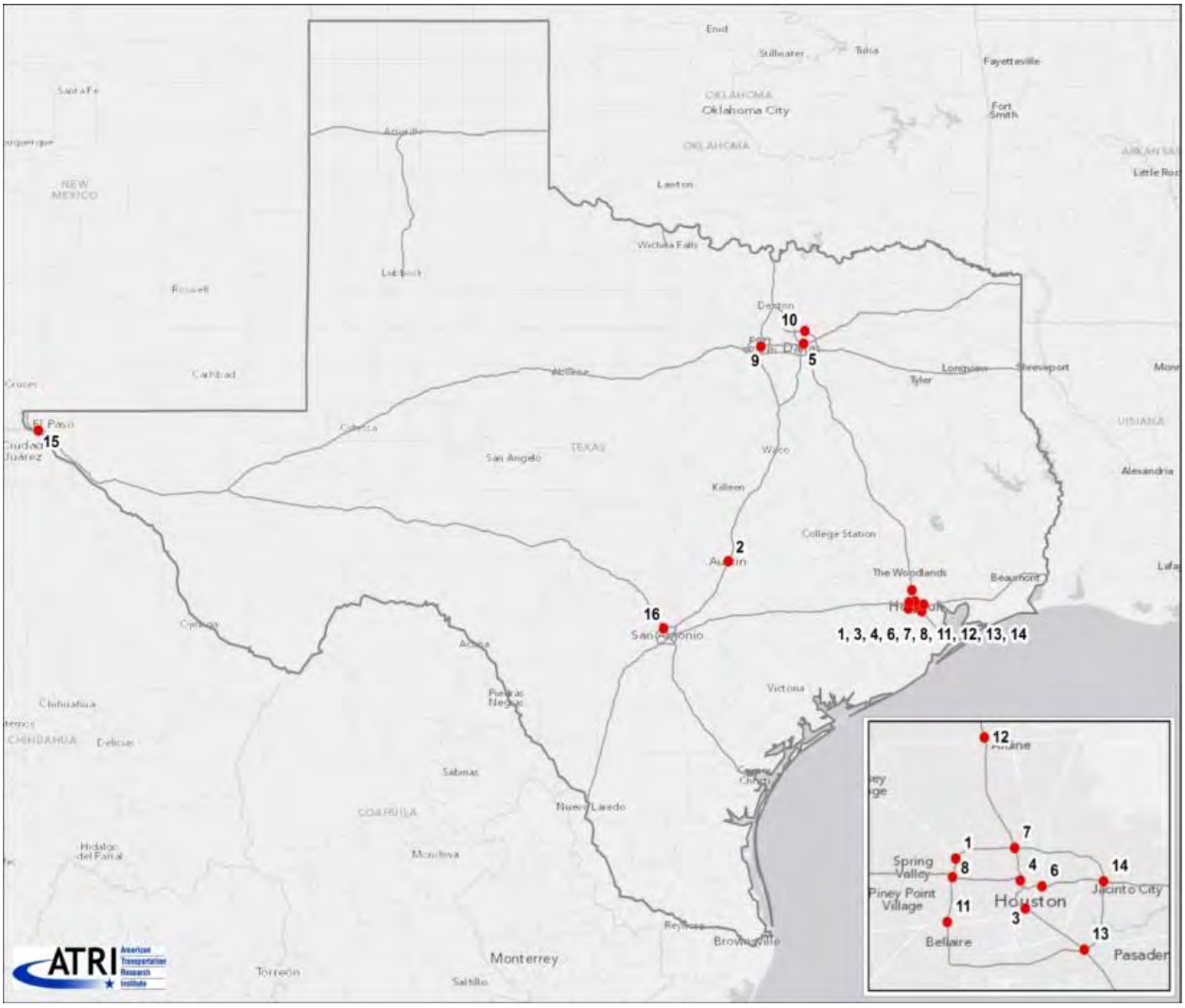
**Exhibit 39. Freight Performance at Texas Bottlenecks**

| LOCATION | RANKING | | TTI |
|---|---|---|---|
| | 2012 | 2010 | |
| Houston, TX: I-610 at US 290 | 2 | 12 | 21 |
| Austin, TX: I-35 | 3 | 7 | 2 |
| Houston, TX: I-45 at US 59 | 7 | 3 | 16 |
| Houston, TX: I-10 at I-45 | 9 | 4 | 1 |
| Dallas, TX: I-45 at I-30 | 10 | 13 | |
| Houston, TX: I-10 at US 59 | 11 | 5 | 19 |
| Houston, TX: I-45 at I-610 (North) | 16 | 14 | 47 |
| Houston, TX: I-10 at I-610 (West) | 21 | 26 | 3 |
| Ft. Worth, TX: I-35W at I-30 | 23 | 29 | 5 |
| Dallas, TX: US 75 at I-635 | 30 | 53 | 14 |
| Houston, TX: I-610 at US 59 (West) | 34 | 50 | |
| Houston, TX: I-45 at Sam Houston Tollway (North) | 62 | 94 | 15 |
| Houston, TX: I-45 at I-610 (South) | 71 | 62 | 59 |
| Houston, TX: I-10 at I-610 (East) | 84 | 44 | 33 |
| El Paso, TX: I-10 at I-110/US-54 | 103 | 89 | 50 |
| San Antonio, TX: I-10 at I-410 (North) | 146 | 142 | 83 |

Source: American Transportation Research Institute, 2013

**Exhibit 40** illustrates the location of the 16 monitored bottlenecks in Texas. As expected, the worst bottlenecks are located in major urban areas, including Houston, Dallas-Ft. Worth, and San Antonio. There are other areas of congestion but those listed are the worst congestions locations as determined by the FHWA's FPM.

**Exhibit 40. Location of Texas Bottlenecks**




Source: American Transportation Research Institute, 2013

Rail bottlenecks result in delays to trains and may simultaneously cause vehicular traffic delays at blocked at-grade highway-rail crossings, increasing delays for both modes, as well as increasing public and private operating costs. As Texas has an extensive rail network with multiple intermodal connections, the statewide impact of bottlenecks can be extensive.

There are many reasons bottlenecks develop on a rail system. They can originate at a single point such as at-grade crossings of rail lines, rail junctions, a section of single track in a predominately double-track line, or a bridge with weight limitations that requires crossing at restricted speeds. Bottlenecks can result over a long area of track from conditions such as an inadequate number of passing tracks, passing tracks that are not long enough for the length of trains using the line, lack of signals, etc.

There are numerous rail bottlenecks throughout the state including regions defined by Houston, Dallas-Fort Worth, Corpus Christi, San Antonio, and Beaumont.

### 4.13.1 Safety

The safety hazards analysis provides a snapshot of the performance of highways and at-grade highway-rail crossings on the Texas Trunk System and main railroad lines. Crash and incident data are analyzed for commercial motor vehicles, at-grade highway-rail crossings, and mainline railroad incidents. During the period from 2010 to 2012 the total statewide number of commercial motor vehicle crashes and the number of commercial motor vehicles crashes on the PTFN have shown an upward trend. The number of total commercial motor vehicle crashes, and incapacitating injury crashes showed a dip in 2011 even though vehicle miles traveled in the state increased 1.36 percent from 2010 to 2011. Of the crashes on the PTFN involving a commercial vehicle, the percentage of fatal crashes was 1.8 percent and the number of crashes involving an injury or possible injury was 28.7 percent for the three year period. Truck rollovers were also examined and **Exhibit 41** lists the top ten rollover locations as identified by The American Trucking Research Institute (ATRI). While several of the rollover locations are located near major urban areas, particularly Dallas-Ft. Worth, many of the top rollover locations are outside of the large cities.

**Exhibit 41. Rollover Frequency at Identified Locations**

| Top Rollover Locations | | |
|---|---|---|
| ID | Location | Number of Rollovers |
| 1 | US 59/South St and US 59/SR 224 | 9 |
| 2 | Central Expy and CF Hawn Fwy/US 175 | 9 |
| 3 | SR 183, SR 114, SR 12 and S 482 | 8 |
| 4 | I-10/US 90 and US 59 | 8 |
| 5 | US 259 and US 59 | 7 |
| 6 | I-30/US 67 and I-35E/US 77 | 7 |
| 7 | I-35 near Bob Bullock Loop/SR 20 | 6 |
| 8 | US 77 near Welder Wildlife | 6 |
| 9 | I-20/US 80 and US 84 | 6 |
| 10 | I-35@ and Martin L King Jr Fwy/US 287 | 6 |

Source: American Transportation Research Institute 2013

It is difficult to attribute large truck rollover accidents to a single cause. Many different factors such as speed, road geometry, load configuration, brake condition, pavement condition, and intersections can all contribute simultaneously (though not necessarily equally) to a rollover event. While this report does not have specific information related to the driver, truck or load types and distributions, some insights about rollover cause can be drawn from the operating environment information gained by mapping the rollover crash locations.

Crash records for the rail system were obtained from the FRA's Office of Safety Analysis website and included all crashes and incidents involving rail traffic that occurred between January 1, 2010 and December 31, 2012 including incidents at highway-rail crossings, and a statewide database of all highway-rail crossings. Since 2010, the total annual number of crashes and resulting fatalities at

highway-rail grade crossings in Texas has increased, while the number of injuries caused by highway-rail grade crossing crashes remained about the same over this same period. Automobiles were the vehicle most often involved in a crash at a grade crossing (31 percent) while truck-trailers were the second most-involved vehicles (26 percent). The percentages for vehicle types involved in at-grade crashes remained approximately the same over the three year period.

There are 75 highway-rail grade crossings where railroads intersect with the TFHN. Forty-eight of these crossings have a commercial motor vehicle average annual daily traffic (AADT) count greater than 500. In the past three years there have been 17 crashes at nine of these crossings resulting in no injuries and fatalities. Six of these nine crossings had an estimated commercial motor vehicle AADT greater than 500.

## *4.14 Unconstrained Needs*

The TFMP is moving on a different schedule than the LRTP. Some of the information regarding the monetary requirements to meet the needs for improving the freight infrastructure are not yet available from the TFMP. Some information regarding highway capacity improvement has been made available from the freight planning team. Investment needs for other modes have been collected from other sources including TxDOT planning documents, plans of individual entities such as airports, and information that is publicly available. These dollar amounts should be considered preliminary and while they may be representative of project requirements they should not be considered final.

### 4.14.1 Highway Needs

Most of the highway and bridge needs for freight have been encompassed in the LRTP. However the entire range of highway and bridge projects for the TFMP have not been completed and some variation from the LRTP may occur. The following estimates have been provided by CDM Smith, Inc. for a series of improvements to ease capacity on both the primary and secondary freight networks. These numbers are preliminary based on the current schedule and status for the freight planning project. **Exhibit 42** indicates the estimates for projects to improve capacity on those corridors in the state that have been identified as part of the Primary Freight Highway Network. The estimates were developed based on corridor segment requirements. For example the section of I-10 between El Paso and Van Horn is treated as a segment and the estimates for expansion produced accordingly. The following **Exhibit 43** shows the total miles and estimated construction costs to widen roads and highways that have been designated as part of the Secondary Freight Highway Network. The exhibits show only the summary totals and the dollar amounts should be regarding as preliminary only.

**Exhibit 42. Primary Corridor Capacity Improvements**

| Primary Freight Highway Network Capacity Improvements | | Additional Mainlines | Addition of Access Roads | Total Estimate |
|---|---|---|---|---|
| Statewide Primary Corridor Total | Miles | 4,347 Miles | 2,420 Miles | |
| | Construction Estimate | $12,171,600,000 | $7,260,000,000 | $19,431,600,000 |

Source: CDM Smith, Inc.

**Exhibit 43. Secondary Freight Highway Network Lane Expansions**

| Secondary Freight Highway Network Lane Expansion | | Secondary Pavement 4 Lane Widening | | Secondary Pavement "Super 2" Widening* |
|---|---|---|---|---|
| | | Additional 2 Lanes | Additional 1 Lane | |
| Total Construction Costs All Districts | Miles | 5,156 Miles | 170 Miles | 3,867 Miles |
| | Construction Estimate | $8,765,200,000 | $170,000,000 | $3,867,000,000 |

Note:
*Estimated at 75% of existing 2 lane roadway

Source: CDM Smith

## 4.14.2 Rail Needs

The needs for freight rail development are included here as they are presented in the Texas Rail Plan from November of 2010. The plan document is available on the TxDOT website. The table below in Exhibit 44 summarizes the estimated cost of rail freight capital needs in Texas through 2030 which was the planning horizon for the plan. Freight rail needs were extrapolated from national studies as a percentage of needs, as estimated for the nation. While these numbers are not specifically calculated for Texas, they were adopted in the Rail Plan to indicate the extent of the needs for freight rail improvements in the state.

**Exhibit 44. Estimated Texas Freight Rail Needs, 2005 to 2030**

| Freight Rail Need | Cost |
|---|---|
| Crossing Closure | $18,900,000 |
| Pedestrian Bridge | $7,500,000 |
| Grade Separation | $2,172,400,000 |
| New Rail Connections | $1,730,340,000 |
| **Total** | **$3,929,040,000** |

Source: Texas Rail Plan 2010 Executive Summary

### 4.14.3 Airport Needs

The Austin-Bergstrom International Airport (AUS)'s Master Plan Update shows planned growth in three upcoming phases. Appendix C of the AUS Master Plan details the cost estimate of each planning level, including the cost of air cargo and belly hold cargo. According to this appendix, AUS plans to pay for $420,134 of the belly hold cargo in Planning Level 2, a third party is committed to pay $73,585,186, $36,244,860 and $3,796,247 for air cargo in Planning Level 1, 2 and 3 respectively and $5,895,162, $1,891,707 and $4,961,006 for belly hold cargo in Planning Level 1, 2 and 3 respectively.

George Bush Intercontinental Airport (IAH) also has an air cargo expansion planned as part of their Capital Improvement Program (CIP) in the IAH Master Plan. During Phase 3, IAH estimates that it will need $20,751,800 in 2017 to study/design and $93,383,100 in 2018 and another $93,383,100 in 2019 to construction the expansion. During Phase 4, IAH will need $23,782,800 in 2023 to study/design and $214,045,200 to finish the construction of the expansion. IAH has no record of funding sources for their air cargo expansion plan.

According to their Master Plan Update, Corpus Christi International Airport (CCIA) plans to expand their support facilities in their long-term plan, Phase 3. CCIA estimates that a new cargo apron will cost $378,000 and construction of an air cargo building will cost $1,746,000. CCIA is anticipating that the development costs of their new support facilities in Phase 3 will be paid for by a private source or a source that is not the airport or federal funding. CCIA estimated their costs in 2006 dollars.

The Dallas/Fort Worth International Airport (DFW) recognizes the need for new cargo facilities in their 2009 Airport Development Plan Update (VFR 2030) so in 2007 they created seven development alternatives. From those seven alternatives, DFW identified two preferred alternative scenarios (Alternative 2 and Alternative 4), although there are no cost estimates of these alternatives at this time.

El Paso International Airport (ELP) expanded their air cargo facilities in the past three years. Currently, they have the largest and most modern air cargo complex on the U.S. Mexico border and have the capability of immediate expansion if needed.

The William P. Hobby Airport (HOU) has also been working on expanding their facilities: During Phase 4 (2018-2022), HOU will also expand their belly freight facility. According to the HOU Master Plan CIP, it is anticipated that the new belly freight facility will cost $13,090,000 and that a third party will cover the total cost.

In the San Antonio International Airport (SAAS)'s Master Plan, air cargo development is planned 2016-2019 with the addition of a north cargo complex that will cost $78,040,000 and a taxiway connector to the complex that will cost $760,000. The total cost of the cargo improvements is anticipated to be funded by a source other than the airport. SAAS estimated their costs in 2010 dollars.

The airport needs that are specifically attributed to freight in these airport planning documents are summarized below in **Exhibit 45**.

**Exhibit 45. Airport Needs**

| | | Austin | Bush | Corpus Christi | Houston Hobby | San Antonio | Dallas – Fort Worth |
|---|---|---|---|---|---|---|---|
| Airport Cost | Air Cargo | - | $445,346,000 | - | - | - | $260,888,005** |
| | Belly Cargo | $420,134 | - | - | $13,090,000 | - | |
| 3rd Party Cost | Air Cargo | $193,626,293 | | $2,124,000 | | $78,040,000 | |
| | Belly Cargo | $12,747,875 | | | | | |

Source: Airport Plans; (**Estimated 35% contingency based on DFW average freight values.)

## 4.14.4 Port Needs

The project funding needs for Texas Ports is presented as taken from the Texas Ports 2013-2014 Capital Program report. This is an annual report that details funding requests for port transportation and economic development projects submitted by eligible ports. The 2013-2014 report identifies capital projects totaling $779,791,400.00. These capital projects do not represent a comprehensive listing of all capital needs of Texas ports. 11 ports provided port profiles for the FY 2013/FY 2014 period. These ports submitted 51 projects, a small part of their capital activities. State funding requirements for all of these projects at a maximum cost share level of 50 percent from the Port Access Account Fund. The report committee included every eligible project submitted with no prioritization. The projects range from improving intermodal connections to security enhancements. Specific details of the plans for each port are available in the full report at the TxDOT website.

**Exhibit 46. FY 2013 Port Project Summary**

| Port and Project Description | Total Estimated Cost | Port Funding | Port Access Account Funding |
|---|---|---|---|
| **Port of Beaumont** | | | |
| Upgrade KCS Railroad Bridge across Port of Beaumont Ship Channel | $16,000,000.00 | $8,000,000.00 | $8,000,000.00 |
| Orange County Railroad Overpass | $9,000,000.00 | $4,500,000.00 | $4,500,000.00 |
| Wetland Impact Mitigation for 215 acres in Orange County | $5,000,000.00 | $2,500,000.00 | $2,500,000.00 |
| *Total* | *$30,000,000.00* | *$15,000,000.00* | *$15,000,000.00* |
| **Port of Brownsville** | | | |
| Deepening and Widening Feasibility Study | $650,000.00 | $325,000.00 | $325,000.00 |
| Lift Station Improvements | $60,000.00 | $30,000.00 | $30,000.00 |
| Water Tank Rehabilitation | $1,033,000.00 | $516,500.00 | $516,500.00 |
| New Infrastructure | $20,500,000.00 | $10,250,000.00 | $10,250,000.00 |
| Improvements to docks, Warehouses, and Cargo Laydown Areas | $3,502,000.00 | $1,751,000.00 | $1,751,000.00 |
| Port Security Improvements | $1,033,000.00 | $1,993,000,00 | $1,993,000,00 |
| Rail Improvements | $2,200,000.00 | $1,100,000.00 | $1,100,000.00 |
| *Total* | *$31,931,000.00* | *$15,965,500.00* | *$15,965,500.00* |
| **Port of Corpus Christi** | | | |
| Rail Infrastructure | $40,000,000.00 | $20,000,000.00 | $20,000,000.00 |
| Rincon Industrial Park | $13,500,000.00 | $6,750,000.00 | $6,750,000.00 |
| La Quinta Terminal Dock – Phase 1 | $3,000,000.00 | $1,500,000.00 | $1,500,000.00 |
| *Total* | *$56,500,000.00* | *$28,250,000.00* | *$28,250,000.00* |
| **Port of Freeport** | | | |
| Velasco Terminal Project | $2,809,000.00 | $1,404,500.00 | $1,404,500.00 |
| Multimodal Facilities | $299,000.00 | $149,500.00 | $149,500.00 |
| Project Cargo Storage and Related Development | $75,000.00 | $37,500.00 | $37,500.00 |
| Cold Storage Facility | $715,000.00 | $357,500.00 | $357,500.00 |
| Security Related | $143,000.00 | $71,500.00 | $71,500.00 |
| Other Projects | $916,400.00 | $458,200.00 | $458,200.00 |
| *Total* | *$4,957,400.00* | *$2,478,700.00* | *$2,478,700.00* |
| **Port of Galveston** | | | |
| 41st St. Harborside Entrance | $1,500,000.00 | $750,000.00 | $750,000.00 |
| RUBB Building | $7,650,000.00 | $3,825,000.00 | $3,825,000.00 |
| Internal Traffic Circulation | $5,000,000.00 | $2,500,000.00 | $2,500,000.00 |
| Vessel Fendering System | $950,000.00 | $475,000.00 | $475,000.00 |
| *Total* | *$15,100,000.00* | *$7,550,000.00* | *$7,550,000.00* |
| **Port of Harlingen** | | | |
| East Dock Refurbishment (100% port funded) | $1,000,000.00 | $0.00 | $0.00 |
| Security Enhancements (Federally funded) | $130,000.00 | $0.00 | $0.00 |
| *Total* | *$1,130,000.00* | *$0.00* | *$0.00* |

**Exhibit 46. FY 2013 Port Project Summary**

| Port and Project Description | Total Estimated Cost | Port Funding | Port Access Account Funding |
|---|---|---|---|
| **Port of Houston** | | | |
| Barbours Cut Terminal | $56,900,000.00 | $28,450,000.00 | $28,450,000.00 |
| Bayport Terminal | $207,870,000.00 | $103,935,000.00 | $103,935,000.00 |
| Turning Basin Terminal | $20,000,000.00 | $10,000,000.00 | $10,000,000.00 |
| *Total* | *$284,770,000.00* | *$142,385,000.00* | *$142,385,000.00* |
| **Port of Palacios** | | | |
| Turning Basin #1 Cargo Deck | $1,200,000.00 | $600,000.00 | $600,000.00 |
| Shipyard Construction | $2,250,000.00 | $1,125,000.00 | $1,125,000.00 |
| Study for Beneficial Use of Dredged Material | TBD | TBD | TBD |
| *Total* | *$3,450,000.00* | *$1,725,000.00* | *$1,725,000.00* |
| **Port of Port Arthur** | | | |
| Berth 6 and Shoreline Stabilization | $25,000 ,000.00 | $12,500,000.00 | $12,500,000.00 |
| Road and Site Access | $1,500,000.00 | $750,000.00 | $750,000.00 |
| Security | $1,200,000.00 | $600,000.00 | $600,000.00 |
| *Total* | *$27,700,000.00* | *$13,850,000.00* | *$13,850,000.00* |
| **Port of Victoria** | | | |
| Rail Staging Area Enlargement | $6,500,000.00 | $3,250,000.00 | $3,250,000.00 |
| Liquid Cargo Dock Additions | $3,500,000.00 | $1,750,000.00 | $1,750,000.00 |
| Erosion Control | $1,500,000.00 | $750,000.00 | $750,000.00 |
| *Total* | *$11,500,000.00* | *$5,750,000.00* | *$5,750,000.00* |
| **Total All FY 2013 Projects** | **$467,038,400.00** | **$232,954,200.00** | **$232,954,200.00** |

**Exhibit 47. FY 2014 Port Project Summary**

| Port and Project Description | Total Estimated Cost | Port Funding | Port Access Account Funding |
|---|---|---|---|
| **Port of Brownsville** | | | |
| Deepening and Widening Feasibility Study | $500,000.00 | $250,000.00 | $250,000.00 |
| Improvements to Docks and Warehouses and Cargo Laydown Areas | $26,038,000.00 | $13,019,000.00 | $13,019,000.00 |
| Water Tank Rehabilitation | $982,000.00 | $491,000.00 | $491,000.00 |
| *Total* | *$27,520,000.00* | *$13,760,000.00* | *$13,760,000.00* |
| **Port of Corpus Christi** | | | |
| La Quinta Terminal | $20,000,000.00 | $10,000,000.00 | $10,000,000.00 |
| Barge Fleeting Area | $3,000,000.00 | $1,500,000.00 | $1,500,000.00 |
| Channel Improvement Project – La Quinta Terminal | $8,000,000.00 | $4,000,000.00 | $4,000,000.00 |
| La Quinta Terminal Dock - Phase 2 | $47,000,000.00 | $23,500,000.00 | $23,500,000.00 |
| *Total* | *$55,000,000.00* | *$39,000,000.00* | *$39,000,000.00* |
| **Port of Houston** | | | |
| Barbours Cut Terminal | $58,690,000.00 | $29,345,000.00 | $29,345,000.00 |
| Bayport Terminal | $114,993,000.00 | $57,496,500.00 | $57,496,500.00 |
| *Total* | *$173,683,000.00* | *$86,841,500.00* | *$86,841,500.00* |
| **Port of Port Arthur** | | | |
| Rail Reliever | $4,000,000.00 | $2,000,000.00 | $2,000,000.00 |
| *Total* | *$4,000,000.00* | *$2,000,000.00* | *$2,000,000.00* |
| **Port of Victoria** | | | |
| Rail Extension to Industrial Park South Property | $5,500,000.00 | $2,750,000.00 | $2,750,000.00 |
| Road Improvements | $6,000,000.00 | $3,000,000.00 | $3,000,000.00 |
| Container Dock Construction | $12,550,000.00 | $6,275,000.00 | $6,275,000.00 |
| RO/RO Facility Construction | $5,500,000.00 | $2,750,000.00 | $2,750,000.00 |
| *Total* | *$29,550,000.00* | *$14,775,000.00* | *$14,775,000.00* |
| **Total All FY 2013 Projects** | **$312,753,000.00** | **$156,376,500.00** | **$156,376,500.00** |

## 5.0 Fiscally-Constrained Analysis

The CDM Smith and TxDOT team creating the TFMP have determined that their approach to project implementation will be to focus development on selected, prioritized corridors rather than on individual initiatives spread around the state. Application of resources to a corridor will provide a more complete return on the investment relative to the needs of the freight community and is consistent with the goals of MAP-21.

The freight planning team is in the process of developing a scoring system to be applied to the primary corridors by segments. The corridor segments are being identified and will be scored based on their ability to meet various criteria determined to be critical to freight mobility in the state. The scoring will include factors related to the goals of the TFMP and key needs and issues identified previously. Some examples would include the number of bridges and overpasses along the segment with height or weight restrictions, or the number of major freight facilities in proximity to the corridor. The corridors will be ranked based on the combined segment scoring. Cost estimates will then be completed for a short list of corridors that will have priority for development.

This work is ongoing and preliminary numbers are anticipated to be available in September. The TFMP is scheduled for completion at the end of the year and will provide more specific freight detail to supplement the LRTP.

# Appendix A
# List of Major New Service Projects

# Texas Transportation Plan

## Tech Memo 10: Scenario Analysis

August 15, 2014

## Acknowledgements

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A multimodal, performance-based needs assessment was conducted for the 2040 Texas Transportation Plan (TTP) to identify the minimal investment required to achieve a state-of-good-repair or similar performance targets over the planning horizon. This Technical Memorandum #10 provides four example investment approaches to better evaluate the costs and outcomes of investing in our transportation system: (1) System Preservation, (2) Metropolitan Mobility, (3) Connectivity and Freight Mobility, and (4) Financially-Constrained "Plus". The expected revenues available to meet statewide multimodal transportation needs are also presented.

## 1.0 Revenue Forecast

Texas' population is expected to increase by 17 million by 2040. Therefore, a substantial investment in transportation infrastructure will be necessary to ensure sufficient and reliable mobility options for system users, safe infrastructure, and continued statewide economic growth. A review of available and forecasted financial resources to make progress towards these TTP goals, among others, is provided below.

### *1.1 State Transportation Revenues*

Revenues for all modes in the State were forecasted for the 2040 TTP using estimates provided by the TxDOT Financial Division, including forecasts of vehicle registration fees, state motor fuel tax, FHWA reimbursements, and transit funds.

State transportation revenues totaled $10.5 billion in 2013 with funding from federal, state, and other sources (**Figure 1**) for all modes analyzed in the TTP. According to TxDOT's revenue forecast shown in **Figure 2**, annual revenues are expected to peak in 2015, followed by a slight decline over the next five years and then steadily increase through 2040. On average, it is estimated that the State can expect $11.6 billion (in 2014 constant dollars) through 2040 for investment in the modes analyzed in the TTP.

**Figure 1: Texas Transportation Main Revenue Sources**

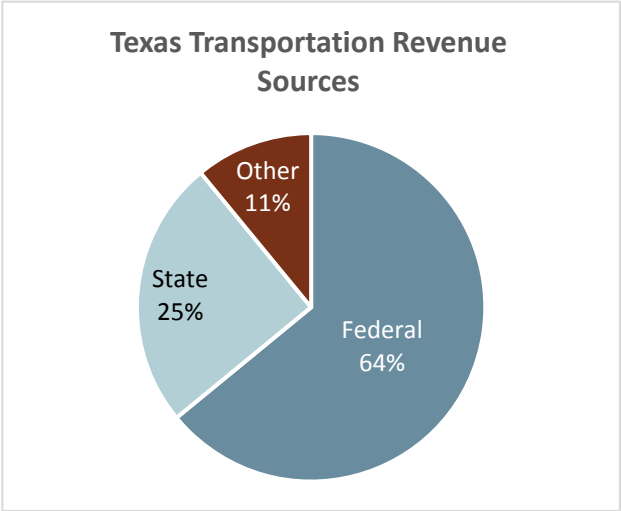
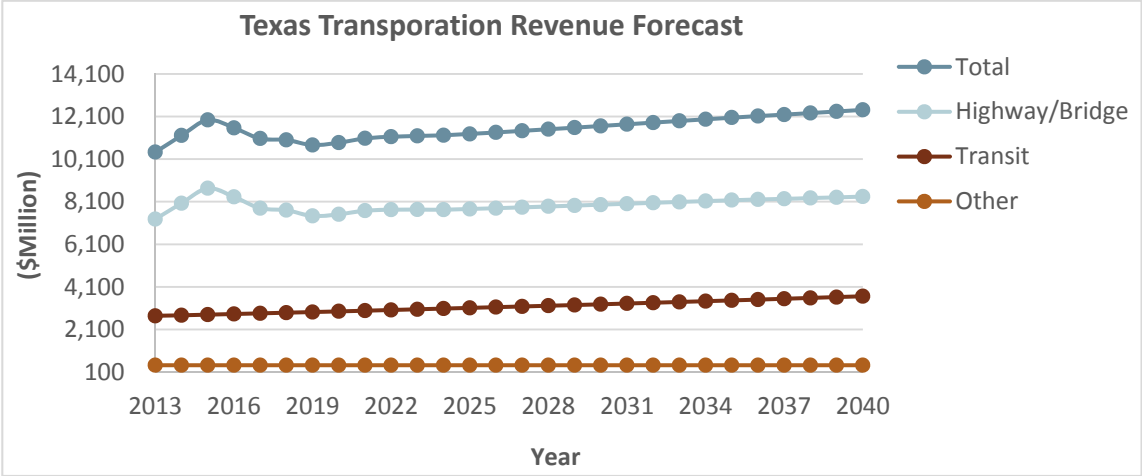


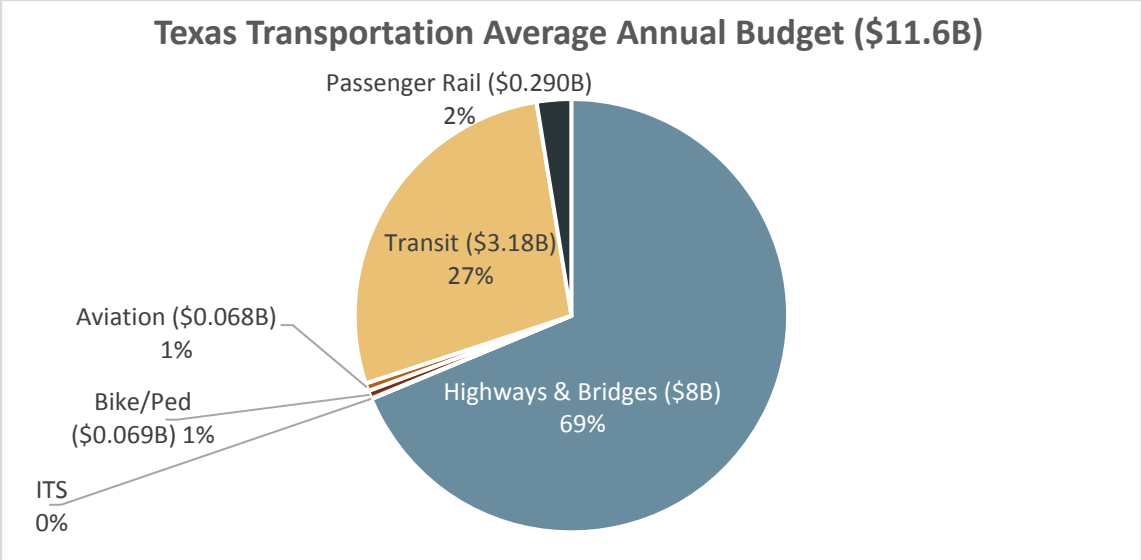
**Figure 2: Revenue Forecasts for TTP Analysis**




## *1.2 Available Revenue by Mode*

Because the forecasted $11.6 billion per year is for all modes in the State, it must be broken out among these modes, which include highway/ bridge, transit, aviation, bicycle/ pedestrian, and passenger rail. Of course, some funds are not flexible and their spending is restricted to a certain mode (for example, federal transit revenues are restricted from being reallocated to other modes) while others are more flexible. **Figure 3** shows the split of how the total available budget is typically divided between the modes analyzed in the TTP. Highways and transit investments represent more than 95 percent of the total annual budget on average.

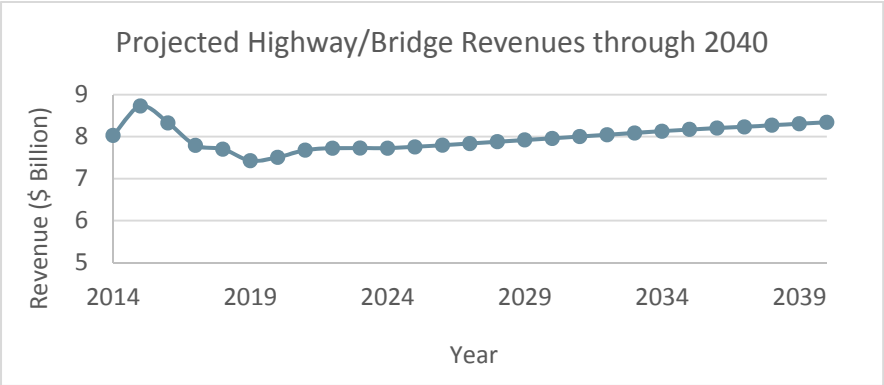
**Figure 3: Annual Budget Share (in 2014 constant dollars) by Mode**



### 1.2.1 *Highway/Bridge*

**Figure 4** shows TxDOT's highway/ bridge revenue forecast through 2040. For investment in the State's highways and bridges (on the State system), ninety percent of the budget for Texas highways and bridges originates from vehicle registration fees, state motor fuel tax, lubricant sales tax, and FHWA reimbursements.

**Figure 4: Highway/Bridge Revenue Forecast**

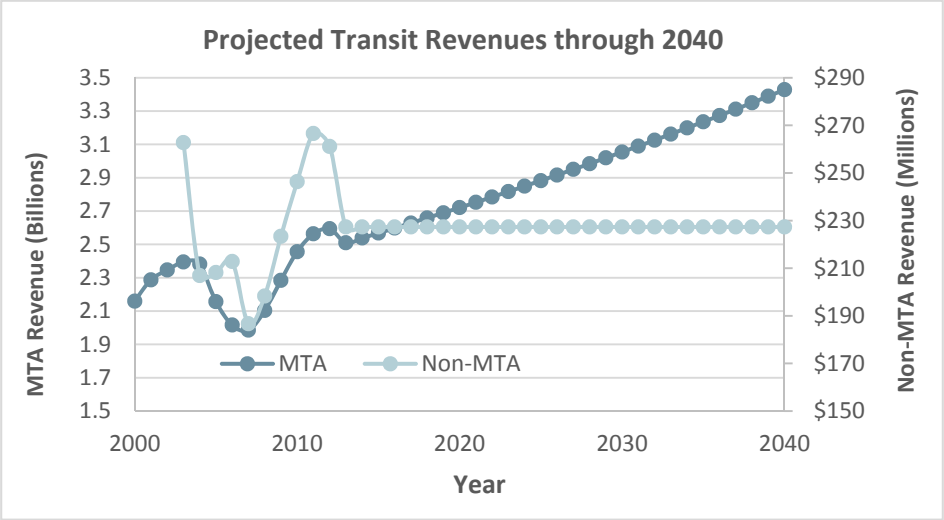



Using TxDOT revenue forecasts and historical expenditures, the average annual discretionary highway budget anticipated through 2040 is approximately $5.5 billion per year in 2014 constant dollars, which includes capital, maintenance, and other reasonably-expected available revenues available to fund TTP investments. While TxDOT's total budget is closer to $8 billion annually, it is important to note that much of the budget is committed to agency operations and other ongoing projects and activities and not available for investment activities identified in the Plan.

### 1.2.2 *Transit*

The TTP transit revenue forecast includes anticipated funds from Metropolitan Transportation Authorities (MTA) and non-MTA operators, which are largely funded through the State. MTAs are direct recipients of funding from the Federal Transit Administration (FTA) and do not receive state funds. Non-MTA agencies receive their funding directly from TxDOT. To forecast the MTA budget the average funding for the past 10 years was used as a baseline for 2014. By taking a longer look back at funding, the dip in MTA funds due to the recent recession were mitigated when making the forecast. A projection growth rate of 1.2 percent was included to account for population growth and new transit service through 2040 (**Figure 3**), resulting in projected annual average revenues of $2.9 billion in 2014 constant dollars.

**Figure 5: Transit Revenue Forecast**




### 1.2.3 Aviation

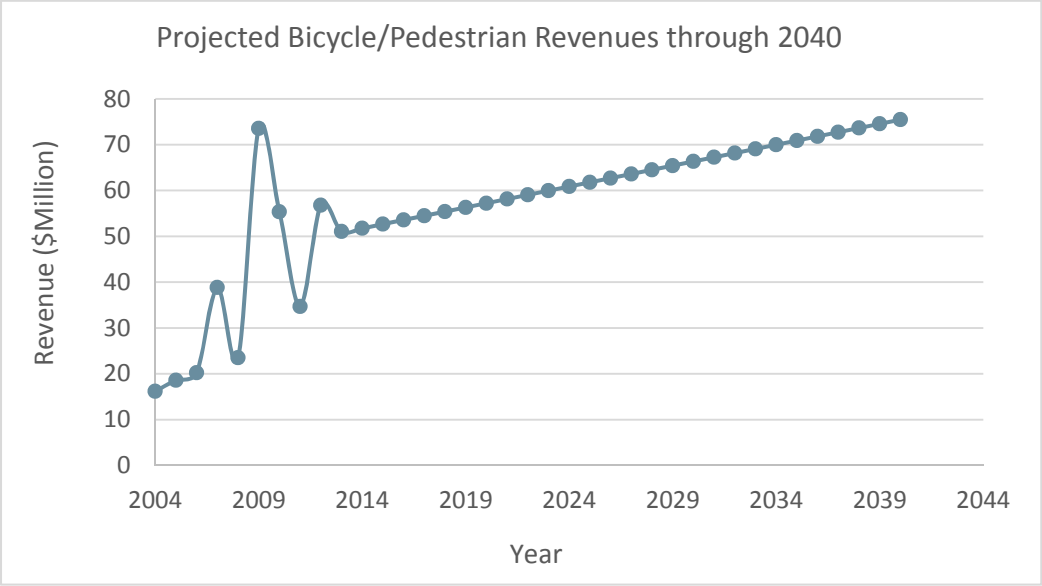
TxDOT estimates that, on average, $58 million in Federal Block Grant Funds will continue to be available through 2040 with an additional $10 million annually available in state funds to support general aviation. Many states have an aviation fuel tax which is used to fund an aviation account; however, Texas receives its aviation funding from the Highway Trust Fund which is supported by a state motor fuel tax.

### 1.2.4 Bicycle/Pedestrian

Funding for the bicycle and pedestrian modes is provided by a variety of federal, state, local, and private sources. In addition, funding programs change over time, particularly when new federal surface transportation laws are implemented. MAP-21 provides states and local jurisdictions more flexibility and local control in the use of federal transportation funds; however, MAP-21 also consolidated some bicycle and pedestrian-specific programs and reduced total funding for these modes.

The state-reported spending on bicycle and pedestrian facilities and programs in the last 10 years was used to forecast the revenue through 2040. The result shows that the average revenue for bicycle/ pedestrian facilities and services is about $69 million per year.

**Figure 6: Bicycle/Pedestrian Revenue Forecast**




### 1.2.5 Passenger Rail

The revenue forecast through 2040 shows that on average $290 million is available for passenger rail each year. This revenue is largely AMTRAK revenue; however, it is important to note that it would not support AMTRAK expansion projects such as Southwest Chief Reroute, and Heartland Flyer nor is it enough to invest in High Speed Rail projects such as Texas Central Railway HSR, and Texas-Oklahoma Passenger Rail Study (TOPRS) without further federal support.

## 2.0 Investment Approaches

As developed for the TTP, unconstrained needs were estimated at more than $20 billion annually (in 2014 constant dollars) with the State primarily responsible for modes that account for 60% of the identified long-term investments (Table 1).

**Table 1: Unconstrained Needs by TxDOT Responsibility Level**

| Primary Responsibility | Modal Subcategories | Needs (in 2014$) |
|---|---|---|
| TxDOT | Pavement, Bridge/ Culvert, ITS, Highway Capacity, Safety/ Other | > $15 billion annually |
| Non-TXDOT | Aviation, Transit, Passenger Rail, Freight, Bicycle/ Pedestrian | > $5 billion annually |
| **Total Statewide Multimodal Needs** | | **> $20 billion annually** |

As described in **Section 1**, the current revenue forecast would be insufficient to satisfy the predicted statewide multimodal needs. To help inform how to spend limited resources, various example approaches were identified and analyzed for long-range performance impacts. For each approach, the corresponding costs were presented to the public in the MetroQuest tool. Each approach is designed to advance the performance of the transportation system in a targeted way.

## *2.1 Approach 1 – System Preservation*

### 2.1.1 Approach Focus and Methodology

Approach 1 is focused on investing in the existing State transportation system to achieve a state-of-good-repair (SGR) for highway, bridge, ITS, and transit assets. In this approach, deficient assets with respect to condition and/ or performance (for example, functional obsolescence) are prioritized and addressed.

The total cost of this approach is $230 billion. The methodology for estimating this cost is as follows:

- CH2M HILL's TAMTools was used to estimate the costs to achieve pavement and bridge state-of-good repair (SGR) as defined by TxDOT and detailed in the TTP Task 3 modal methodology memos. TAMTools estimates the needs using life-cycle management principles in conjunction with TxDOT's current practices. Bridges and pavements on the state-owned system plus all existing ITS assets are included.
- The Transit Economic Requirements Model (TERM) was used and tailored for Texas to determine SGR needs for all existing transit stock in the state in MTA, small urban, and rural areas.
- SAM-v3 2010 was used with 2040 demographics in order to show the congestion impacts on the existing network. The committed network is not included in this approach since it is preservation only and the congestion results in LOS F in many areas on the network.
- All safety needs are addressed and the cost are included.

The Approach includes the investment areas and costs as shown in **Table 2**.

**Table 2: Approach 1 – Investments and Costs**

| Investment Area | Approach 1 - Performance Goals | Cost to Achieve |
|---|---|---|
| Pavement | Achieve and maintain SGR for existing State-owned highways with proactive maintenance and capital reinvestment | $108 B |
| Bridge/ Culvert | Achieve and maintain state-of-good-repair for existing State-owned bridges and culverts with proactive maintenance and capital reinvestment | $42 B |
| ITS | Maintain SGR for existing assets | $2 B |
| Highway Capacity | Allow congestion to worsen | $0 |
| Transit | Achieve and maintain SGR for existing assets and existing service levels | $73 B |
| Safety/ Other | Address any additional statewide safety needs | $5 B |
| **Total Estimated Cost of Approach 1 (2014 $)** | | **$230 B** |

### 2.1.2 Approach Performance and Deficiencies

Table 2 shows the performance outcomes for each predictive measure analyzed for the TTP. These would be the performance outcomes at the end of the planning horizon (2040) if $230 billion were invested according to this approach.

Performance outcomes are shown on a scale of "high-medium- or- low," which would correspond to a good-fair-poor condition state for the measures analyzed.

- Low performance thresholds represent poor conditions and can be characterized as system conditions that are worse than today, and would be seen by the user as significant wear and tear on infrastructure and transit assets and worsening congestion, in many cases gridlock.
- Medium performance thresholds represent fair conditions. Infrastructure assets in fair condition represent conditions worse than today. Fair/medium mobility conditions represent congestion levels similar to those experienced today.
- High performance thresholds represent ideal conditions. This includes achieving a state-of-good-repair for infrastructure and transit assets and congestion levels that are better than those experienced today.

Texas legislation requires the identification of priority corridors, projects, or areas of the state that are of particular concern in meeting goals and objectives of the TTP. Approach 1 is focused largely on the TTP goals of asset management and safety (Table 3). This approach is also focused on stewardship, using resources to make cost-beneficial investments to achieve state-of-good-repair for highway, bridge, and transit assets. This approach does not attempt to reduce or manage congestion statewide and does not improve mobility, connectivity, and freight movements.

**Table 3: Investment Approach 1 – Performance Outcomes**

| Investment Area | Performance Measure | State-of-Repair |
|---|---|---|
| Bicycle and Pedestrian | % Bike/Ped Needs Met | **Low** |
| Non-highway Freight | % Freight Needs Met | **Low** |
| Mobility and Congestion Reduction | Rural LOS | **Low** |
| | Urban LOS | **Low** |
| Pavements on the National Highway System (NHS) | % NHS Pavement Lane Miles in "Good" Condition (by IRI) | **High** |
| | % NHS Pavement Lane Miles in "Good" or better Condition (by Condition Score) | **High** |
| Non-NHS Pavements | % Non-NHS Pavement Lane Miles in "Good" Condition (by IRI) | **High** |
| | % Non-NHS Pavement Lane Miles in "Good" or better Condition (by Condition Score) | **High** |
| Bridges on the NHS | % Structurally Deficient NHS Bridges | **High** |
| | Count Structurally Deficient NHS Bridges | **High** |
| Non-NHS Bridges | % Structurally Deficient Non-NHS Bridges | **High** |
| | Count Structurally Deficient Non-NHS Bridges | **High** |
| MTA Transit | % of MTA Assets in SGR | **High** |
| | Additional Annual MTA Riders | **High** |
| Non-MTA Transit | % of Non-MTA Assets in SGR | **High** |
| | Additional Annual Non-MTA Riders | **High** |
| Passenger Rail | % Passenger Rail Needs Met | **Low** |
| ITS | % ITS Needs Met | **Low** |
| NPIAS Aviation | NPIAS Project Backlog | **Low** |
| Non-NPIAS Aviation | Non-NPIAS Project Backlog | **Low** |

The outcomes of Approach 1 as presented to the public in Outreach Round #2 is shown in **Figure 7**.

**Figure 7: Investment Approach 1 – Impacts on Long-range Goals**

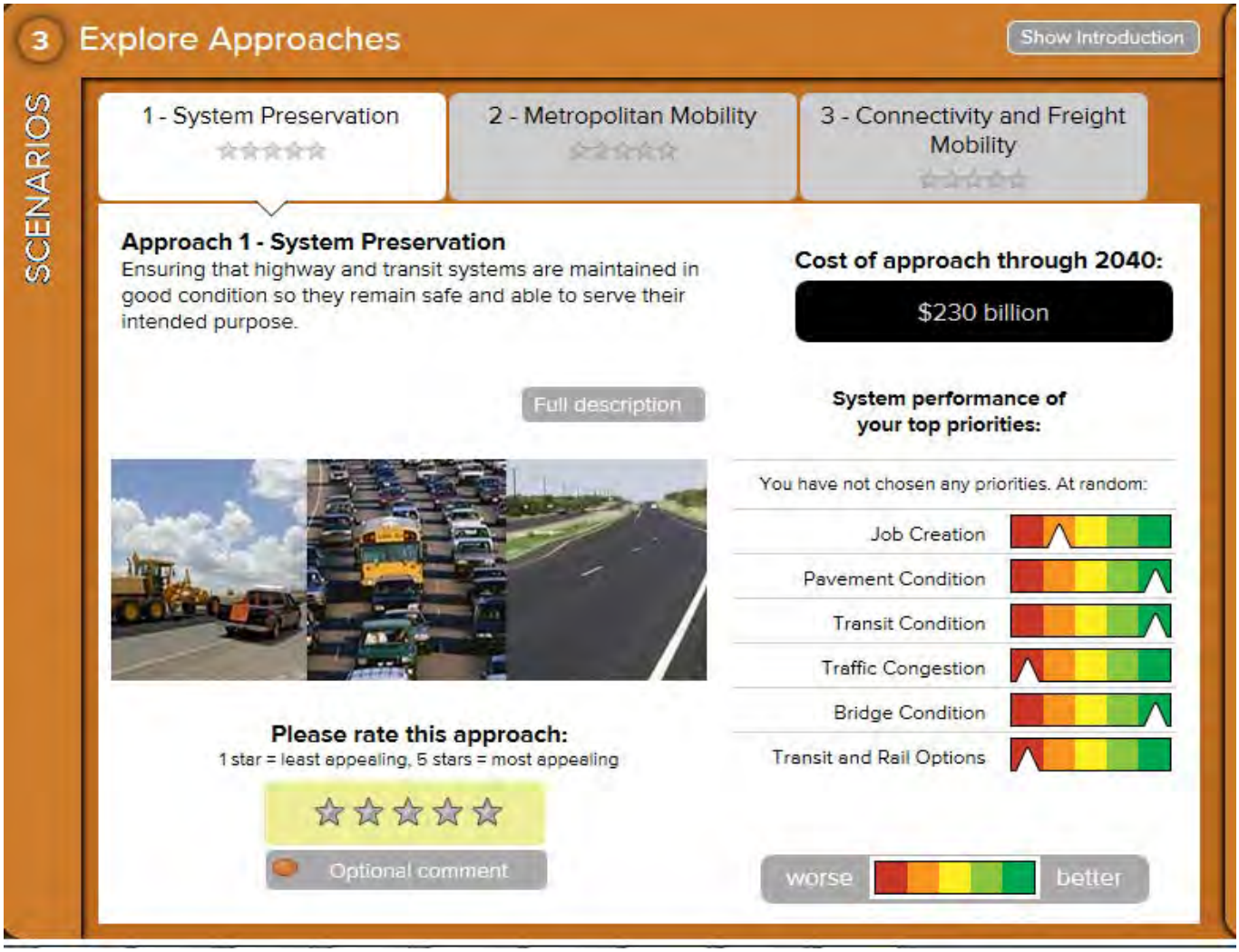



Figure 7 shows that pavements and bridges as well as transit assets statewide will be in excellent condition at the end of the planning horizon if Approach 1 were followed. Statewide mobility would be reduced given the lack of investment in highway expansion and multimodal alternatives. More specifically, if Approach 1 were implemented:

- Bridges would be kept in good condition, remaining structurally sound and open for use.
- State roadways would be generally pothole free and support a smooth ride.
- Buses, trains, and associated facilities in all areas of the state would be comfortable and reliable.
- With current transit service levels maintained, ridership as a percentage of the total population would decrease since new service would not be provided.
- Congestion in all areas of the state would be worse than today.
- Preserving our system would create a minimal number of new jobs.
- Safety is TxDOT's number one priority and all statewide safety concerns would be addressed.

## 2.2 *Approach 2 – Metropolitan Mobility*

### 2.2.1 Approach Focus and Methodology

Investment Approach 2 is focused on addressing congestion in highly populated areas of the state to reduce the time that drivers spend in congested travel. The objective of this approach is to address congestion in urban and suburban areas through strategic capacity enhancements, operational improvements, and investments in multimodal facilities in order to reduce the time spent in traffic. System reliability is addressed by enhancing transit alternatives in fastest-growing areas and "collar" regions, which are suburban growth areas. Highway/ bridge preservation dollars in this approach are focused on the Interstate system. If implemented, Approach 2 would cost $475 billion (in 2014 constant dollars) through 2040.

The methodology for estimating the costs of Approach 2 is as follows:

- All committed highway expansion projects as well as additional highway widening/ROW to ensure LOS D or better in metropolitan areas (costs calculated using the SAMv3 on a per-mile basis).
- All committed transit enhancements documented in existing metropolitan transportation plans (MTPs), and the costs to achieve fair condition states for all pavement and bridge assets in the State with a focus on fair or better for the Interstate network.
- Maintenance projects for all *proposed* highway and transit assets are included since this approach uses the existing and committed network.
- Transit SGR needs in metropolitan areas.
- All urban gap transit expansion needs.

The Approach includes the investment areas and costs as shown in Table 4.

**Table 4: Approach 2 – Investments and Costs**

| Investment Area | Approach 2 – Performance Goals | Cost to Achieve |
|---|---|---|
| Pavement | Achieve and maintain SGR for the Interstate system with proactive maintenance and capital reinvestment | $83 B |
| Bridge/ Culvert | Achieve and maintain state-of-fair-repair for existing State-owned bridges and culverts with proactive maintenance and capital reinvestment; achieve SGR on Interstate system | $39 B |
| ITS | Maintain SGR for existing assets and deploy new ITS in metropolitan areas | $14 B |
| Highway Capacity | Ensure LOS D or better in metropolitan areas | $235 B |
| Transit | Achieve and maintain SGR for existing and new assets in metro areas; expand beyond existing service levels | $96 B |
| Safety/Other | Address any additional safety needs as well as bike and pedestrian needs statewide | $8 B |
| Total Estimated Cost of Approach 2 (2014 $) | | $475 B |

### 2.2.2 Approach Performance and Deficiencies

Table 5 shows the performance outcomes for each predictive measure analyzed for the TTP. These would be the performance outcomes at the end of the planning horizon (2040) if $475 billion were invested according to this Approach.

Performance outcomes are shown on a scale of "high-medium- or- low," which would correspond to a good-fair-poor condition state for the measures analyzed.

**Table 5: Investment Approach 2 – Performance Outcomes**

| Investment Area | Performance Measure | State-of-Repair |
|---|---|---|
| Bicycle and Pedestrian | % Bike/Ped Needs Met | High |
| Non-highway Freight | % Freight Needs Met | Low |
| Mobility and Congestion Reduction | Rural LOS | High |
| | Urban LOS | High |
| Pavements on the National Highway System (NHS) | % NHS Pavement Lane Miles in "Good" Condition (by IRI) | High |
| | % NHS Pavement Lane Miles in "Good" or better Condition (by Condition Score) | High |
| Non-NHS Pavements | % Non-NHS Pavement Lane Miles in "Good" Condition (by IRI) | High |
| | % Non-NHS Pavement Lane Miles in "Good" or better Condition (by Condition Score) | High |
| Bridges on the NHS | % Structurally Deficient NHS Bridges | High |
| | Count Structurally Deficient NHS Bridges | High |
| Non-NHS Bridges | % Structurally Deficient Non-NHS Bridges | High |
| | Count Structurally Deficient Non-NHS Bridges | High |
| MTA Transit | % of MTA Assets in SGR | High |
| | Additional Annual MTA Riders | High |
| Non-MTA Transit | % of Non-MTA Assets in SGR | High |
| | Additional Annual Non-MTA Riders | High |
| Passenger Rail | % Passenger Rail Needs Met | High |
| ITS | % ITS Needs Met | High |
| NPIAS Aviation | NPIAS Project Backlog | High |
| Non-NPIAS Aviation | Non-NPIAS Project Backlog | Low |

The outcomes of Approach 2 as presented to the public in Outreach Round #2 are shown in Figure 8.

**Figure 8: Investment Approach 2 – Impacts on Long-range Goals**

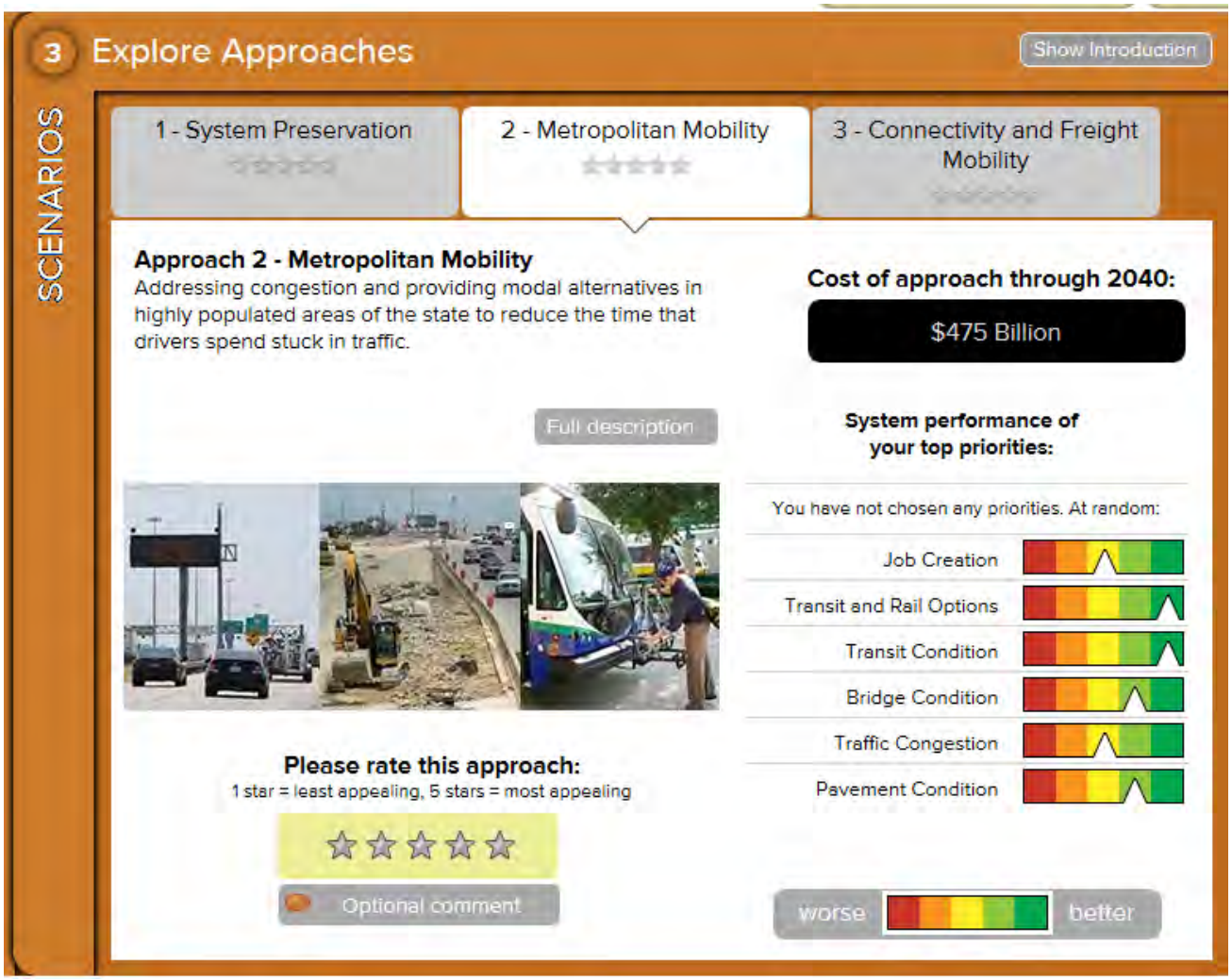



**Figure 8** shows that Approach 2, while costing more than twice as much as Approach 1, would only maintain current congestion levels and would not meet SGR for all infrastructure assets in the state. More specifically, if Approach 2 were implemented:

- Bridges on the interstate system and other major roads would be kept in good condition, with some signs of aging. The condition of bridges on other roadways would deteriorate further with only routine maintenance applied.
- Pavement on the interstate system and other major roads would be kept in fair condition with some potholes and cracking evident. Pavement on other roads would show significant wear and tear with only routine maintenance applied.
- Buses, trains, and associated facilities in urban areas would be kept in good condition, while the condition of those assets in rural areas will deteriorate with only basic maintenance applied.

- Transit and rail ridership in urban regions of the state would increase as transit services are enhanced to accommodate population growth and expanded to reach previously underserved areas. Current ridership trends are assumed to remain the same for rural areas. Additional bike and pedestrian enhancements are provided in urban areas.
- Congestion in urban areas would be the same as it is today despite high population growth; reducing congestion in metropolitan areas would increase access and support urban job growth.
- Safety is TxDOT's number one priority and all statewide safety concerns would be addressed.

## *2.3 Approach 3 – Connectivity and Freight Mobility*

### 2.3.1 Approach Focus and Methodology

The objective of Approach 3 is to support the efficient movement of goods and services to create jobs and sustain a vibrant and growing economy. This approach is largely focused on rural investments, and includes improving interregional connectivity along the primary and secondary freight network, adding intercity passenger rail between major State and economic activity centers (Oklahoma to South Texas and DFW to Houston), and increasing the accessibility of rural regions to goods and services. If implemented, Approach 3 would cost $460 billion (in 2014 constant dollars) through 2040.

The costs of Approach 3 were developed as follows, and include:

- All committed highway expansion projects.
- The widening of the primary freight network to eliminate bottlenecks (LOS C or better) (the Primary Freight Network includes all interstates in Texas).
- The pavement and bridge costs to achieve fair or better conditions for the systems, with good or better conditions on the Primary Freight Network.
- All costs to complete the Texas Trunk System as well as enhancements to rural transit.
- Intercity rail construction from Oklahoma to South Texas and between Dallas and Houston.

The investment focus and costs of Approach 3 are shown in Table 6.

**Table 6: Approach 3 – Investments and Costs**

| Investment Area | Approach 3 - Performance Goals | Cost to Achieve |
|---|---|---|
| Pavement | Achieve and maintain SGR for the Primary Freight Network with proactive maintenance and capital reinvestment | $93 B |
| Bridge/ Culvert | Achieve and maintain state-of-fair-repair for existing State-owned bridges and culverts with proactive maintenance and capital reinvestment; achieve SGR on Primary Freight Network | $36 B |
| ITS | Maintain SGR for existing assets | $2 B |
| Highway Capacity | Eliminate freight bottlenecks (LOS C or better on Primary Freight Network) | $246 B |
| Transit | Achieve and maintain SGR for existing and new assets in rural areas; expand beyond existing service levels and add intercity passenger rail | $74 B |
| Safety/ Other | Address any additional safety needs as well as bike and pedestrian needs statewide and Primary Freight Network rumble strips | $9 B |
| Total Estimated Cost of Approach 3 (2014 $) | | $460 B |

### 2.3.2 Approach Performance and Deficiencies

Table 7 shows the performance outcomes for each predictive measure analyzed. These would be the performance outcomes at the end of the planning horizon (2040) if $460 billion were invested according to this approach.

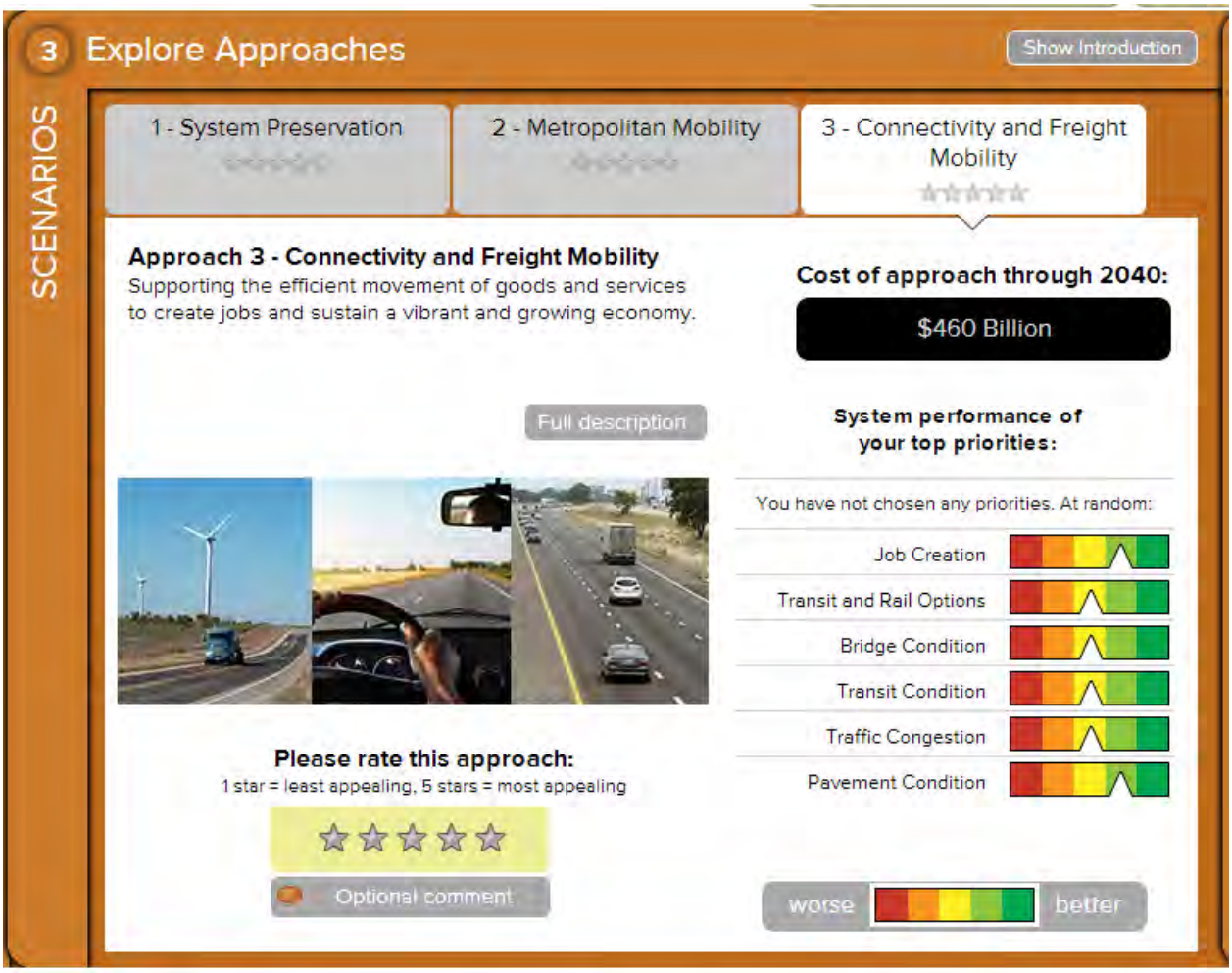
Performance outcomes are shown on a scale of “high-medium- or- low,” which would correspond to a good-fair-poor condition state for the measures analyzed.

**Table 7: Investment Approach 3 – Performance Outcomes**

| Investment Area | Performance Measure | State-of-Repair |
|---|---|---|
| Bicycle and Pedestrian | % Bike/Ped Needs Met | **Low** |
| Non-highway Freight | % Freight Needs Met | **High** |
| Mobility and Congestion Reduction | Rural LOS | **High** |
| | Urban LOS | **High** |
| Pavements on the National Highway System (NHS) | % NHS Pavement Lane Miles in "Good" Condition (by IRI) | **High** |
| | % NHS Pavement Lane Miles in "Good" or better Condition (by Condition Score) | **High** |
| Non-NHS Pavements | % Non-NHS Pavement Lane Miles in "Good" Condition (by IRI) | **Low** |
| | % Non-NHS Pavement Lane Miles in "Good" or better Condition (by Condition Score) | **Medium** |
| Bridges on the NHS | % Structurally Deficient NHS Bridges | **High** |
| | Count Structurally Deficient NHS Bridges | **High** |
| Non-NHS Bridges | % Structurally Deficient Non-NHS Bridges | **High** |
| | Count Structurally Deficient Non-NHS Bridges | **Medium** |
| MTA Transit | % of MTA Assets in SGR | **Low** |
| | Additional Annual MTA Riders | **High** |
| Non-MTA Transit | % of Non-MTA Assets in SGR | **High** |
| | Additional Annual Non-MTA Riders | **High** |
| Passenger Rail | % Passenger Rail Needs Met | **Low** |
| ITS | % ITS Needs Met | **Low** |
| NPIAS Aviation | NPIAS Project Backlog | **High** |
| Non-NPIAS Aviation | Non-NPIAS Project Backlog | **High** |

The outcomes of Approach 3 as presented to the public in Outreach Round #2 are shown in **Figure 9**.

**Figure 9: Investment Approach 3 – Impacts on Long-range Goals**




Because Approach 3 is focused on rural connectivity and freight movements, congestion in metropolitan areas would worsen; however, at a state level, conditions on the Primary Freight Network and Interstate System would be similar to today. Additional outcomes of Approach 3 are as follows:

- Bridges located along roadways with significant freight traffic would be maintained in good condition, with some signs of aging. The condition of bridges on other roadways would deteriorate further with only routine maintenance applied.
- Pavement on roadways that support significant freight traffic would be kept in fair condition with some potholes and cracking evident. Pavement on other roadways would show significant wear and tear with only routine maintenance applied.
- Buses, trains and associated facilities in rural areas would be maintained in good condition and enhanced to accommodate rural needs. The condition of assets in urban areas would deteriorate with only basic maintenance applied.
- Transit and passenger rail ridership would increase for transit and passenger rail in rural areas as more accessible and convenient travel options are provided in these regions as well as

intercity rail between major metropolitan areas. Current ridership trends would persist for urban areas. Additional bike and pedestrian enhancements would be provided in rural areas.

- Congestion in rural areas would be reduced compared to today. Congestion would be eliminated on the Primary Freight Network, but would worsen in metropolitan areas.
- Reducing travel delays for freight traffic would reduce the cost of moving goods, support the State's growing economy, and create jobs.
- Safety is TxDOT's number one priority and all statewide safety concerns are addressed.

## *2.4 Approach 4 – Financially Constrained "Plus"*

### 2.4.1 Approach Focus and Methodology

While not presented to the public, Approach 4 was evaluated for the TTP to show the performance outcomes associated with investments under the State's current revenue forecast. While the total state revenues available for transportation investments for all modes through 2040 are likely adequate to achieve a preservation-focused strategy, it was previously noted that many of these funds are committed to agency operations and other projects. Because of these constraints, TxDOT has estimated that an additional $5 billion in revenues is needed annually to maintain current system conditions.

Given funds available for investment for all modes, and when invested at a multimodal level, a total average annual investment of $14 billion is used in the analysis to represent a constrained approach. It is important to note, however, that this figure represents more money than is currently available for state multimodal investments. Additionally, it is important to note that this approach is not performance-based in that it is not designed to meet specific performance goals for the system; rather, it is shown to better understand expected outcomes if the State continues to invest similarly to its current strategies ament categories.

**Table 8: Approach 4 – Investment Allocations**

| Investment Area | Average Annual Budget (in 2014 constant dollars) |
|---|---|
| Pavement | $4 B |
| Bridge/ Culvert | $1.6 B |
| ITS | $0.5 B |
| Highway Capacity | $3 B |
| Transit | $3.9 B |
| Additional Safety Needs | $0.4 B |
| Non-Highway Freight | $0.5 B |
| Bicycle/ Pedestrian | $0.1 B |
| **Total** | **$14 B** |

### 2.4.2 Approach Performance and Deficiencies

Table 9 shows the performance outcomes for each predictive measure analyzed. These would be the performance outcomes at the end of the planning horizon (2040) if $350 billion were invested according to this approach.

Performance outcomes are shown on a scale of "high-medium- or- low," which would correspond to a good-fair-poor condition state for the measures analyzed.

**Table 9: Investment Approach 4 – Performance Outcomes**

| Investment Area | Performance Measure | State-of-Repair |
|---|---|---|
| Bicycle and Pedestrian | % Bike/Ped Needs Met | High |
| Non-highway Freight | % Freight Needs Met | TBD |
| Mobility and Congestion Reduction | Rural LOS | Medium |
| | Urban LOS | Low |
| Pavements on the National Highway System (NHS) | % NHS Pavement Lane Miles in "Good" Condition (by IRI) | High |
| | % NHS Pavement Lane Miles in "Good" or better Condition (by Condition Score) | High |
| Non-NHS Pavements | % Non-NHS Pavement Lane Miles in "Good" Condition (by IRI) | High |
| | % Non-NHS Pavement Lane Miles in "Good" or better Condition (by Condition Score) | High |
| Bridges on the NHS | % Structurally Deficient NHS Bridges | High |
| | Count Structurally Deficient NHS Bridges | High |
| Non-NHS Bridges | % Structurally Deficient Non-NHS Bridges | High |
| | Count Structurally Deficient Non-NHS Bridges | High |
| MTA Transit | % of MTA Assets in SGR | High |
| | Additional Annual MTA Riders | High |
| Non-MTA Transit | % of Non-MTA Assets in SGR | High |
| | Additional Annual Non-MTA Riders | High |
| Passenger Rail | % Passenger Rail Needs Met | Low |
| ITS | % ITS Needs Met | High |
| NPIAS Aviation | NPIAS Project Backlog | Low |
| Non-NPIAS Aviation | Non-NPIAS Project Backlog | High |

Approach 4 represents a balanced investment approach with a preservation focus. It was designed to evaluate system condition and performance given funding constraints and current investment allocations.

- Bridges and pavements on the Interstate system and other major roads would be kept in good condition, with some signs of aging. The condition of bridges on other roadways would deteriorate further with only routine maintenance applied.
- Buses, trains, and associated facilities in both urban and rural areas would be kept in good condition.
- Bicycle and pedestrian enhancements are provided in rural and urban areas.
- Intercity passenger rail is not funded.
- Non-highway freight needs are being developed as part of the Texas Freight Mobility Plan and are thus not available to evaluate against the allocated amount. Highway freight needs are incorporated into the general highway, bridge and expansion needs.
- Transit and rail ridership in urban regions of the state would increase as transit services are enhanced to accommodate population growth and expanded to reach previously underserved areas. Current ridership trends are assumed to remain the same for rural areas.
- Congestion in urban areas would be worse than it is today; however, strategic mobility enhancements and operations strategies would be funded.
- Safety is TxDOT's number one priority and all statewide safety concerns would be addressed.

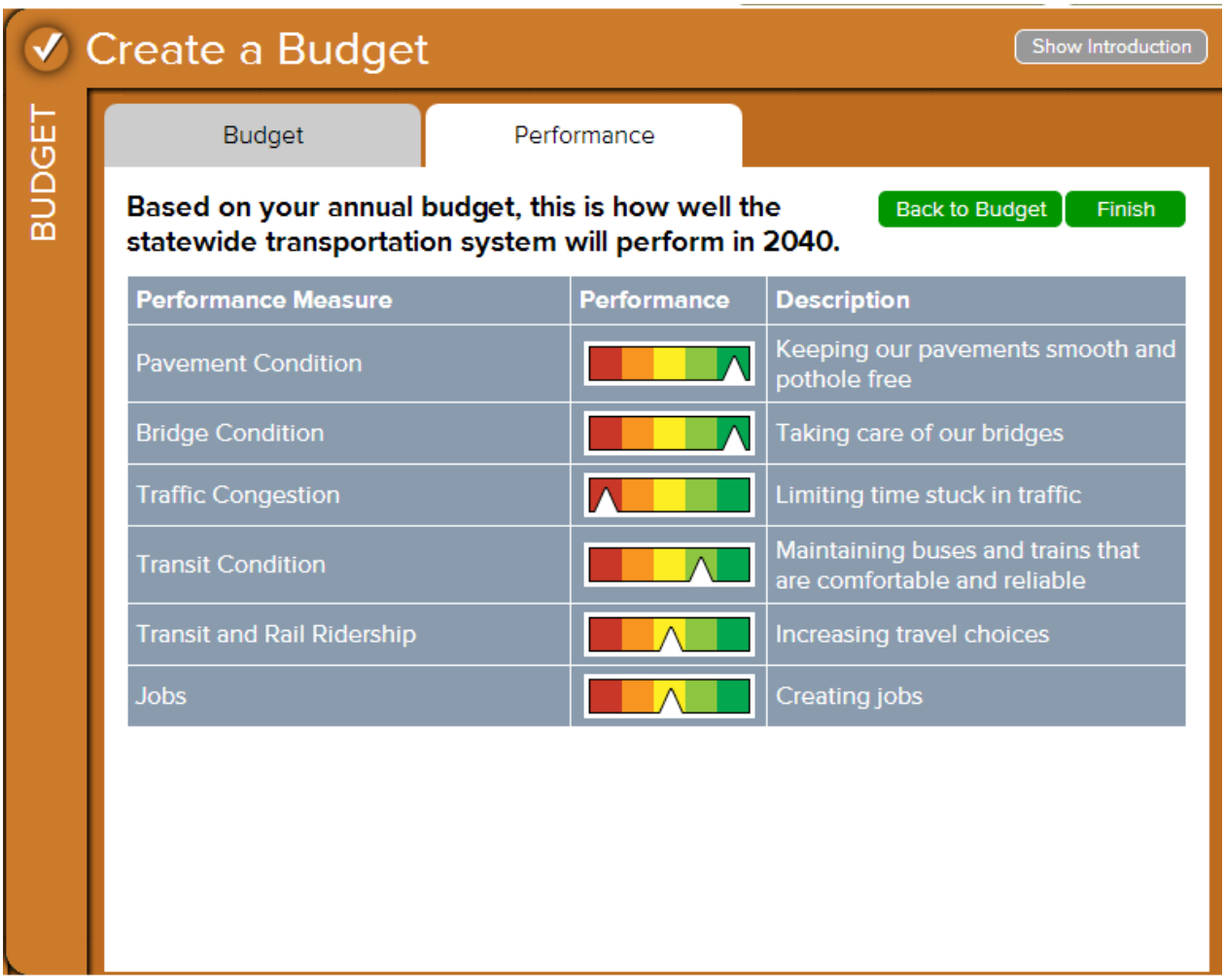
While the public was not presented with a specific Approach 4, the MetroQuest Tool was used to allow the public to better understand the long-term effects of investing in various ways. The public was asked to allocate an annual budget of $14 billion with the following constraints:

- **Highway/ Bridge** - A total annual budget of $5.5 billion was estimated, with a 40–60 percent "split" between highway preservation and expansion categories pre-allocated. Given the uncertainty in federal funds and diminishing value of state and federal gas tax revenues, this will likely degrade significantly over the Plan horizon unless alternative revenue sources/ collection methods are addressed. This number is greater than the UTP total budget because it includes major and minor maintenance, ROW, and preliminary engineering.
- **Transit** – A total annual budget of $3.5 billion was estimated, and includes MTA and small urban/ rural funds as well as funds that "pass through" TxDOT.
- **Freight** – No pre-existing budget was identified/ estimated for freight projects.

In the MetroQuest Tool, the public was "given" $5 billion annually in "new" money that was unrestricted. They were asked to allocate investments in highway, transit, and freight areas. The impact of their spending decisions on related performance measures was then provided in real-time on a "dashboard." The dashboard uses a readily understood red to green color scale.

The performance values behind this color scale are provided below. Using the MetroQuest Tool, the outcomes of example Approach 4 are shown in **Figure 10**.

**Figure 10: Investment Approach 4 – Impacts on Long-range Goals**




## 3.0 Summary

Four distinct examples of investment approaches were evaluated in this memo, in consideration of forecasted revenue and the potential for future capital infusions. Table 10 provides a comparison among all approaches.

Tradeoffs between system preservation and mobility will need to be considered during the performance target setting and resource allocation process.

**Table 10: Investment Approach Summary – Performance Outcome State of Repair**

| Mode | Investment Category | Performance Measure | Approach 1: Preservation | Approach 2: Metro | Approach 3: Connectivity | Approach 4: Balanced with Extra $5B across all modes |
|---|---|---|---|---|---|---|
| Pavement | National Highway System (NHS) Pavements | % NHS Pavement Lane-Miles in a State-of-Good-Repair (based on IRI) | High | Low | Low | High |
| | | % NHS Pavement Lane-Miles in a State-of-Good-Repair (based on Condition Score) | High | Low | Low | High |
| | Non-NHS Pavements | % Non-NHS Pavement Lane-Miles in a State-of-Good-Repair (based on IRI) | High | Low | Low | Medium |
| | | % Non-NHS Pavement Lane-Miles in a State-of-Good-Repair (based on Condition Score) | High | Low | Low | Low |
| Bridge | NHS Bridges | % Structurally Deficient NHS Bridge Deck Area | High | Low | Low | Low |
| | | Count of Structurally Deficient NHS Bridges | High | Low | Low | Low |
| | Non-NHS Bridges | % Structurally Deficient Non-NHS Bridge Deck Area (on State System) | High | High | High | High |
| | | Count of Structurally Deficient Non-NHS Bridges (on State System) | High | High | High | High |
| Highway Mobility | Rural Mobility | Rural Level-of-Service | Low | Low | Low | Low |
| | Urban Mobility | Urban Level-of-Service | Low | High | High | Low |
| Transit | Metropolitan Transit Authority (MTA) Transit Asset Preservation | % of MTA Assets in a State-of-Good-Repair | Low | High | Low | High |
| | MTA Transit Service Enhancements | Additional MTA Annual Rider Trips in Millions | High | High | High | High |
| | Non-MTA Transit Asset Preservation | % of Non-MTA Assets in a State-of-Good-Repair | Low | High | Low | High |
| | Non-MTA Transit Service Enhancements | Additional Non-MTA Annual Rider Trips in Millions | High | High | High | High |

**Table 10: Investment Approach Summary – Performance Outcome State of Repair**

| Mode | Investment Category | Performance Measure | Approach 1: Preservation | Approach 2: Metro | Approach 3: Connectivity | Approach 4: Balanced with Extra $5B across all modes |
|---|---|---|---|---|---|---|
| Passenger Rail | Passenger Rail | % Passenger Rail Needs Met | Low | Low | Low | Low |
| Non-Highway Freight | Non-Highway Freight | % Non-Highway Freight Needs Met | Low | Low | Low | High |
| Intelligent Transportation Systems (ITS) | ITS | % ITS Needs Met | Low | High | Low | High |
| Aviation | National Plan of Integrated Airport Systems (NPIAS) Aviation | NPIAS Project Backlog | Medium | Medium | Medium | Medium |
| | Non-NPIAS Aviation | Non-NPIAS Project Backlog | High | High | High | High |
| Bicycle/Pedestrian | Bicycle/Pedestrian | % Bicycle/Pedestrian Needs Met | High | High | Low | High |

# Texas Transportation Plan

## Tech Memo 11: Safety and Security

October 24, 2014

## Acknowledgements

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# 1.0 Introduction

The Texas Transportation Plan 2040 (TTP) is the State's long-range transportation plan which covers the size and scope of the Texas transportation system, including all modes of public transportation. This memo serves to review and analyze current and historical safety and security documentation provided by the State in order to verify that current planning efforts are consistent with federal planning requirements and strategic plan goals.

To achieve the above objective, a thorough review of available State, regional and local planning documentation was conducted in order to identify current safety and security trends. This technical memo documents conclusions and observations as related to this effort. Discussions on transportation safety and security are prepared separately in the following sections.

# 2.0 Overview of Transportation Safety Planning

Safety has been incorporated into the transportation planning process since federally mandated in the year 1982. This section summarizes recent efforts regarding transportation safety planning in the state of Texas, associated federal requirements, potential gaps, and strategies in moving forward.

## *2.1 Requirements on Transportation Safety Planning from New Legislation*

In 2012, the Moving Ahead for Progress in the 21st Century (MAP-21) transportation legislation was signed into law. MAP-21 builds on and refines many of the highway, transit, bike, and pedestrian programs and policies established in 1991. Under MAP-21, performance management will transform federal highway programs and provide a means to more efficient investment of federal transportation funds by focusing on national transportation goals, increasing the accountability and transparency of the federal highway programs, and improving transportation investment decision-making through performance-based planning and programming. MAP-21 establishes seven national performance goals for the federal highway program, one of which is to achieve a significant reduction in traffic fatalities and serious injuries on all public roads. Meanwhile, MAP-21 planning rules call for consideration of eight planning factors, one of which is to increase the safety of the transportation system for motorized and non-motorized users.

## *2.2 Current Transportation Safety Planning in Texas*

A thorough literature review revealed that transportation safety planning has been incorporated into many statewide and regional transportation planning documents in Texas. A discussion on the relevance of each document is provided in the following sections.

### 2.2.1 Comprehensive Transportation Safety Planning

In cooperation with other federal and state agencies, TxDOT has developed comprehensive transportation safety planning documents to guide transportation safety management and improve the safety performance for the highway system.

### Texas Strategic Highway Safety Plan

TxDOT produced the first Strategic Highway Safety Plan (SHSP) for Texas in 2006. The Texas SHSP established statewide goals, objectives, and key emphasis areas for transportation safety and identified key safety needs for guiding investment decisions to reduce fatalities and serious injuries on all public roads. To make the Texas SHSP a living document, TxDOT generates a report of progress each calendar year based on the most recent available crash data. The current edition of the Texas SHSP report of progress is for the calendar year 2013.

Based on the crash data analysis results, the Texas SHSP identified several safety issues for the state and grouped them into the following four emphasis areas:

- Crash type & location, including run-off road crashes, head-on crashes, intersection crashes, work zone crashes and railroad grade crossing crashes;
- System users, including older drivers, teen drivers, motorcyclists, bicyclists, pedestrians and large trucks;
- Driver behavior, including driving under the influence, speeding, lack of restraint use, aggressive driving, and distracted driving;
- System administration, including traffic and crash records, E911 reporting systems, public awareness, and policy maker awareness.

The safety issues, crash reduction objectives for each emphasis area and potential countermeasures that may have helped to meet the objectives are included in the annual progress report.

### Texas Highway Safety Performance Plan

To identify traffic safety problem areas and programs to reduce the number and severity of traffic-related crashes, injuries and fatalities, TxDOT has initiated the endeavor to develop the Texas Highway Safety Performance Plan (HSPP) for each fiscal year since 2006. The Texas HSPP for each fiscal year contains the goals, strategies, performance measures and objectives Texas has set for improving the safety performance of the roadway system.

Altogether 14 areas were covered by the TxDOT traffic safety program, which are:

- Planning and administration;
- Alcohol and other drug countermeasures;
- Emergency medical services;
- Motorcycle safety;
- Occupant protection;
- Pedestrian/bicycle safety;
- Police traffic service;
- Speed control;
- Traffic records;
- Driver education and behavior;
- Railroad/highway crossing;
- Roadway safety;
- Safe communities and
- School bus safety.

The Texas HSPP identified impaired driving, safety belts, motorcycles and speeding as areas that need special emphasis in order to improve traffic safety and decrease injuries and fatalities. As an outgrowth of the strategic planning process, Texas developed 19 specific goals for the traffic safety program, 70 specific strategies, and 39 specific performance measures. Objectives have been established for all 39 performance measures for 2013. The plan also lists other program goals for each of the Texas Traffic Safety Program's areas, specifies the strategies employed to accomplish the goals, and reports the status of the performance measures based on the most current data.

### 2.2.2 Transportation Safety Plan for Specific User Groups

Texas Strategic Action Plan for Motorcycles 2013-2018

Motorcycle deaths in Texas increased by 10% in 2011, from 435 in 2010 to 479 in 2011. Motorcycle deaths accounted for 16% of total traffic fatalities in 2011. In 2011, Texas experienced a decrease in the number of motor vehicle traffic deaths; however, the increased percentage of motorcyclist deaths offset gains in road traffic deaths.

To reduce the rate of motorcycle crashes per registered motorcycles and reduce the rate of fatal and severe motorcycle injuries, as established in the 2012 Texas SHSP Report of Progress, TxDOT developed the Texas Strategic Action Plan for Motorcycles (SAPM) 2013-2018.

To aid in the plan's development, several activities including a review of published literature on motorcycle safety countermeasures, a review of intelligent transportation system (ITS) and other advanced technologies for motorcycles and other vehicles, an analysis of motorcycle crash and injury data, and a statewide survey of motorcycle riders were completed. A list of potential motorcycle crash and injury countermeasures were evaluated and prioritized by motorcycle safety experts and advocates.

The plan is organized under 13 key focus areas including:

- Motorcycle/rider conspicuity,
- Motorists awareness of motorcycles,
- Licensing,
- Rider education and training,
- Impaired riding,
- Speeding,
- Personal protective gear,
- Roadway/infrastructure,
- Legislation and regulations,
- Law enforcement,
- Program management,
- Program evaluation and data, and
- Motorcycle and vehicle technologies/ITS.

For each area, the plan identified several initiatives and action steps, prioritized by motorcycle safety experts. The group prioritized and ranked approximately 73 crash reduction countermeasures on the basis of their effectiveness in preventing motorcycle crashes and in reducing the severity of injuries to riders.

#### San Antonio – Bexar County Pedestrian Safety Action Plan

The San Antonio-Bexar County Metropolitan Planning Organization Pedestrian Safety Action Plan (Plan) defines a set of actions to encourage walking and to make it safer. The Plan provides a framework for making decisions about facility design and allocating resources necessary to make walking a viable choice for a wide variety of trips. This Plan contains profiles for 43 recommended treatments for improving pedestrian safety. Each profile provides a definition of the recommended treatment, why and where it is used, and to what degree it is currently being implemented in the region.

### 2.2.3 Safety-related Sections within Comprehensive Transportation Planning

Transportation safety planning has been incorporated into the comprehensive transportation planning process at state and metropolitan planning organization (MPO) levels in Texas.

#### State-Level

TxDOT developed the Texas Statewide Long-range Transportation Plan (SLRTP) 2035 to provide an inventory and address the need for improvements to the state's transportation system-roadways, pedestrian and bicycle facilities, transit, freight and passenger rail, airports, waterways and ports, pipelines, and intelligent transportation systems (ITS). Section 6 of the SLRTP is about transportation safety and security.

A brief description on the responsibilities of TxDOT divisions about administering federal and state grant programs to improve safety on various modes of the transportation systems in Texas were provided first, followed by a summary on the backgrounds, key points and current status of the TxDOT SHSP and the Texas Traffic Safety Program (TTSP). The SLRTP also listed information on safety program for bicycle and pedestrian, public transportation, freight rail, airport, waterways, pipeline, ports and border, etc.

#### MPO-Level

Federal law requires that all urbanized areas in the United States with a population of more than 50,000 must have a designated MPO to facilitate the federally-required multimodal transportation planning process. Altogether there are 25 MPOs in the state of Texas. Five MPOs listed below were selected for in-depth investigation because of their population base and geographical distribution.

#### Houston Galveston Area Council

The Houston-Galveston Area Council (H-GAC) serves the urbanized areas of Houston, Conroe-the Woodlands, Lake Jackson-Angleton, and the Texas City. In August 2005, the H-GAC Transportation Policy Council (TPC) established the Regional Safety Council (RSC) to address the region's increasing traffic safety issues.

The RSC approved the State of Safety in the Region (SOSR) report in February 2007, which provided a comprehensive review of traffic safety in the Houston-Galveston region. The SOSR report identified the critical traffic safety issues in the region and outlined strategies for addressing these problems. The report made a total of 17 recommendations for improving safety.

### North Central Texas Council of Governments

The North Central Texas Council of Governments (NCTCOG) serves a 16-county region of North Central Texas. Mobility 2035 - The Metropolitan Transportation Plan for North Central Texas (Mobility 2035 – 2013 Update) is a long-range transportation plan for the metropolitan planning area that guides the implementation of multimodal transportation improvements, policies, and programs in the metropolitan planning area through the year 2035. Chapter 5 of the document is about Operational Efficiency. Section 3 of Chapter 5 specifically discusses transportation system safety and security.

Mobility 2035 – 2013 Update established multiple goals for the metropolitan area transportation system. The goal on safety is to "ensure adequate maintenance and enhancing the safety and reliability of the existing transportation system." Meanwhile, the Mobility 2035 – 2013 Update supports multiple transportation system safety programs, including 1) freeway incident management program; 2) regional mobility assistance patrol program; 3) regional safety information system; 4) safety education and training program; and 5) crash casual road factors program.

### The Alamo Area Metropolitan Planning Organization

The Alamo Area MPO develops transportation plans and programs to address the transportation safety needs of the greater San Antonio area. The Mobility 2035 Metropolitan Transportation Plan is the basic framework for the Alamo Area MPO's continuous, comprehensive, and coordinated regional transportation planning efforts for the next twenty-five years. To develop the best transportation system for the area, the Mobility 2035 Metropolitan Transportation Plan proposed "considering safety in the project selection process" as one of the policies for the roadway system. Based on data for the MPO region and information received from the regional safety committee, the emphasis areas for the region include impaired driving, motorcycle fatalities and injuries, road rage/aggressive driving, speed, cell phone usage and crashes, bicycle and pedestrian crashes involving a vehicle, and distracted driving, etc.

### Capital Area Metropolitan Planning Organization

The Capital Area Metropolitan Planning Organization (CAMPO) is the MPO for Bastrop, Burnet, Caldwell, Hays, Travis, and Williamson Counties in Texas. The CAMPO Safety and Security Taskforce was formed in 2007 and is made up of CAMPO and other agencies. The taskforce meets as needed to discuss new data, new ideas, and to review methods of analysis for safety and security planning in CAMPO plans and programs.

CAMPO also partners with the TxDOT and other transportation agencies to track and evaluate the safety of transportation facilities in Central Texas. Data for crashes involving automobiles, bicycles and pedestrians are provided with information on the severity of injuries related to each incident. CAMPO also keeps data on a variety of other safety issues related to transportation. CAMPO and its member jurisdictions use crash data to plan and prioritize safety improvements.

#### Corpus Christi MPO

The Corpus Christi MPO serves the urbanized area of Corpus Christi in Texas. Mobility CC creates the framework for a comprehensive, integrated, multi-modal transportation network for the City of Corpus Christi through balancing access, mobility, health and safety needs of motorists, transit users, bicyclists, and pedestrians of all ages and abilities. To improve the safety performance of the roadway, Mobility CC incorporated several policies and objectives for the planning, designing, constructing and maintenance of the roadway network, including 1) promote bicycle, pedestrian and public transportation rider safety; 2) create safe routes to parks and open spaces; and 3) provide children with safe and appealing opportunities for walking and bicycling to school and reduce the risk of injury to children through traffic collisions near school.

### 2.2.4 Summary of Existing Transportation Safety Planning

The following section summarizes the common characteristics and general patterns among the transportation safety planning documents from different jurisdictions, which could be used to guide transportation safety planning for the state of Texas. Also, notable gaps in the review of these documents is identified.

#### Identified Emphasis Areas

Generally, emphasis areas are identified in the transportation safety planning process based on historic crash data, roadway network characteristics, federal and/or state policies on transportation safety management, etc. The identified emphasis areas could be used to guide the investment on transportation safety improvements so that maximum benefit cost ratio could be achieved.

Based on the historical crash data analysis results, different emphasis areas were selected by different agencies in their transportation safety planning. The most commonly selected emphasis areas are motorcyclists, bicyclists, pedestrian, DUI, speeding, aggressive driving, safety belt, distracted driving, children safety and traffic and crash records. The results indicate that vulnerable users including pedestrian, bicyclists and motorcyclists have been identified as emphasis areas at different jurisdiction levels so that special attention should be paid to them.

#### Noted Gaps in Review of Safety Planning Documents

The state of Texas employed a data-driven process for identifying the emphasis areas and setting the targets on transportation safety performenance. To meet the goals and performance measures that the state set on transportation safety, the following gaps have been noted:

- Statewide transportation safety planning documents for all roadway users
  TxDOT has developed the comprehensive transportation safety planning documents for the roadway safety management process, including the *Texas Highway Safety Performance Plan* and the *Texas Strategic Highway Safety Plan*. However, no relevant transportation safety planning documents for vulnerable roadway users, such as pedestrians, bicyclists, etc. have been developed yet. To reduce the number of fatalities for pedestrians, bicyclists and any other vulnerable roadway users, guidelines on improving transportation safety for those vulnerable roadway users are necessitated.
- Transportation safety planning in the MPO and other local agency transportation planning process
  Currently many MPOs have already included transportation safety as one integral part of their transportation planning efforts. However, still there are some MPOs for which the transportation safety has not been incorporated into their transportation planning process yet. To enhance the statewide safety performance of the whole roadway system (including both state and local system), it's necessary to incorporate the transportation safety into the comprehensive transportation planning process at all levels.
- Lack of transportation safety planning for commercial vehicles
  Specific attention should be paid to the safety performance of commercial vehicles due to the weight of the vehicle itself and severity of commercial vehicle related crashes. However, no guidelines and/or planning documents on transportation safety of commercial vehicles have been developed for the state of Texas yet. A comprehensive transportation safety planning review for commercial vehicles should be developed based on available crash data and any other relevant policies for the state of Texas.
- Strategies, Targets and Goals in Transportation Safety Planning
  To improve the safety performance of the roadway system, the transportation safety planning documents set specific strategies, goals and/or objectives for region under investigation. **Table** 1 lists the different goals included in the relevant transportation safety planning documents.

**Table 1. Target and Goal for Different Transportation Safety Planning**

| Document Name | Strategy, Target and/or Goal |
|---|---|
| Texas SHSP | Crash reduction objectives for each emphasis area |
| Texas HSPP | 19 goals for the traffic safety program and objectives for 39 performance measures |
| Texas SAPM | 13 goals plus initiatives and action steps under each goal |
| Texas SLRTP | N/A |
| H-GAC | 17 recommendations for improving safety in 4 emphasis areas |
| NCTCOG | One goal on safety and multiple core concepts to support the goal |
| Alamo Area MPO | One goal for pedestrian and bicyclist safety respectively |
| El Paso MPO | N/A |
| CAMPO | Set "safety" as one of the 12 goals on transportation planning |
| Corpus Christi MPO | Set specific goals on pedestrian and bicyclist safety |

## *2.3 Texas Transportation Safety Goals, Performance Measures and Targets*

The TTP sets the following goals on transportation safety in Texas: 1) improve multimodal transportation safety; 2) reduce the number of fatalities and severe injuries on public roads. Specifically, the following goals are selected to be achieved:

- Reduce fatal and serious injury crashes
- Improve safety of at-grade rail crossings
- Eliminate conflicts between modes wherever possible
- Increase bicycle and pedestrian safety through education, the design of new facilities, and improvements to existing facilities
- Educate the public on the dangers of high-risk driving behaviors
- Coordinate with enforcement to improve driver compliance with laws
- Improve incident response times

Based on the new legislation, the following performance measures are recommended to track and measure the effectiveness of the goals set in the TTP:

- Number of fatalities
- Number of serious injuries
- Number of fatalities/serious injuries per million vehicle miles traveled
- Number of fatalities/serious injuries per million population
- Number of crashes between train and vehicle
- Number of fatalities/serious injury crashes between train and vehicle

- Number of pedestrian and bicyclist fatalities and serious injuries
- Number of pedestrian and bicyclist fatalities per million population
- Number of fatal and serious injury crashes involving cell phone use/speeding
- Safety belt usage rate
- Number of fatal crashes due to DUI
- Average incident response time/incident clearance time

# 3.0 Transportation Security Planning in Texas

## *3.1 Introduction and Background*

Texas is a uniquely important state, with a $1 trillion gross state product, three of the country's most populous cities, and a diverse population of over 24 million. Texas shares a 1,254-mile international border with Mexico and has a 367 mile long coastline on the Gulf of Mexico, which contains some of the busiest, most economically important shipping lanes and ports in the United States. The threats that face the State of Texas include the following categories:

- Natural hazards, such as wildfires, floods, hurricanes, tornadoes, lightning, snow, ice storms, earthquakes, and droughts;
- Technological hazards, such as major transportation accidents, oil spills, industrial fires and explosions, nuclear facility accidents, and hazardous material spills;
- Homeland security threats, including terrorists using conventional, chemical, biological, nuclear, and radiological weapons, as well as cyber attacks, and cross-border violence by transnational crime organizations;
- Other threats and hazards, including human and animal epidemics and pandemics, civil unrest, disruptions in production and distribution of critical goods and services, and energy shortages.

The most frequent major disasters in Texas are flooding, tornados, and hurricanes. Texas ranks first among the states for frequency of tornados and flash floods, and the state has more than 10 million acres of floodplain. It is second only to Florida in the number of hurricane impacts, and, nationwide, suffers the greatest economic impact from hurricane losses.

The surface transportation system of the state of Texas is a vast, open system of interdependent networks. Consisting of the subsectors of mass transit, highways, freight rail, and pipelines, this network is critical to the state's economy and the way of life of its residents. The following section summarized key points derived from major technical documents on transportation security planning and management at federal, state and MPO levels.

## 3.2 *Transportation Security Planning at Federal Level*

### 3.2.1 Homeland Security Presidential Directive

Critical infrastructure includes those assets, systems, and networks, which, if damaged, could result in significant consequences, such as adverse impacts on national economic security, national public health and safety, public confidence, the environment, loss of life, or some combination of these. Attacks against critical infrastructure could have a significant impact on the economy or cripple transportation, trade, and commerce.

The Homeland Security Presidential Directive (Presidential Directive) establishes a national policy for federal departments and agencies to identify and prioritize United States critical infrastructure and key resources and to protect them from terrorist attacks. The Presidential Directive requires that "the Department of Transportation and the Department of Homeland Security will collaborate on all matters relating to transportation security and transportation infrastructure protection." The Department of Transportation is responsible for "operating the national air space system." The Department of Transportation and the Department of Homeland Security will collaborate in "regulating the transportation of hazardous materials by all modes (including pipelines)." The Presidential Directive also requires that the Secretary of Homeland Security shall "coordinate protection activities for transportation systems, including mass transit, aviation, maritime, ground/surface, and rail and pipeline systems."

### 3.2.2 Surface Transportation Security Priority Assessment

The Surface Transportation Security Priority Assessment (Assessment) provides a comprehensive framework for the continued improvement of surface transportation security and identify discrete areas of focus to guide the decisions and actions of security partners in applying their respective capabilities. The interagency staff identified 10 issue areas commonly identified by surface transportation security stakeholders that require further review to improve the effectiveness of national surface transportation security, including:

- Federal coordination
- Risk management
- Research and development
- Hardening
- Credentialing
- Federal inspections
- Grants
- Training
- Information sharing
- Rulemaking

Recommendations developed through the Assessment include the need to consider industry best practices, coordinate risk assessments and share information across the Federal agencies, incorporate vulnerability and consequence into risk assessments, and improve the grant process by clarifying Federal roles and tracking performance. Each recommendation includes a suggestion for a lead agency to execute the action item.

## *3.3 Transportation Security Planning at State Level*

### 3.3.1 State of Texas Emergency Management Plan

The State of Texas Emergency Management Plan (the State Plan) describes how the State will mitigate against, prepare for, respond to, and recover from the impact of hazards to public health and safety. The State Plan establishes operational concepts and identifies tasks and responsibilities required to carry out a comprehensive emergency management program. It describes the State's emergency management organization and a statewide system of coordination. The State Plan defines the emergency responsibilities of the TxDOT as following:

- Provides for the safe, effective, and efficient movement of people and goods over State-maintained highways and farm-to-market/ranch roads, and via multimodal forms of transportation throughout the State;
- Supervises the maintenance of State highway and ferry systems and their design, environmental oversight, acquisition of right of way, materials testing and validation, and construction;
- Issues oversize/overweight permits, and routing as necessary; receives, disburses, and administers federal and State funds for general aviation airports and assists small communities in building, maintaining, and upgrading airports; provides financial and technical assistance to providers of urban, or rural, public transit for the elderly or disabled; regulates outdoor advertising along highways and rural roads; oversees programs in traffic engineering, traffic safety, and traffic management; and oversees inspection of railroad operations and equipment, hazardous-materials handling on railroads, signal operation, and railroad tracks within Texas;
- Facilitates communication with Mexican officials and advises on international transportation along the Texas-Mexico border;
- Supports tourism, by operating travel information centers and publishing travel literature.

### 3.3.2 Texas Homeland Security Strategic Plan 2010-2015

The Texas Homeland Security Strategic Plan 2010-2015 serves as a high-level road map for the state's homeland security efforts for calendar years 2010-2015. It provides overarching guidance for state, regional, and local homeland security and emergency management plans and operations. It also helps inform federal partners who support Texas' homeland security efforts.

Texas has a vast number of critical infrastructure that could be vulnerable to a myriad of natural and manmade disasters. The critical infrastructure for the transportation system include:

- 150 major dams
- 1,853 aircraft landing areas
- 21 international airports
- 12 deep draft ports
- 17 shallow draft ports
- 26 land ports
- 128 cargo ports
- 296,000 miles of streets, highways, interstates
- 10,000 miles of railroad line
- 76,000 miles of hazardous liquid pipeline
- 50,572 bridges
- 141,000 miles of natural gas pipeline

The Texas Gulf Coast is home to deep and shallow water ports and the Gulf Intracoastal Waterway, with interconnecting rail and highway transportation corridors that are vital to U.S. national defense. There are 29 marine ports in the state, ranging from some of the busiest freight transportation hubs in the nation to smaller recreational and fishing harbors. Of these 29 ports, 12 are classified as deep water ports, while the remaining 17 are shallow draft ports. The largest ports in terms of throughput and capacity include the Port of Houston, Port of Corpus Christi, Port of Beaumont, and the Port of Galveston. In addition to its maritime ports, Texas has 1,853 private and public airport facilities, of which 21 are international airports. While the large international airports are of obvious homeland security concern, the hundreds of smaller airports can also present a threat. Texas has 26 official land ports, from the westernmost in El Paso to the easternmost in Brownsville. Texas land ports typically experience about 33 million pedestrian crossings, 61 million vehicle crossings, and 1.1 million rail crossings annually.

## *3.4 Transportation Security Planning at MPO Level*

### 3.4.1 North Central Texas Council of Governments

The North Central Texas Council of Governments (NCTCOG) incorporated transportation security into its long range transportation planning efforts. Enhancing the security of transportation system is one of the highest priorities of transportation agencies in the Dallas-Fort Worth region. Regional coordination of information sharing, response plans, response capabilities, and protection of critical infrastructure are key components to addressing transportation system security.

Annually, NCTCOG and regional transportation partners assess transportation and other regional components for nomination to the Critical Infrastructure Inventory/Key Resources. The confidential inventory is used in developing security measures for surveillance and protection of the identified regional assets. Transportation and Emergency Responders Uniform Communication System

(TERUCS) enables network communication between emergency operations centers and traffic management centers in the Dallas-Fort Worth area.

The region's intelligent transportation system infrastructure is an integral part of the transportation system security program. Current and future transportation and transit management center ITS components include closed-circuit televisions, lane control signals, dynamic message signs, ramp meters, mobility assistance patrols, vehicle detectors, transit vehicle tracking, in-vehicle navigation, integrated radio systems and automated vehicle location, automated fleet maintenance system, and automated HOV/managed lane enforcement. These traffic monitoring, incident detection, and response systems are utilized in improving the security of the regional transportation system.

NCTCOG and other regional partner agencies are working to establish coordination and organization procedures for using transportation resources for local and county agencies preparing for, responding to, and recovering from incidents which impact the residents of North Central Texas. Transportation support such as providing land, air, rail, or other resources for emergency response or assistance operations, and coordinating resources to facilitate an effective, efficient, and appropriate response and support are being assessed.

## *3.5 Texas Transportation Security Performance Measures and Targets*

The target of the TTP on transportation security is to ensure the security of the critical infrastructure in Texas and minimize the possible effects from natural hazards, terrorism attacks, etc when occurred. Specifically, the following goals are selected to be achieved:

- Develop the comprehensive database for all critical infrastructures within the state
- Establish an emergency response system and minimize emergency response times
- Coordinate the transportation security activities at state, county and city level
- Training and education on transportation security response measures

The following performance measures are selected for monitoring the effectiveness of the goals achieved:

- Percentage of critical infrastructure identified and archived in the state critical infrastructure database
- Emergency response time
- Frequency of transportation security training and drills held among state, county and city agencies
- Percentage of State population that receive training and/or educational materials on transportation security response protocol

**Table 2** provides the recommended targets, by five year increment, for each performance measure.

**Table 2. Recommended Targets for Each Performance Measure**

| Performance Measure | 2015 (baseline) | 2020 | 2025 | 2030 | 2035 |
|---|---|---|---|---|---|
| Number of fatalities | baseline | 10% reduction | 15% reduction | 18% reduction | 20% reduction |
| Number of serious injuries | baseline | 12% reduction | 20% reduction | 23% reduction | 25% reduction |
| Number of fatalities/serious injuries per million VMT | baseline | 11% reduction | 20% reduction | 22% reduction | 22% reduction |
| Number of fatalities/serious injuries per million population | baseline | 15% reduction | 22% reduction | 25% reduction | 30% reduction |
| Number of crashes between train and vehicle | baseline | 25% reduction | 35% reduction | 45% reduction | 50% reduction |
| Number of fatalities/serious injury crashes between train and vehicle | baseline | 25% reduction | 35% reduction | 45% reduction | 50% reduction |
| Number of pedestrian and bicyclist fatalities and serious injuries | baseline | 8% reduction | 10% reduction | 13% reduction | 15% reduction |
| Number of pedestrian and bicyclist fatalities per million population | baseline | 10% reduction | 12% reduction | 15% reduction | 18% reduction |
| Number of fatal and serious injury crashes involving cell phone use/speeding | baseline | 20% reduction | 25% reduction | 28% reduction | 30% reduction |
| Safety belt usage rate | baseline | 90% usage | 95% usage | 95% usage | 95% usage |
| Number of fatal crashes due to DUI | baseline | 5% reduction | 7% reduction | 9% reduction | 10% reduction |
| Average incident response time/incident clearance time | baseline | 15% reduction | 20% reduction | 23% reduction | 25% reduction |