Texas-Mexico Border Region Connectivity Plan

Appendix D

Region-to-Region

Preface

Disclaimer on Regional Definitions

The West, Central, and South border regions referenced in this report each encompass portions of multiple TxDOT districts. These regions were not defined according to district boundaries, but instead reflect functional relationships among key origins and destinations within approximately 100 miles of the Texas-Mexico border. Each region represents a cluster of border-crossing activity hubs that are interconnected by shared supply chains and primary freight corridors.

This regional structure was developed to support the assessment of region-to-region connectivity. It emphasizes how well current corridors align with actual freight movement and helps identify capacity limitations or connectivity gaps that may not be apparent when using administrative boundaries alone.

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Texas-Mexico Border Region Connectivity Plan

Overview of the Region-to-Region Plan and the Methodology

Texas Department of Transportation

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Step 1 – Data Collection and Literature Review

Task A: Material Inventory & Review – Activities in this task developed an inventory of relevant studies, plans, and reference documents. From that list, the study compiled up to 20 of the most relevant plans and materials for TXDOT. Once TXDOT approved the list, the study analyzed each of the plans and materials, developing a material review matrix highlighting the relevant data, findings, and provisions for the Border Connectivity Plan.

Task B: Establish Goals and Objectives – Based on information and input gathered from stakeholder interviews, the project developed draft study goals and objectives aligned and compounding from those goals and objectives established as part of the Phase 1 study but customized to regional border connectivity priorities. The study then refined the goals and objectives based on TXDOT input and produced a one-pager to communicate the final goals and objectives.

Task C: Data Inventory & Collection – To understand and describe existing and forecasted conditions and needs, significant data was required. The data inventoried included network attributes, traffic data, origin-destination data, safety data, socio-economic data, land use data, and other relevant planning data. The study conducted a Data Collection Inventory to identify collected data, data needing updates, and additional necessary data. TXDOT provided all necessary data for purchase, including travel demand models and data from the Mexican side of the border for the study to inventory and analyze. The study coordinated data collection efforts, avoiding duplication, and developed a GIS database with various datasets to assess connectivity issues, utilizing the Texas Statewide Analysis Model and regional MPO models.

Task D: Existing Conditions & Needs Assessment – Building off of the information provided from the State border corridor studies and the approved local studies, the study assessed and documented the existing conditions and performance of inter-regional travel, areas and factors of poor performance, and identified the needs impacting the movement of goods and people between the three border regions. Needs were categorized by type and severity. The baseline conditions assessment, conducted during the Phase 1 study was used as a launching point, but updated based on the current conditions as provided from TXDOT provided INRIX, Streetlight, IMPLAN, TREDIS, and telematics data. Performance and condition metrics, updated activity and profile data were developed, and used to create a framework to identify critical facilities for POE connectivity and border thoroughfare challenges, including first and last mile connectors. A data-centric analysis was then conducted to analyze RBCN corridors and local travel demand models to assess conditions for arterials connecting border regions. The results from this assessment were then reviewed and vetted by TXDOT districts as well as MPOs prior to transitioning to the next task.

Step 2 – Analysis of Existing and Forecasted Conditions

Task E: Forecast Conditions & Needs Assessment – Building on the information from the State border corridor studies and approved local studies, the study forecasted future conditions and needs for border regions. They established trend lines for passenger and commercial vehicle crossings and commodity flows, using historical data and travel demand models, with a forecast year of 2050. The study identified performance metrics, documented contributing factors, and categorized needs by severity. Similar to the Existing Conditions, TXDOT-provided data, including INRIX, Streetlight, IMPLAN, TREDIS, and telematic data, was used to enhance the forecasts. The study assessed future infrastructure conditions, considering physical capacity, safety, and design constraints, and developed projections of future performance. These projections were presented in a way that both technical and non-technical audiences could understand. Future needs related to border and intermodal connectivity were identified, and a high-level assessment of the impact on operational performance measures was conducted. The findings were summarized in a technical memorandum, providing a comprehensive analysis of future connectivity needs and challenges for the border regions.

Step 3 – Assessment of Existing and Forecasted Needs

Task E: Forecast Conditions & Needs Assessment – Building on the information from the State border corridor studies and approved local studies, the study forecasted future conditions and needs for border regions. They established trend lines for passenger and commercial vehicle crossings and commodity flows, using historical data and travel demand models, with a forecast year of 2050. The study identified performance metrics, documented contributing factors, and categorized needs by severity. Similar to the Existing Conditions, TXDOT-provided data, including INRIX, Streetlight, IMPLAN, TREDIS, and telematic data, was used to enhance the forecasts. The study assessed future infrastructure conditions, considering physical capacity, safety, and design constraints, and developed projections of future performance. These projections were presented in a way that both technical and non-technical audiences could understand. Future needs related to border and intermodal connectivity were identified, and a high-level assessment of the impact on operational performance measures was conducted. The findings were summarized in a technical memorandum, providing a comprehensive analysis of future connectivity needs and challenges for the border regions.

Step 4 – Assessment of Unmet Needs

Task F: Unmet Border Connectivity Needs – This task compared the needs identified in the forecast conditions to existing projects, to identify unmet needs on the RBCN. The study compared these needs to the projects in the BTMP, the latest Unified Transportation Program (UTP, and those under development by the districts, local governments, MPOs, and Mexican entities. By comparing the identified needs to planned projects, the study identified unmet region-to-region needs on the CBCN. These unmet needs were then compared to stakeholder input to develop an inventory of unmet border connectivity needs between border regions. The unmet needs were then scored and categorized as high, medium, or low based on stakeholder input and the relative importance of the facility in the RBCN scoring.

Step 5 – Strategies and Considerations

The final output of the study effort is this Border Region Connectivity Plan. The analyses of existing and forecasted conditions and needs led to the identification of a set of strategies and recommendations intended to meet those needs.

Task G: Strategies and Recommendations – The study authored the multimodal policy, program, and project strategies to address the unmet needs identified and advance planned projects on the RBCN. Based on the connectivity issues, challenges, and gaps identified in previous tasks and stakeholder input, the study developed short-, medium-, and long-term recommendations. These included policies, programs, and projects to enhance interregional border connectivity. The BTMP Phase I, latest UTP, district projects, and ongoing border efforts served as the foundation for proposed capital improvements. Additionally, Texas Delivers 2050 and the latest statewide modal plans were used as starting points for policy and program recommendations, supplemented by findings from the needs assessment.

The focus was on advancing the most critical planned region-to-region border connectivity projects and identifying new solutions for unmet interregional connectivity needs. The study collaborated with TXDOT and other stakeholders to vet and refine the recommendations and author the Unmet Needs List, Interregional Border Connectivity Findings and Strategies Technical Memorandum, and Interregional Border Connectivity Recommendations and Strategies presentations.

Task H: Border Region Connectivity Plan – At the conclusion of all other tasks, the study produced this final report summarizing the study process, stakeholder engagement, data inventory, existing and forecasted conditions, needs assessment, strategies, recommendations, and implementation plan. A TXDOT approved outline guided the report's development which was populated by content created for each of the previous tasks. Upon completion of the final report, the study will create a full-color, brochure-type executive summary for TXDOT to disseminate to other stakeholders.

Texas-Mexico Border Region Connectivity Plan

Region-to-Region Goals and Objectives

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Background and Introduction

The 2021 Border Transportation Master Plan (BTMP) recommended that the TxDOT Transportation Planning and Programming (TPP) Division's International Trade and Border Planning branch study strategies to improve connectivity between border crossings and regions. Specific objectives associated with the considerations are:

- Address the potential impact of disruptive events by providing enhanced network redundancy on both sides of the border.
- Enable demand management techniques to address congestion.
- Support the future growth of the Texas (U.S.) and Mexican economies by meeting demands of higher forecasted movements of people and goods through enhanced network connectivity.
- Facilitate connectivity between border region multimodal transportation networks.

The Border Region Connectivity Study (BRCS) is advancing this considerations by identifying a Regional Border Connectivity Network (RBCN), evaluating existing and future needs along these routes, and developing recommendations and an implementation plan. This study will be informed by binational stakeholder engagement. At the study outset, a study purpose and goals and objectives will be established in collaboration with stakeholders to guide future study development. The BTMP defined goals as "aspirational areas on which the BTMP should focus," while objectives "represent specific, measurable priorities for the BTMP." The draft goals and objectives presented below were informed by a review of the BTMP and of other recent statewide and TxDOT strategic plans. Technology Deployment were added to the BTMP goals based on this review. The draft study purpose, goals, and objectives will be presented to stakeholders for their input during the first round of outreach in Spring 2024.

Study Purpose, Goals, and Objectives

Study Purpose: Enhance multimodal connectivity within and between border regions to make travel safer and more efficient for people and goods, promote economic development, and improve resiliency and redundancy for border regions in Texas and Mexico.

Goal	Description	Objectives
Mobility and Reliability	Provide options for efficient, reliable transportation between border regions	• Develop recommendations to address current efficiency needs on the Regional Border Connectivity Network (RBCN). • Develop recommendations to address future efficiency needs on the RBCN. • Develop a plan to advance recommendations, including the timeline, agency, and possible funding.
Economic Competitiveness	Enhance economic linkages between border regions to boost regional competitiveness and support continued growth in border trade values	• Identify and enhance key supply chains that rely on border region connectivity. • Identify economic development drivers for border regions in Texas and Mexico. • Strengthen economic connectivity between border regions and inland markets in the US and Mexico.

Goal	Description	Objectives
Safety and Security	Improve travel safety between and within border regions	• Reduce crashes and improve safety on the RBCN. • Improve security of people and goods movement within the border regions and between the regions on the RBCN.
Connectivity	Improve connectivity within and between border regions	• Develop a network of TxDOT roadways significant to border region connectivity. • Prioritize transportation needs and improvements to improve border region connectivity.
Cross-Border Resiliency	Increase interconnectivity between border regions to provide resiliency in the event of disruptions	• Improve redundancy, access, and network completeness on RBCN to reduce the impact of disruptions • Improve redundancy, access, and network completeness on RBCN to enable safe and secure evacuation and disaster response

Goal	Description	Objectives
Sustainable Funding	Develop the Regional Border Connectivity Network (RBCN) to direct funding toward projects that improve border connectivity	• Using a data-driven project development approach, prioritize projects that benefit border connectivity. • Identify project development needs to ensure projects are shovel ready as funding becomes available. • Seek opportunities for innovative funding strategies such as private partnerships, bi-national funding with Mexico, and new federal funding programs.
Customer Service	Engage binational stakeholder groups and border region travelers to identify needs and guide future implementation	• Prioritize bilingual communication and engagement in all outreach and public communications. • Provide meaningful opportunities for public and stakeholder input to influence the direction and outcome of projects, inclusive of underserved communities. • Engage stakeholders on both sides of the US-Mexico border.
Asset Preservation	Maintain, preserve, and modernize assets on RBCN	• Utilize a data-driven approach to asset management and maintaining a State of Good Repair. • Incorporate knowledge of local context in asset management planning from freight volumes on key roadways to the impacts of regional climate on capital assets.
Stewardship and Sustainability	Leverage border connectivity investments to protect and enhance the environment in border regions	• Foster binational coordination of infrastructure development on the RBCN • Account for extreme weather and public health impacts in project prioritization and development. • Promote binational collaboration for extreme weather impact evaluation and shared sustainable development.

Goal	Description	Objectives
Technology Deployment	Leverage technology for safer and more efficient movement of people and goods across the border and between border regions	• Employ innovative technologies to address transportation challenges faced in border regions. • Seek opportunities for cross-border training and partnership on implementing advanced technology infrastructure.

Texas-Mexico Border Region Connectivity Plan

Region-to-Region Network Designation Process

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Introduction

As part of the Border Region Connectivity Study, designating the network that will later be used for performance measurement and needs assessment. This tech memo describes the steps to designate the network in Texas-Mexico border regions. TxDOT Roadway Inventory On System network will serve as the universal network from which the Regional Border Connectivity Network will be designated.

Identifying the Regional Border Connectivity Network – Highway

The process to identify the border region network is both data driven, and stakeholder informed. The network is assessed based on three major evaluation factors: people and goods movement, strategic supply chains, and market access and connectivity. All the data related to the three evaluation factors above is gathered and each segment of the network is assessed with respect to each factor. This produces a preliminary identified network which is then presented to various stakeholders and entities with insight into needs and challenges of the network for their input. Using the stakeholders' inputs, the study will revise and finalize the network. The network designation criteria are described below.

People and Goods Movement

The network is assessed based on its importance to the movement of both people and goods. The following metrics[1] are considered for this evaluation:

- Passenger Demand, existing and forecast
    - AADT, %passenger car, AADT forecast, population, population forecast, intercity bus volume
- Freight Demand, existing and forecast
    - AADTT, %truck, tonnage of freight, value of freight, AADTT forecast (tonnage/value forecast), freight-reliant industry employment, freight-reliant industry employment forecast
- Cross border passenger demand, existing and forecast
    - AADT, AADT forecast, %passenger car
- Cross border freight demand, existing and forecast
    - AADTT, AADTT forecast, tonnage, value, %truck

It is worth noting that the focus of this memo is on the highway network. Other modes of transportation such as rail, maritime, air, and bike and ped will be included in the final multimodal network. Regarding bike/ped, the connectivity of the statewide bike/ped network will be examined and compared with the regional bike/ped networks.

[1] Data sources: TxDOT, Transearch, US Census, relevant BTS data sources (e.g. Border Crossing/Entry Data), TTI Border Crossing Information System (BCIS), equivalent Mexico data for all the above (as far as they are available)

People and Goods Movement

The border region network is evaluated based on its level of support for strategic supply chain industries and businesses that depend on cross border traffic. The following steps[2] define how to analyze the network from a strategic supply chain perspective:

- Define strategic supply chain industries
    - Study the bi-national supply chain profiles of the three border regions and assess how these profiles fit within the tri-national/global supply chains
        - Commodity code to NAICS crosswalk
    - Number of industries depend on share of total trade
- Study the impacts of recent and ongoing reshoring/nearshoring trends on the regional supply chains
    - CNT report, general research to identify nearshoring industries
        - Auto, aerospace, ag as example
- Determine businesses associated with the identified industries
    - Using NAICS codes
- Evaluate the network in terms of servicing the industries and associated businesses
    - Identify hot spots, industrial clusters, key developments of the foreign trade industry

Market Access and Connectivity

People cross the border for various reasons such as accessing employment, education institutes, retail centers, and health care. Goods and freight cross the border to access major transportation routes, transportation hubs, and markets. The network is assessed based on its role in providing market access and connectivity for both people and goods. This evaluation will incorporate existing and future infrastructure development. The metrics[3] chosen for this assessment are as follows:

- Connection to top ODs and multimodal transportation facilities are the most important for connectivity for all communities/freight movements
    - People: airports, bus stations, train stations, seaports
    - Freight: airports, seaports, inland ports, transload facilities, and intermodal facilities, key routes (e.g. I-35, I-27, I-10, US 83, etc.)
- Market access
    - Major education, retail, employment, and health care centers

[2] Data sources: cross border commodity data (USA Trade Online, USDA, etc), Transearch, infoUSA, Truck Analysis Tool, Mexico data (to the extent of availability. Examples are but not limited to Direct Foreign Investments in Mexico from Secretaria de Economia related to the nearshoring trends and impacts), Stakeholder interviews, future land use

[3] Data sources: BTS National Transportation Atlas Database (NTAD), LoadMatch, Class I Railroad websites, TxDOT, Transearch, Replica (or other OD data), Truck Analysis Tool

Texas-Mexico Border Region Connectivity Plan

Region-to-Region Network Needs Methodology

Texas Department of Transportation

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Introduction & Scope

This document describes the methodology and approach to identifying and assessing network needs along the Regional Border Connectivity Network (RBCN). The RBCN is a subset of the multimodal transportation system in the Texas-Mexico border region, critical to serving the movements of goods and people to and from, within and through the border region. The RBCN was developed based on a data driven process with inter-regional demand as a primary consideration. Further input to the RBCN will be incorporated through District and other stakeholder input as the project progresses. For this project, the border region is defined as the area within a 100-mile buffer from the Texas-Mexico border in both Texas and Mexico, including the four TxDOT border districts Pharr, Laredo, El Paso, and Odessa.

The methodology recommended in this document includes a data-driven approach and will draw on the relevant stakeholders' input and existing plans and studies. The needs identified through this process will form the basis for the strategies and recommendations of the Regional Border Connectivity Study.

Evaluating the Regional Border Connectivity Network Needs and Gaps

The process of identifying existing and future needs and gaps along the RBC Network will include a series of assessments across several metrics or criteria. Criteria selection was guided by the goals of the RBC Study. Each assessment will identify the network's performance level in relation to the goal to be achieved. The level of performance will be used to indicate the presence of a need or gap and help direct recommendations to improve the network under each goal.

Align Needs Criteria with Study Goals

Network needs criteria are based on the premise of improving border region connectivity and achieving the study's goals. Each criterion should provide a quantifiable assessment of how well the network performs in relation to achieving each goal.

The goals established for the present study build upon those of TxDOT's Border Transportation Master Plan (BTMP) Phase 1, incorporating additional themes and goals, reflecting the changes in connectivity, safety, asset preservation, economic competitiveness, and customer service since 2020. Metrics are categorized to convey their overarching objectives more effectively.

Potential Metrics	Data Sources	Relevant BTMP Phase I Content/Findings
Goals: Mobility, Reliability, and Connectivity (Section 2.2)		
Existing and forecasted volume-to-capacity ratios and LOS , both total and commercial	TxDOT traffic count data, Transearch, POE crossing counts, TxDOT SAM	Utilization rates of border crossings for POV, bikes/pedestrians, and CMVs from 2014-2018 and projected utilization rates in 2050
TTRI (Travel Time Reliability Index - INRIX or VHT - free flow VHT) for both passenger and commercial vehicles	RITIS (providing metrics based on NPMRDS data)	
Travel time delays for both passenger and commercial vehicles	RITIS (providing metrics based on NPMRDS data); INRIX data for calculating northbound wait times at border crossings.	Reduced border crossing times due to delays that are resulting in lost economic opportunities.
Route directness and redundancy	TxDOT's SAM and INRIX data	
Bus/transit routes, bike lanes, and network completion gaps	TxDOT; Bicycle Tourism Trails Network; regional and local agencies	Summaries of challenges intermodal connectivity issues, including gaps in bus/transit routes and bike lanes.
Goals: Safety and Security (Section 2.3)		
Crash Frequencies (hot spot)- total and commercial	TxDOT's Crash Records Information System (CRIS) Query Tool	Maps of bicycle / pedestrian, CMV and POV fatality crashes and road incident density in border regions; crashes per 100 million VMT between 2015 and 2019 and border regions
Fatalities/Serious Injuries due to roadway crashes- total and commercial	TxDOT CRIS Query Tool	POV and CMV crash rate (crashes per VMT) in all three border areas were compared to the statewide average
Crash contributing/causing factors	TxDOT CRIS Query Tool	
Pedestrian/bike-involved crashes	TxDOT CRIS Query Tool	Maps of bicycle / pedestrian, fatality crashes and road incident density in border regions; does not provide data about non-fatal crashes
Bridge strikes	TxDOT CRIS Query Tool	

Potential Metrics	Data Sources	Relevant BTMP Phase I Content/Findings
At Grade Rail crossings incidents	FRA safety data; TxDOT CRIS system's "Railroad Flag" field	Maps of at-grade rail incidents in border regions
Blocked crossing duration and frequency	FRA Rail Grade Crossing Data	
Goals: Asset Preservation and Technology Deployment (Section 2.4)		
Current Design Standards (Frontage roads, lane width, shoulders, etc.)	TxDOT Minimum Designs for Trucks and Buses: Roadway Manual, Section 7; consultations with local and regional stakeholders	
Pavement condition	TxDOT Pavement Conditions Data	Maps of pavement conditions in border areas
Bridge Height Restrictions	TxDOT Bridge Condition Data	Number of bridges with clearance lower than 14 ft in each border area
Bridge condition	Need for improved comprehensive statewide approach to bridge condition management, improved preventative maintenance, more frequently updated data on bridge conditions in Mexico.	Number of bridges categorized by condition in each border area from TXDOT 2018 Report on Texas Bridges.
Railway condition	TxDOT State Rail Plan; stakeholder consultations	High level conditions on condition of rail crossings
Border facility condition	GAO Report to Congressional Requesters, "Border Infrastructure: Actions Needed to Improve Information on Facilities and Capital Planning at Land Border Crossings," July 2019.	Identifies border facilities in poor condition and in need of maintenance; also identifies border facilities that have not been assessed
Weight restrictions	TxDOT	
Presence of movable bridges	TxDOT	
Frequency and distribution of Oversized/Overweight (OS/OW) permits	Texas DMV	
Existence of ITS Infrastructure	ITS Inventory	

Potential Metrics	Data Sources	Relevant BTMP Phase I Content/Findings
Goals: Economic Competitiveness, Cross-Border Resiliency, and Sustainable Funding (Section 2.5)		
Exposure to risk	TxDOT Statewide Resiliency Plan vulnerability assessment	
Goals: Customer Service, Stewardship and Sustainability (Section 2.6)		
Only access to historic/cultural/tourist locations/activities	TxDOT multimodal network data; National Transportation Atlas Database	
E.V. charging inventory and proximity	U.S. Department of Energy; TxDOT and FHWA AFC data; Mexico's national power company CFE (Comision Federal de Electricidad), ChargeNow, Tesla, INECC (Instituto Nacional de Ecologia y Cambio Climatico)	
Existence or lack of rest areas and Truck Parking - inventory and amenities	TxDOT Texas Statewide Truck Parking Study Need for additional CMV parking at or need the border to accommodate delays.	

Goals: Mobility, Reliability, and Connectivity

Multimodal transportation is driven by vehicular demand, operational capacity, route choice, reliability, and connectivity. People want to get to their destination quickly, reliably, and safely. They will choose their method of transport based on several factors, including origin and destination, mode/route travel time and reliability, and transport cost, as well as other factors such as personal preference, the importance of sustainability, the convenience of transit locations, etc.

Shippers also desire to move their goods as efficiently as possible through the logistics chain and will determine their preferred route based on cost, travel time, and reliability, which includes both transport on the road or rail link as well as border processing for international traffic. The shippers may deviate to alternative routes in times of delay but typically will take their preferred route, which allows them to plan out their scheduling. From a shipper's point of view, cost and reliability matter as they strive to meet delivery deadlines.

Transportation agencies like TxDOT are concerned with traffic volumes, which impact road maintenance and quality, and bottlenecks on the roads, which affect the competitiveness of the sector compared to other modes and routes. In the case of rail, volumes are key due to the strong relationship between traffic volumes and cost. From a regional economic perspective, network performance is reflective of trade, the balance of trade, types of commodities flowing through the corridors, and the impact on employment and economic growth.

This assessment will pinpoint segments of the RBCN that have undergone or are currently undergoing rapid growth in demand and are projected to continue experiencing such growth. To identify highly congested areas, measures like travel time delay, reliability, and level of service (LOS) will also be calculated based on existing and forecasted demand.

- **Existing and forecasted Highway Level of Service (LOS)**: Based on current and forecasted highway traffic volumes, an LOS analysis will be conducted for both current and forecasted highway conditions.
    - **Objective**: Identify areas of congestion (bottlenecks/hot spots) for further evaluation.
    - **Data sources**: Current traffic and projected traffic growth; infrastructure changes and resulting travel patterns.
- **TTRI (Travel Time Reliability Index) and travel time delays**: To evaluate the reliability of travel times for vehicles on a specific route, the Travel Time Reliability Index (TTRI) is calculated as the ratio of Average Travel Time during peak hours to Free-Flow Travel Time. Travel time delays are determined by comparing the actual time taken to travel a road section to the time expected at uncongested speeds.
    - **Objective**: Identify areas of congestion (bottlenecks/hotspots) and rank them by severity.
    - **Data sources**: the vehicle speed data provided by the Regional Integrated Transportation Information System (RITIS).
- **Route directness and redundancy**: Route redundancy can be assessed by looking at the existence or lack of parallel routes between major origins and destinations. Route directness is another connectivity measure calculated by comparing travel times on the most frequently used routes between major ODs with other less used routes for the same O.D. pair. In rail's case, the network can be assessed in terms of the portion of sections with single and double tracking.
    - **Objective**: Identify the level of connectivity between border regions. One example outcome might be the need for a new location highway; another outcome may be to upgrade a substandard facility that serves a more direct route but is poorly designed to do so.
    - **Data sources**: TxDOT's SAM and INRIX data.
- **Type of access (separated/at grade)**: The percentage of grade-separated crossings by corridor indicates the connectivity of the road networks as at-grade crossings disrupt roadway movements (including bike and pedestrian movements) and cause longer travel times, reduced reliability, and safety incidents.
    - **Objectives**: Identify the level of disruptions in roadway activity due to at-grade rail crossings.
    - **Data sources**: FRA produces data on the number of grade-separated rail/highway crossings.

- **Cross-sectional connectivity (main lanes and frontage if applicable)**: TxDOT's SAM model and road network files can be used to assess the existence of frontage roads to provide access between arterials and local communities. The distance between highway access points can also be measured to understand community connectivity.
    - **Objective**: Understand connectivity between local communities, businesses, and transportation facilities with primary arterial roads.
    - **Data sources**: TxDOT's SAM model and road network files.
- **Bus/transit routes, bike lanes, and network completion gaps**: Bus, transit routes, and bike lanes can be examined for completeness and potential gaps by looking at satellite imagery and route maps from TXDOT and municipalities. Consultations with local and regional agencies can also inform the assessment.
    - **Objective**: Identify the potential gaps in bus/transit routes and bike networks.
    - **Data sources**: TxDOT; regional and local agencies.

Goals: Safety and Security

Overall, transportation system safety and security are determined by both the design of infrastructure (intersections, ramps, roadway curve geometry, etc.) as well as the behavior of individual transportation system users and operators. Studying the safety and security of this system is important because safety concerns like crashes have a significant human cost in terms of property loss, injury, and death, and disruptive events like crashes also have a significant impact on the reliability and efficiency of the transportation system. Therefore, understanding safety issues provides valuable information to complement the mobility, reliability, and connectivity measures described in the section above.

The safety and security assessment relies primarily on historical data on vehicle crashes. The identification of crash hot spots will be used to identify and assess causal factors attributed to design and/or driver behavior. Comparison of crash rates by area and functional classification to statewide averages will highlight those areas of the network that experience higher than normal incidents. Evaluating the type of crash and the vehicles involved will aid in determining suitable alternatives or recommendations.

- **Crash frequencies (hot spot)- total and commercial**: At its most basic level, this metric involves reporting a count of total and commercial crashes in the regions of interest and can provide insight into the share of crashes associated with different types of vehicles, and trends in crash counts (and system safety) over time. However, additional value can be added to this metric by examining the geographic distribution and clustering of crashes. This metric involves mapping the individual locations of crash events for different classes or sizes of vehicles and translating individual crash events into clustered crash "hotspots." This type of analysis can also be broken down and done by vehicle type (passenger, commercial, etc.) and/or by crash severity (property damage, injury, fatality, etc.). This type of heat mapping or cluster mapping work provides invaluable basic context for further safety analysis by identifying the elements of the transportation network that have the greatest or most severe safety concerns. In turn, hotspots or clusters of crashes can undergo prioritization or more focused analysis.

The crash frequency information is also important for understanding transportation connectivity because it provides insight into areas of the transportation network where crashes or safety concerns overlap with unreliable travel times or frequent delays; this provides information on areas where safety problems are significant contributors to the reliable movement of traffic.

  - **Objective**: Identify the share of crashes associated with different types of vehicles and trends in crash counts.
  - **Data sources**: TxDOT's Crash Records Information System (CRIS) provides detailed reporting on the severity, cause, and other characteristics of vehicle crashes reported in Texas.

- **Fatalities/serious injuries due to roadway crashes- total and commercial**: This metric tracks the number of crashes in the region of interest by crash severity and type of vehicle involved. This type of analysis can be particularly useful for understanding the safety impacts of crashes involving freight vehicles, which are often much larger than passenger vehicles, pedestrians, and bicyclists and, therefore, may contribute disproportionately to the region's count of severe or fatal crashes.
  - **Objectives**: When calculated for a multi-year time period, this metric provides insight into the share and severity of crashes associated with different vehicle types and provides an understanding of whether or not safety trends are being influenced by crashes with specific types of vehicles.
  - **Data sources**: TxDOT's CRIS Query Tool, which provides a field indicating whether a crash involved a commercial motor vehicle (CMV), as well as other fields related to the characteristics of CMVs, and other vehicles involved in crashes.
- **Crash contributing/causing factors**: This metric utilizes the "Contributing Factor" fields in TxDOT's CRIS data to measure the count of common causes of vehicle crashes over time and provide insight into the major causes of crashes and whether certain types of causes are trending up or down. This metric is useful for understanding and improving connectivity because it provides insight into whether crashes are being driven by human or infrastructure related factors.
  - **Objectives**: When used in conjunction with mapping efforts (such as the heatmaps described above), this metric can inform safety interventions at specific locations or corridors, such as changes to built infrastructure or targeted enforcement efforts.
  - **Data sources**: TxDOT's CRIS Query Tool.
- Pedestrian/bike-involved crashes: Pedestrians and bicyclists are much less protected than transportation users in vehicles and are at a much higher risk of injury and death in crashes. This metric tracks the number of crashes where at least one of the involved parties is a pedestrian or bicyclist.
  - **Objectives**: This information is important for border region connectivity because bicyclist and pedestrian movements make up a share of cross-border passenger movements.

    - **Data sources**: This metric would be obtained from TxDOT CRIS's database "Unit Description" field, which contains values to identify crashes involving pedestrians and bicyclists.

- **Bridge strikes**: This metric tracks the count of bridge strikes by CMVs in the region of interest. This metric is important for regional connectivity because low-clearance bridges can be an impediment to efficient truck routings, and bridge strikes can result in infrastructure damage, further vehicle accidents, and road closures.
    - **Objectives**: Identify impediments to efficient truck routings. Network Needs Methodology 10
    - **Data sources**: This metric would be created using the CRIS platform's "Bridge Detail" field, which contains a value to indicate an overpass struck by a vehicle, and CRIS fields describing CMVs.
- **At grade rail crossing incidents**: This metric tracks the count of grade crossing collisions in the region of interest.
    - **Objectives**: Grade crossing collisions are important to understand because they affect the mobility and safety of multiple modes of transportation.
    - **Data sources**: TxDOT CRIS system's "Railroad Flag" field, which indicates whether or not a crash involved or was related to a train or railroad crossing; FRA's safety data can also inform this analysis.
- **Blocked crossing duration and frequency**: This metric tracks the duration that grade crossings are blocked by trains and the frequency of blockages. These blockages also create public safety concerns because they can prevent the timely response of fire, police, and medical services. In the case of pedestrian movements, blocked crossings also create a safety risk, as people may trespass on rail property or climb under or over stationary parked trains.
    - **Objectives**: Understanding the regional connectivity issues due to excessively blocked railroad crossing creates significant impediments to mobility for all other transportation users, including bicyclists and pedestrians. Goals: Asset Preservation and Technology Deployment.
    - **Data sources**: This metric would be created using railroad grade crossing blockage reporting data collected and published by the Federal Railroad Administration.

Goals: Asset Preservation and Technology Deployment

Asset preservation issues include pavement conditions, bridge conditions, border crossing conditions, and border inspection facility conditions. The needs assessment will capture the condition of built assets and identify hotspots for necessary improvements or preventative maintenance. It will also analyze the application of critical technologies and the resilience of built assets to threats like natural events and cybersecurity disruption.

- **Current design standards**: Geometric design elements of road and bridge infrastructure can have a major impact on the flow of traffic and roadway safety, especially for large commercial vehicles. Design features, including narrow rights of way, roundabouts, and sharp turns, can inhibit the flow of commercial traffic or even render certain routes impassable.
  - **Objectives**: Understanding road design features that can inhibit the flow of commercial traffic or even render certain routes impassable for them.
  - **Data sources**: TxDOT's Roadway Design Manual provides a detailed set of standards for the geometry of different road classifications. Consultations with key stakeholders in commercial freight will allow the needs assessment to identify specific locations where road design creates challenges for the movement of commercial traffic in border areas.
- **Pavement condition**: Roadways that experience high use and/or insufficient maintenance may exhibit poor pavement condition, which can impede the flow of goods and passengers and result in serious safety concerns. The presence or lack of sufficient drainage can also have a major impact on the integrity of road infrastructure, especially during extreme weather events.
  - **Objectives**: Analyze the pavement conditions along important connectors between border areas.
  - **Data sources**: TxDOT's Pavement Management Information System (PMIS) dataset ranks pavement conditions on a scale of zero to 100, assessing both distress and ride quality.
- **Bridge height restrictions**: Large commercial vehicles must choose routes that avoid bridges that provide insufficient overhead clearance, increasing travel times and adding to congestion on the limited number of viable routes.
  - **Objectives**: Understand potential bottlenecks created by low bridges in border areas.
  - **Data sources**: TxDOT's Bridge Division maintains data on the height of bridges in its network.
- **Bridge condition**: Bridges that experience high use and/or insufficient maintenance may exhibit poor or deteriorating condition. The presence or lack of sufficient drainage can also have a major impact on the integrity of bridge infrastructure, especially during extreme weather events. This can pose serious safety concerns and impede the flow of traffic.
  - **Objectives**: Identify priorities for maintenance and improved infrastructure along important connectors between border areas.

  - **Data sources**: TxDOT's Bridge Division maintains datasets on the condition of bridges in its network.
- **Railway condition**: Railways and rail crossings that experience high use and/or insufficient maintenance may exhibit poor or deteriorating condition. Poorly maintained railways pose serious safety concerns and can cause disruptions to the flow of traffic. The condition of railway facilities and intermodal connections is also important to consider.
  - **Objectives**: Understand the condition of intermodal and rail facilities in border areas.
  - **Data sources**: TxDOT maintains data on the condition of railways; stakeholder consultations can highlight segment-level issues.
- **Border facility condition**: Border inspection facilities that experience high traffic and/or insufficient maintenance may exhibit deteriorated service. This can contribute to delays and slow processing times at the border. Unlike roads or railways, there are fewer systems in place to systematically repair and rehabilitate border facilities over time.
  - **Objectives**: Understand the condition of border crossing facilities.
  - **Data sources**: The needs assessment will draw on TxDOT and GAO reports on the condition of border facilities and conduct stakeholder consultations.
- **Weight restrictions**: In addition to statewide regulations on the acceptable weight and load size carried by commercial vehicles, TxDOT maintains more than 16,000 miles of load-restricted highways and over 2,000 load-restricted bridges with limits lower than the statewide standard. The presence of load-limited roads and bridges forces large commercial vehicles that exceed these limits to choose alternate routes, increasing cost and travel time and potentially contributing to congestion along viable routes. It is also important to ensure that these limits are respected, as oversized vehicles can accelerate the deterioration of road infrastructure and contribute to safety risks for all users. Weigh-in-motion (WIM) technology is one tool that is often used to ensure that weight limits are respected along important transit corridors.
  - **Objectives**: Analyze weight and load restrictions in border areas and consider areas where WIM and other enforcement tools might be utilized.
  - **Data sources**: TxDOT maintains interactive maps of load-restricted roads and bridges statewide.
- **Presence of movable bridges**: Movable bridges are typically found over waterways to allow large marine vessels to pass underneath. Movable bridges can cause major delays, as they stop traffic while opening or closing. Bridges often carry broadband and fiber infrastructure and play a critical role in connecting communities. However, movable bridges cannot carry this type of infrastructure, which can create barriers to broadband and fiber connectivity.
  - **Objectives**: Identify infrastructure barriers to broadband and fiber connectivity.
  - **Data sources**: TxDOT's bridge inventory dataset.

- **Cyber security of infrastructure increasingly critical for resilient supply chains**: Critical infrastructure, especially ports of entry into the U.S., face a growing risk of cyber-attacks. In recent years, high-profile data breaches have occurred in ports, utilities, and pipelines across the United States. As a result, it is critical to ensure that ports of entry along the U.S.-Mexico border are sufficiently prepared.
    - **Objectives**: Identify potential gaps in cyber security at border crossings, airports, and intermodal facilities.
    - **Data sources**: Consultations with key stakeholders.
- **Safety warning detection system (presence or absence)**: In 2018, TxDOT adopted the Texas Freight Mobility Plan (TFMP), which included a recommendation to implement a statewide freight safety and operations program. These systems allow for real-time monitoring and enforcement of overweight/oversized vehicle regulations and allow TxDOT to quickly identify problems on the network and respond accordingly, such as a bridge that has been struck by an oversized vehicle. In addition, the state's rail system makes use of a variety of safety and detection systems to prevent collisions at rail crossings.
    - **Objectives**: Identify potential gaps in safety warning detection systems.
    - **Data sources**: TxDOT, FRA, and consultations with key stakeholders.
- **Frequency and distribution of oversized/overweight (OS/OW) permit**: The Texas DMV imposes weight limits on all vehicles using Texas roadways, which may only be exceeded by applying for and receiving an OS/OW permit. Vehicles that exceed the weight limit of roadways and bridges put excess strain on these assets, accelerating their deterioration.
    - **Objectives**: Understanding the number of OS/OW vehicles using Texas roadways and the routes that they most frequently travel is necessary for accurately projecting future maintenance needs in border regions.
    - **Data sources**: Texas DMV data on the issuance of OS/OW permits.

Goals: Customer Service and Stewardship and Sustainability

Transport sustainability strategies often focus on reducing VMT, whether through mode shifts or the use of new engine technologies. For passenger transport, this includes reducing VMT of single-occupant vehicles and increasing transit usage. For freight, VMT can be reduced by making trips more efficient by reducing empty backhaul trips, making short-haul trips (like e-commerce) more efficient, minimizing congestion, minimizing detours, and modal shifts to rail.

- **Access to historic/cultural/tourist locations/activities**: Tourism is important to the Texan economy, bringing over $80 billion in direct spending in 2019 and supporting more than 761,000 jobs (Texas Travel Industry Association). Further, tourism has indirect impacts on other sectors, including transport through passenger travel by air, train, car rental, and transit. Transport connectivity to tourist locations is essential for the tourism industry to function. Further, certain attractions, such as sports stadiums and concert venues, bring large influxes of people in a short period of time. Transport routes must be able to accommodate these acute flows, or severe congestion will occur and impact other goods, people, and movements as well as the attraction users. Alternate routes to venues can spread traffic over multiple routes, improving traffic flows. Transit can move larger numbers of people at once than personal vehicles. Bike and pedestrian routes can also alleviate pressures from the system.
    - **Objective**: Assess connectivity to major attractions, noting gaps in alternate routes and transit options.
    - **Data sources**: TxDOT multimodal network data; National Transportation Atlas Database.
- E.V. charging inventory and proximity: A necessary requirement for the growing use of E.V.s and alternative fuels for both passenger and goods movements is the establishment of strategically placed charging stations along major passenger and freight highway corridors. Given the two competing types of truck zero-emission technology, this requires both electric charging stations as well as hydrogen refueling stations. Current Alternative Fuel Corridor (AFC) standards require a maximum of 50 miles between stations to ensure range confidence.
    - **Objective**: Determine the status and gaps in the alternative fuel charging network in Texas and Mexico
    - **Data sources**: U.S. Department of Energy; TxDOT and FHWA AFC data; Mexico’s national power company CFE (Comision Federal de Electricidad), ChargeNow, Tesla, INECC (Instituto Nacional de Ecologia y Cambio Climatico).

- **Existence or lack of rest areas and truck parking**: Truck drivers rely on rest areas for a safe and convenient place to obtain their mandated rest periods. An insufficient number of rest areas or lack of rest areas in strategic areas leads to drivers resorting to parking on the side of the road, which is a safety risk. Further, rest areas with driver amenities improve the quality of life of drivers and make the profession more appealing. In addition, rest areas can be used by tourists, buses, and passenger vehicles; as noted earlier, tourism is an important driver of the economy, and quality rest areas support the attractiveness of the region to tourism. This assessment will take an inventory of truck parking areas and amenities.
    - **Objective**: Identify gaps in truck parking and hotspots of trucks parking in unsafe areas due to lack of parking.
    - **Data sources**: TxDOT Statewide Truck Parking Study; Jason's Law Truck Parking Survey.

Texas-Mexico Border Region Connectivity Plan

Region-to-Region Existing Conditions Memorandum

Texas Department of Transportation

Contents

Background

The most recent Texas-Mexico Border Transportation Master Plan (BTMP) was published in March 2021. The Texas Department of Transportation (TxDOT) completed this effort in collaboration with various stakeholders and community members to develop a long-range plan for the Texas-Mexico border region that facilitates the efficient movement of people and goods. The plan produced 22 policy recommendations, 153 programs, and 661 project recommendations for future consideration and implementation.

One of the 22 policy recommendations of the BTMP was to "provide multimodal connectivity between border crossings to provide enhanced network redundancy for efficient border region trips." The Region-to-Region Connectivity Study is a continuation of this policy consideration and will identify needs and make recommendations to improve multimodal connectivity in the border regions. The Region-to-Region Connectivity Study is made up of the memos listed in **Table 1** below.

The Region-to-Region Connectivity Study will leverage and align with other ongoing TxDOT initiatives. Concurrent TxDOT studies include:

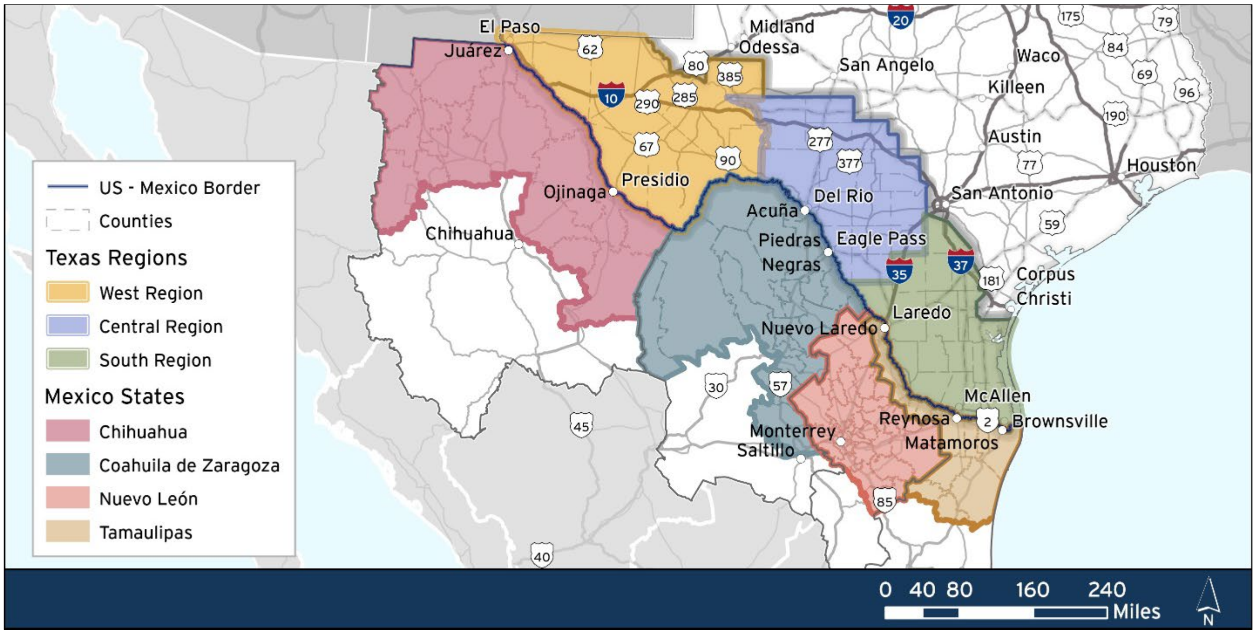
- First and last-mile connectivity
- Connections between border crossings, inland ports, seaports, and airports

Table 1: Previous, Ongoing, & Future Memos Informing the Region-to-Region Study

Memo	Status
Network Designation	Submitted
Goals and Objectives	Submitted
Network Needs Methodology	Submitted
Existing Conditions	**This Memo**
Existing Needs Assessment	Submitted
Forecast Conditions and Needs Assessment	Submitted
Unmet Border Connectivity Needs	Submitted
Strategies and Recommendations	Submitted
Border Region Connectivity Plan	Submitted

Figure 1 identifies the Texas/Mexico border region considered for this study which consists of an area that is within approximately 100 miles of the Texas-Mexico border. This region is home to 13.6 million people and includes the West, Central, and South border regions of Texas and parts of Chihuahua, Coahuila de Zaragoza, Nuevo Leon, and Tamaulipas in Mexico. In total, there are 43 counties in Texas and 99 municipalities or second-level administrative divisions in Mexico (*municipios*).

Figure 1: Region-to-Region Study Area



Memo Overview

Information in this memo was obtained from available data sources including the Texas Demographic Center, the U.S. Census Bureau, the U.S. Bureau of Economic Analysis, the Bureau of Transportation Statistics, Transearch, and TxDOT. Using the BTMP and other existing reports and data, goals and objectives were developed along with network criteria to establish the Regional Border Connectivity Network (RBCN). Once the RBCN was established, TxDOT engaged in technical analysis and stakeholder input to identify needs, trends, and strategies for region-to-region connectivity along the borders.

This memo builds upon the following memos:

- *Draft* Network Designation, *December 2023*
- *Draft* Goals and Objectives, *January 2024*
- *Draft* Network Needs Methodology, *February 2024*

This memo will examine recent data on socioeconomic indicators, trade and the freight trucking industry, traffic volumes, and infrastructure conditions. The analysis will inform the subsequent existing needs assessment, forecast conditions, future needs assessment and ultimately inform the study's recommendations, strategies, and plans.

Goals and Objectives

The goals and objectives for the Region-to-Region Connectivity Study were developed in conjunction with binational stakeholders to guide the data collection, analysis, and recommendations throughout the study. The Draft Study Goals & Objectives (December 2023) focuses on enhancing transportation efficiency, reliability, and connectivity between border regions, while simultaneously boosting economic competitiveness and ensuring safety and security. Key objectives include efforts to maintain and modernize transportation assets, protect the environment, and increase cross-border resiliency. To view the complete goals and objectives for the study, review the Study Goals & Objectives.

Regional Border Connectivity Network (RBCN) Designation

As part of the Region-to-Region Connectivity Study, designating the Regional Border Connectivity Network (RBCN) to be used for performance measurement and needs assessments. This section describes how the network was designated in the Texas-Mexico border regions. For a complete understanding of the network designation process, see Draft Network Designation Process memo (Dec 2023) and Draft Network Needs Methodology memo (Feb 2024).

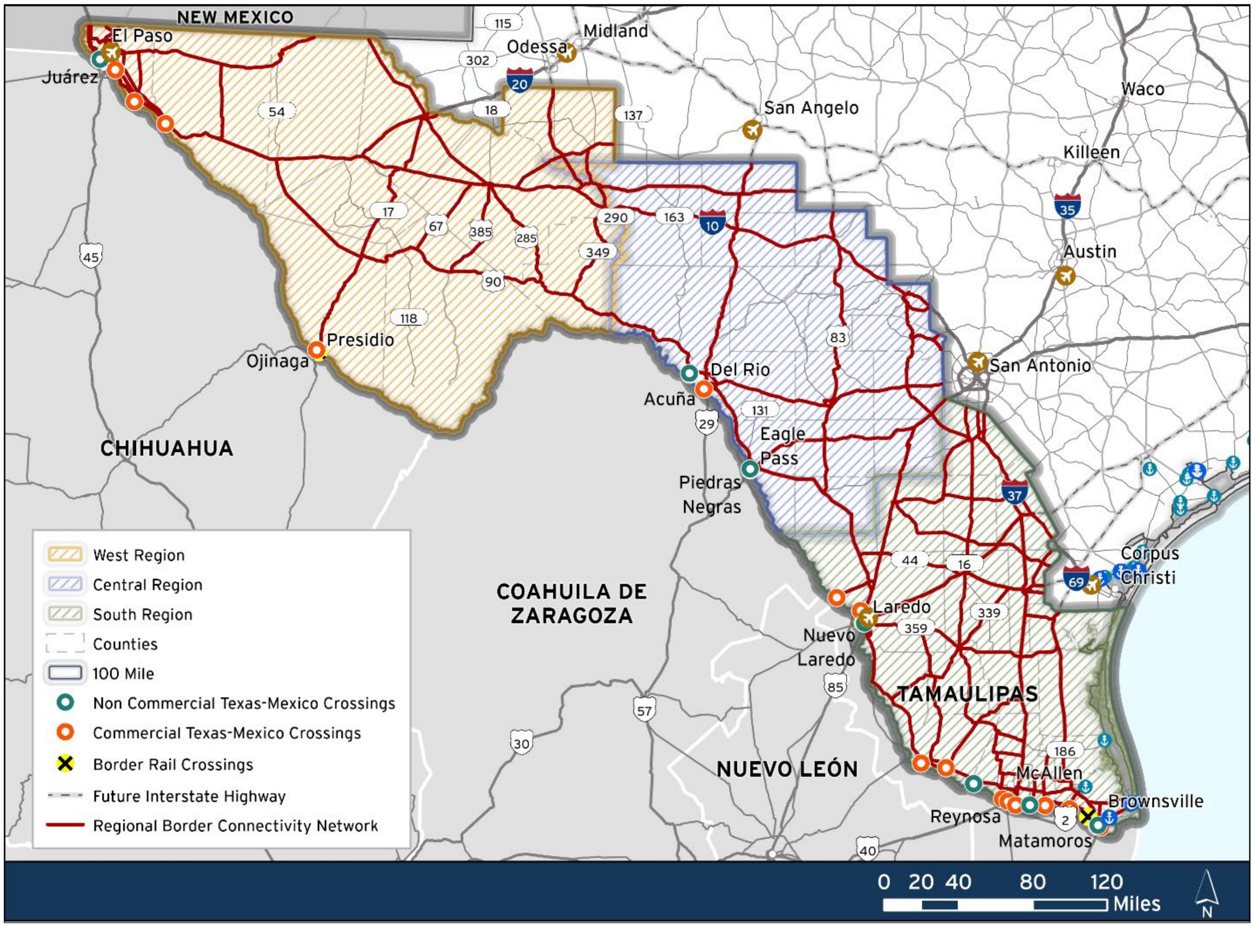
The process of identifying the border region consisted of two separate phases: one that was data-driven and another that was informed by stakeholders. This collaboration helped to refine and adjust the network to better reflect real-world conditions, ensuring that the final delineation is both accurate and relevant to the needs in the border region.

The network was developed and scored based on two high-level themes: the movement of people and goods, and market access and connectivity.

The second phase involved collaborative engagement with TxDOT districts, specifically the El Paso, Laredo, and Pharr districts. Stakeholder feedback was instrumental in refining the initial network draft. Discussions incorporated input on future plans and projects, such as US 67, Port-to-Plains Segment 3, and the I-10 Corridor Studies, considering alignment with regional development priorities and infrastructure goals.

The process resulted in a finalized network (**Figure 2**) spanning 4,958 miles. This extensive coverage ensures comprehensive transportation accessibility and efficiency, connecting all 43 counties within the study area, where 1,639 miles of the network are in the West region, 1,232 miles in the Central region, and 2,088 miles in the South region. The resulting network, the RBCN, will be the focus of the rest of this study.

Figure 2: Regional Border Connectivity Network



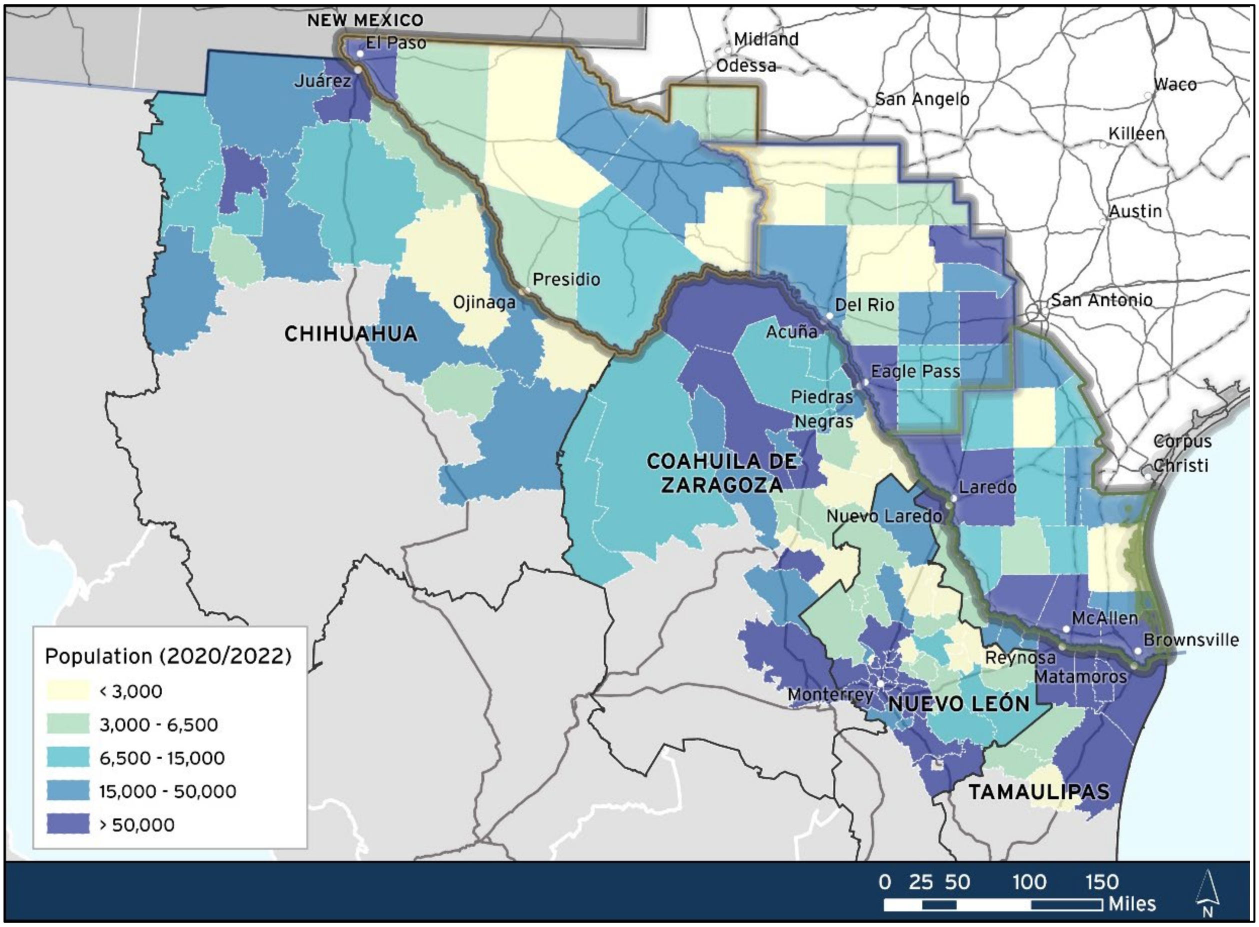
Demographic and Socioeconomic Profile

The following provides an overview of the existing conditions in the study area, focusing on vulnerabilities that could create barriers to transportation equality. The section focuses on the Texas side of the study area due to the abundance of readily available data and locations where infrastructure improvements would occur that would more-directly impact residents. Understanding existing conditions and burdens is important to developing equitable programs and projects that create the most benefits while minimizing and mitigating adverse impacts.

Population

The Texas-Mexico border, which spans over 1,200 miles, is a region of significant economic and cultural exchanges. The study area represents almost 200 cities and towns comprised of over 13 million people. **Figure 3** depicts the population within the counties and municipalities or second-level administrative divisions in Mexico (*municipios*) included in the study area, which reveals major population concentrations in El Paso/Juarez, Monterrey, and Brownsville/Matamoros. These three metropolitan areas make up 72% of the total population in the study area.

Figure 3: Study Area Population, 2020 Mexico & 2022 Texas



Source: Texas Demographic Center, Texas Population Projections 2020 to 2060, 1.0 Migration Scenario; INEGI Principales resultados por localidad (ITER) del Censo de Población y Vivienda 2020

Table 2 presents population distribution by region/state, revealing that nearly half of the residents in the study area reside in Nuevo León. Most of this population is concentrated in the Monterrey metropolitan area, the second-largest metropolitan area in Mexico.

Table 2: Study Area Population, 2020 Mexico & 2022 Texas (in thousands)

Region	Population	% of Border Region
West	915.9	6.7%
Central	307.3	2.3%
South	1,823.0	13.4%
Texas Border Region	3,046.2	22.4%
Chihuahua	1,820.7	13.4%
Coahuila	1,055.4	7.8%
Nuevo Leon	5,665.8	41.7%
Tamaulipas	1994.6	14.7%
Mexico Border Region	10,536.5	77.6%
Border Region Total	13,582.7	100%

NOTE: Discrepancies in the total are due to rounding. *Source: Texas Demographic Center, Texas Population Projections 2020 to 2060, 1.0 Migration Scenario; INEGI Principales resultados por localidad (ITER) del Censo de Población y Vivienda 2020*

High-Risk Populations

The US Census Bureau Community Resilience Estimates (CRE) data shows approximately 29% of residents in the study area in Texas are considered high-risk for social vulnerability and the impacts of disasters, exceeding the Statewide high-risk percentage of 22% (see **Table 3** and **Figure 4**). Investing in infrastructure improvements is crucial for improving the quality of life and economic opportunities for residents in these regions.

Using microdata from the American Community Survey (ACS), the CRE measures individuals within a given community using the following pre-selected risk component:

- Household Income-to-Poverty Ratio (total family income divided by the poverty threshold of less than 130%).
- Single or zero caregiver household with one or no individuals ages 18-64.
- Unit-level crowding (less than 0.75 persons per room).
- Communications barrier (limited English-speaking household or no one in the household over 16 with a high school diploma).
- No one in the household is employed full-time, year-round. (This is not applicable if all household residents are ages 65 years or older.)
- Disability posing constraints to daily activity. (People who report any one or more of the following six disability types: hearing, vision, cognitive, ambulatory, self-care or independent living difficulties.)

- No health insurance coverage.
- Ages 65 or older.
- Households without a vehicle.
- Households without broadband internet access.

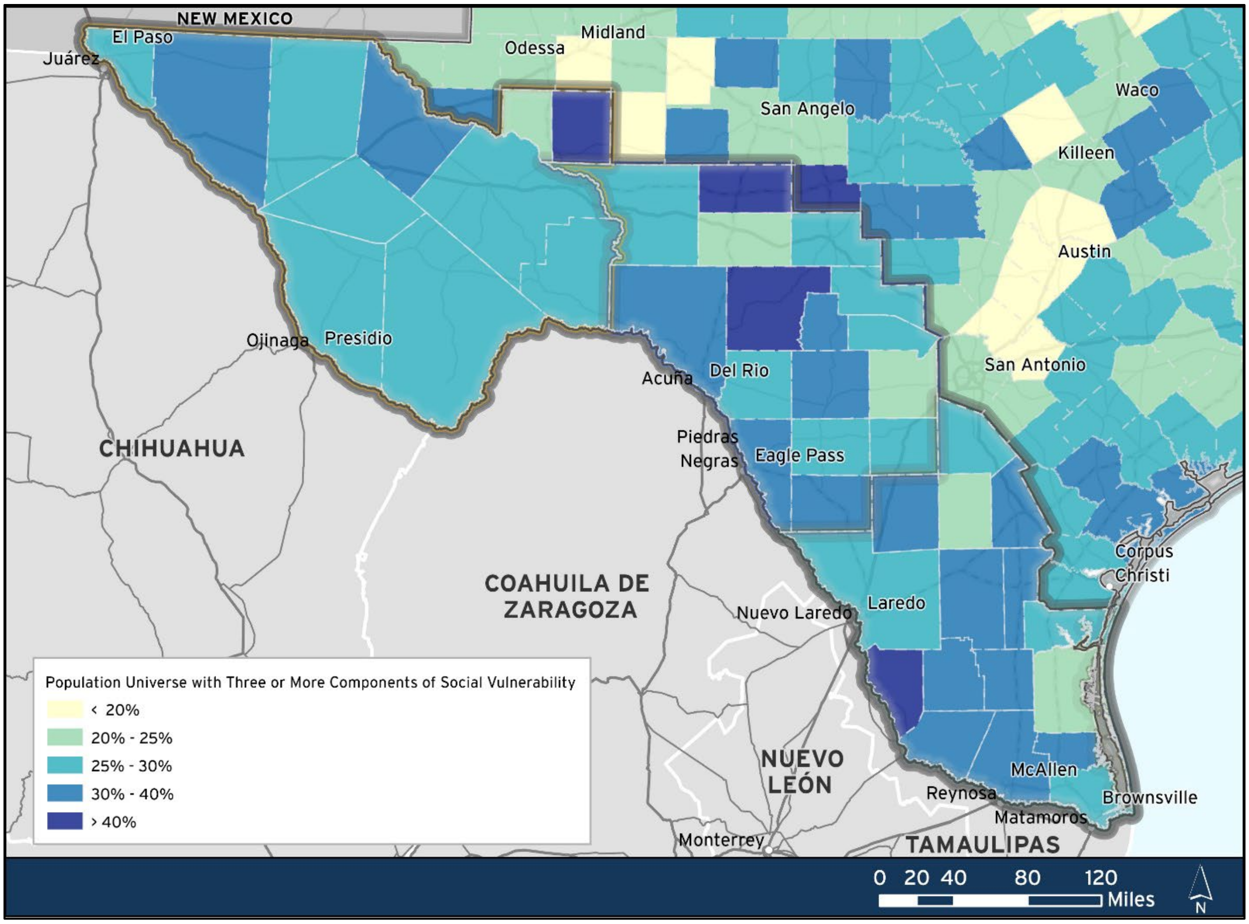
The CRE provides estimates of the total number of people living in a community by the number of components of social vulnerability. Each individual is assigned a 0 or 1 for each of the components based upon their individual or household attributes listed above. An individual will be assigned a 1 if either of the characteristics is true for their household. The result is an index that produces aggregate-level (tract, county, and state) small area estimates: the CRE.

The number of people with:

- 0 components of SV (Low)
- 1-2 components of SV (Medium)
- 3 or more components of SV (High)

Urban areas like El Paso and Laredo benefit from relatively well-developed infrastructure, including roads, schools, and healthcare facilities. However, rural areas often have needs for basic services. For instance, rural West Texas faces significant healthcare challenges due to a shortage of medical providers. Many communities are designated by the Texas Department of State Health Services as Health Professional Shortage Areas with over 3,500 patients per physician. Texas colonias are low-income communities of substandard housing developments that lack basic services located within 150 miles of the Texas-Mexico border. An estimated 500,000 people live in thousands of colonias along the Texas-Mexico border.

Figure 4: Rate of Population Universe with Three or More Components of Social Vulnerability, Texas Study Area 2022



Source: US Census Bureau 2022 CRE Data

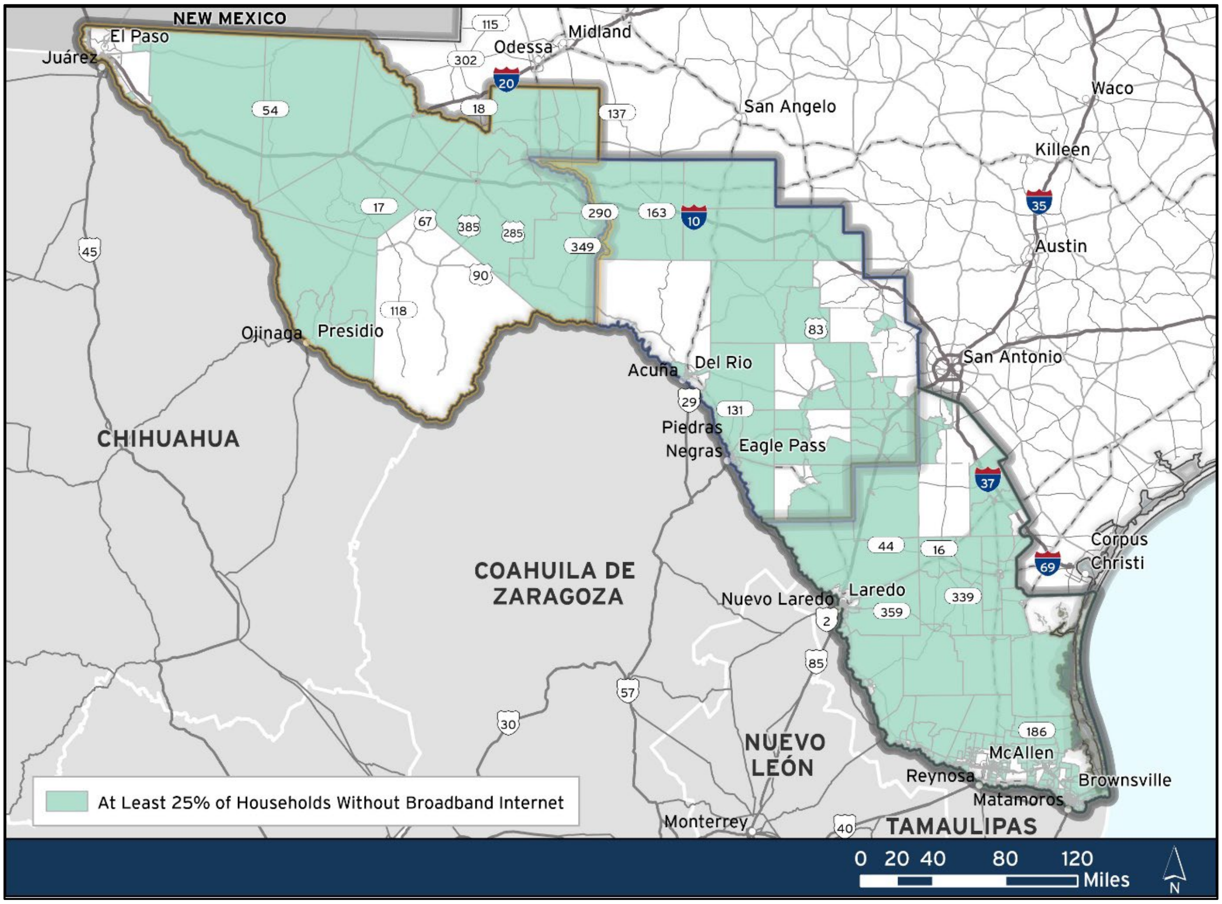
Table 3: High-Risk Populations, Texas Study Area 2022 (in thousands)

Region	Population	Estimated number of individuals with three or more components of social vulnerability	Percent individuals with three or more components of social vulnerability
West	915.9	249.0	27.2%
Central	307.3	88.7	29.0%
South	1,823.0	549.4	30.1%
Texas Border Region	3,046.2	887.1	29.1%
Texas	29,620.9	6,539.8	22.1%

NOTE: Discrepancies in the total are due to rounding. *Source: US Census Bureau 2022 CRE Data*

One of the CRE risks includes households with broadband internet access. As shown in **Figure 5**, broadband is not readily available in the counties in the study area. Lack of high-speed internet presents a barrier to accessing digital content and participation in the transportation planning process. Strategies for outreach to reach those without broadband is vital to ensure transportation equality.

Figure 5: 25% or More of Households Without Broadband Internet, Texas Study Area 2023



Source: USDOT Equitable Transportation Community (ETC) Explorer's Transportation Insecurity Analysis Tool (TIAT) Data at census tract level.

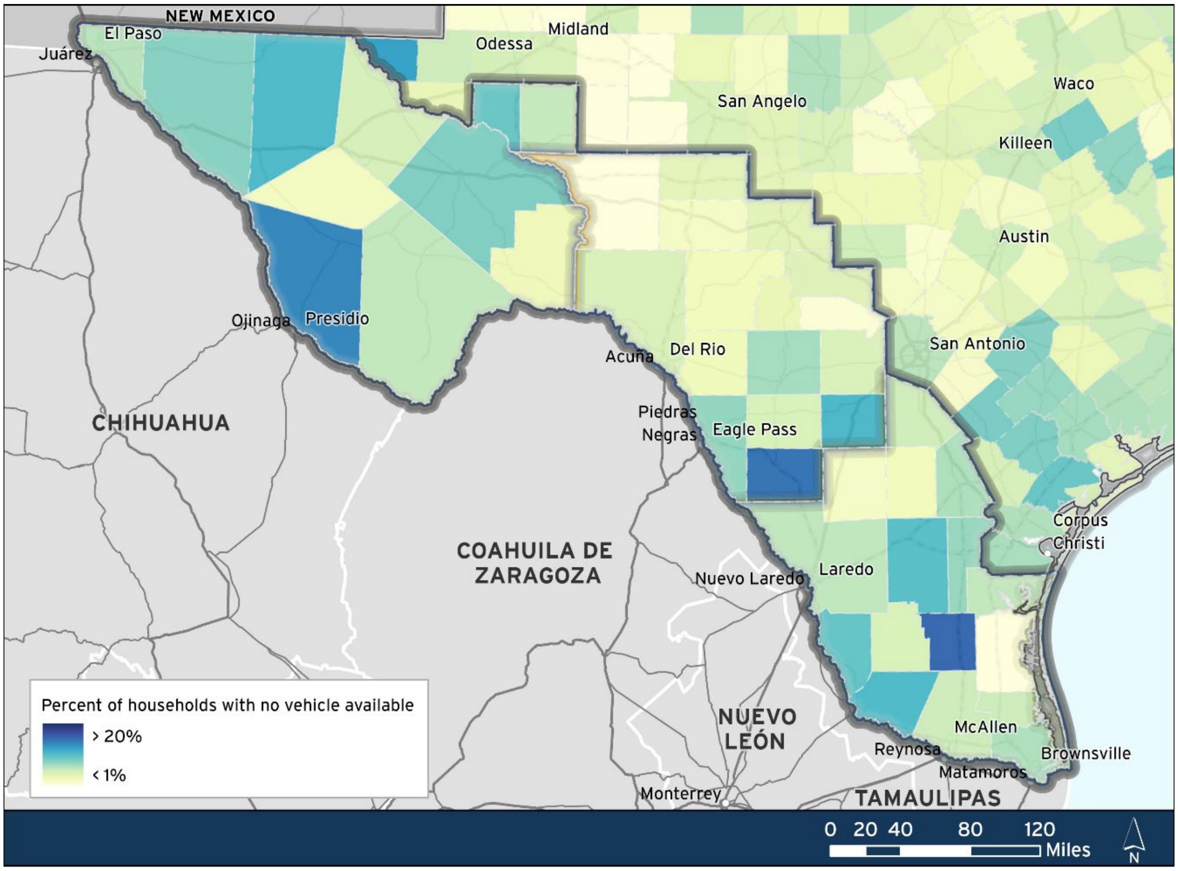
Commute to Work

Texas, including the study area, relies heavily on vehicles for several reasons. Outside of urban centers, vast distances necessitate driving. These significant distances are especially challenging for those with limited access to personal vehicles and for those who rely on a single roadway to connect with the rest of the transportation system. Even within urban areas, commutes often cover long distances. Moreover, public transportation options are limited. As a result, there are fewer zero car households and more individuals drove or carpooled to work compared to the rest of Texas and the nation (see **Table 4** and **Figure 6**).

Transportation expenditures for households with at least one vehicle are much higher than for households with no vehicles. According to the USDOT, in 2022, households with income lower than $25,000 who owned at least one vehicle spent 38% of their after-tax income on transportation; while households with the same income who did not own or lease a vehicle spent 5% of their after-tax income on transportation. People without access to a vehicle may be limited to jobs within walking distance or accessible by public transportation, limiting opportunities. Remote work is transforming the economy, allowing more individuals to avoid daily commutes, but driving continues to the primary mode of commuting to work.

Commuting times in the border region reflect the infrastructural challenges and the impact on the daily lives of residents (see **Table 4**). The Texas-Mexico border crossings experience significant delays, which affect both personal and commercial travel. The number of people crossing the border is expected to grow, intensifying the pressure on border infrastructure, and increasing commute times. By 2050, the delay for people crossing into the U.S. is forecast to exceed 202 million person-hours annually.

Figure 6: Percentage of Households with No Vehicles, Texas Study Area 2022



Source: ACS, Vehicle Availability Variables (2022 5 Year Estimates)

Table 4: Commute to Work, Texas Study Area 2022 (in thousands)

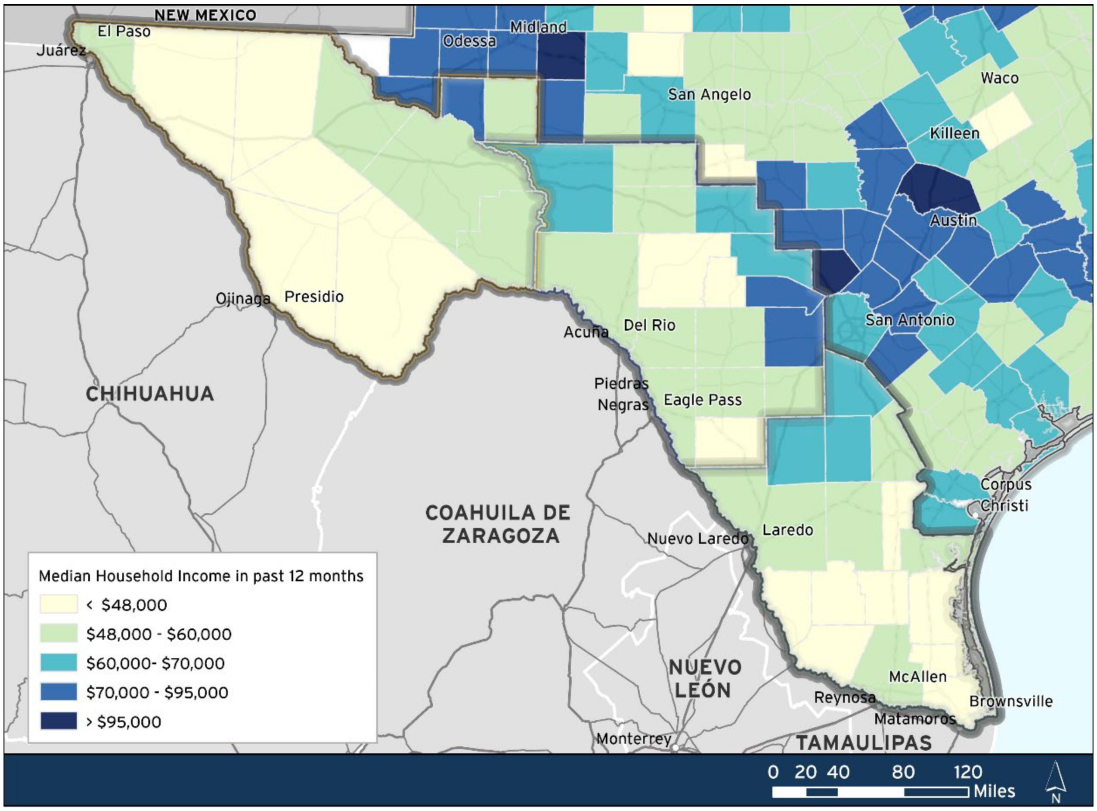
Region	Workers 16 Years and Older	Car, truck, or van		Worked from home	Mean travel time to work (minutes) (range depending on county)	Zero Vehicle Households
		Drove alone	Carpooled			
West	403.5	78.1%	11.0%	6.6%	8-28.1	2.0%
Central	128.4	78.5%	11.3%	6.2%	7.9-38.7	1.6%
South	709.4	77.9%	10.3%	7.2%	13.1-33.2	2.0%
Texas Border Region	1,241.2	76.2%	10.6%	6.5%	8-38.7	1.8%
Texas	13,755.4	75.1%	9.7%	11.0%	26.6	2.3%
USA	156,703.6	71.7%	8.5%	11.7%	26.7	4.3%

NOTE: Discrepancies in the total are due to rounding. *Source: US Census Bureau Table S0801 Commuting Characteristics by Sex (ACS 2022 – 5 Year Estimates)*

Poverty and Income

The median household income in Texas in 2022 According to the US Census Bureau ACS data is $73,035. Virtually every county in the study area in Texas have median household incomes below the state median, as shown in **Figure 7**. While the study area generally enjoys a lower cost of living compared to other metropolitan regions of the state, this does not fully account for the disparity in incomes as the poverty rates are also higher compared to Texas as a whole as described herein.

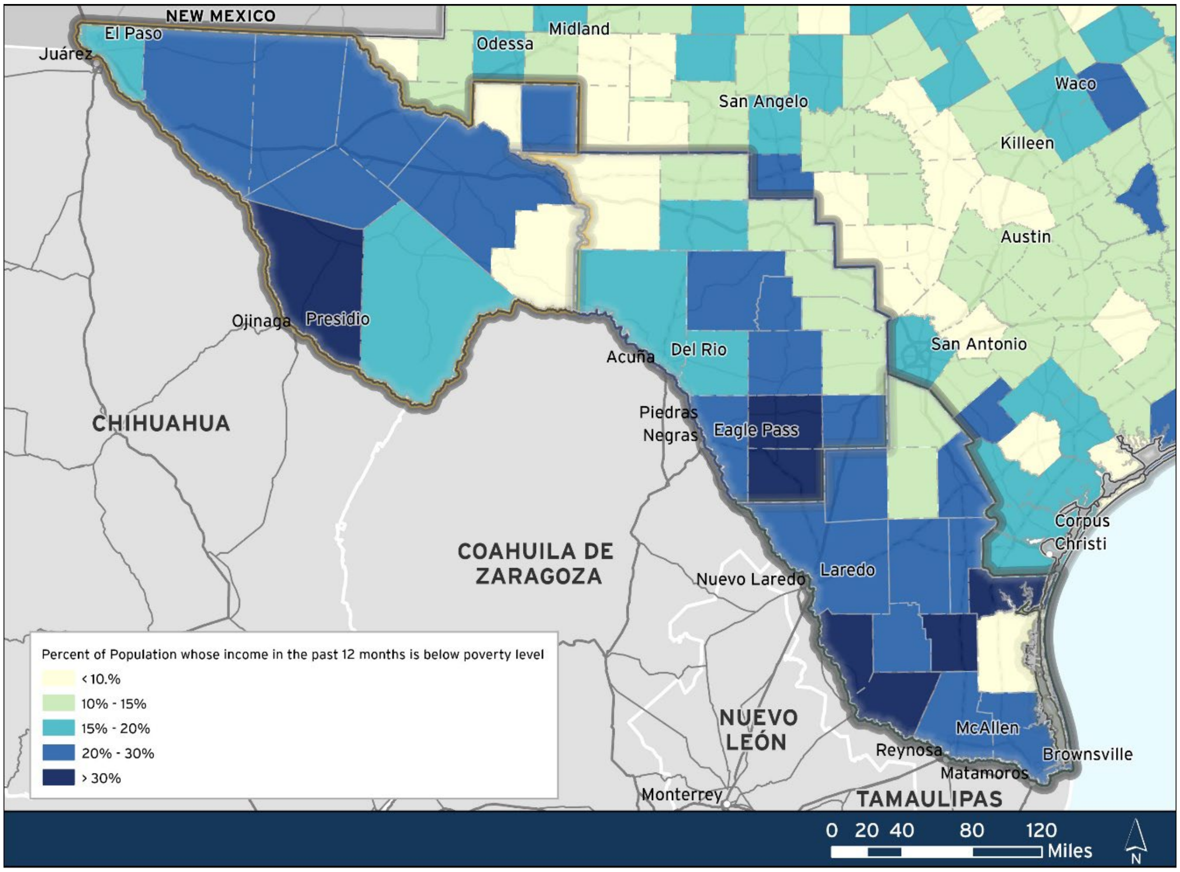
Figure 7: Median Household Income, Texas Study Area 2022



Source: US Census Bureau Table 19013 Median household income in the past 12 months (in 2022 inflation-adjusted dollars) (2022 ACS 5 Year Estimates)

Poverty rates are higher in the Texas border region counties than in the rest of the state (see **Figure 8** and **Table 5**)**.** Despite economic growth and wage increases over recent decades, a substantial portion of the population remains under the poverty line. In 2022, approximately a quarter (25%) of Texas households along the border lived in poverty, compared to 13% of households nationally.

Figure 8: Poverty Status, Texas Study Area 2022



Source: US Census Bureau Table S1701 Poverty Status in the Past 12 Months (ACS 2022 – 5 Year Estimates)

Table 5: Poverty Status, Texas Study Area 2022 (in thousands)

Region	Total Population	Estimate Below Poverty Level	Percent Below Poverty Level
West	906.1	177.8	19.6%
Central	300.9	54.0	17.9%
South	1,798.2	467.7	26.0%
Texas Border Region	3,005.1	699.5	23.3%
Texas	29,416.7	4,113.6	14.0
USA	325,521.5	40,951.6	12.6%

NOTE: Discrepancies in the total are due to rounding. *Source: US Census Bureau Table S1701 Poverty Status in the Past 12 Months (ACS 2022 – 5 Year Estimates)*

Improving transportation infrastructure can help boost job creation and economic development in these regions. Enhanced transportation networks facilitate easier access to job opportunities. Transportation projects provide immediate employment as well.

Minority Populations

The counties along the Texas-Mexico border are home to a predominantly Hispanic or Latino population, reflecting the cultural and historical ties between Texas and Mexico as shown in **Table 6**. The Kickapoo Traditional Tribe of Texas, the Ysleta Del Sur Pueblo, and the Lipan Apache are significant Native American communities with historical and contemporary ties to the Texas-Mexico border region.

The Kickapoo Traditional Tribe of Texas, based in Maverick County and originating from the Great Lakes, resides primarily in Eagle Pass. The tribe maintains cultural practices and a binational presence, with members frequently traveling between Texas and Mexico.

The Ysleta Del Sur Pueblo, or Tigua, tribe is in El Paso County and descends from the Pueblo peoples displaced from New Mexico in 1680. They were recognized as a Texas Native American tribe in 1967 and regained federal recognition in 1987. The tribe continues to preserve its cultural heritage and operates various cultural and economic initiatives to support its community.

The Lipan Apache, historically present along the Rio Grande, are known for their nomadic lifestyle and traditional hunting practices. Although not federally recognized, they have state recognition and continue to advocate for their cultural preservation and federal acknowledgment. The tribe organizes cultural events and maintains social and political organizations.

Racial and ethnic minorities are considered historically underserved as they have a history of being discriminated against or denied access. Achieving transportation fairness requires careful consideration of these populations.

Table 6: Minority Race and Ethnicity, Texas Study Area 2020 (in thousands)

Region	Total Population (includes White alone)	Hispanic or Latino	Not Hispanic or Latino					
			Black or African American alone	American Indian and Alaska Native alone	Asian alone	Native Hawaiian and Other Pacific Islander alone	Some Other Race alone	Population of two or more races:
West	927.4	81.7%	2.7%	0.3%	1.2%	0.2%	0.3%	1.2%
Central	311.4	62.1%	1.2%	0.5%	0.6%	0.1%	0.3%	1.6%
South	1,818.5	90.1%	0.4%	0.1%	0.8%	0.0%	0.2%	0.5%
Texas Border Region	3,057.3	84.7%	1.2%	0.2%	0.9%	0.1%	0.2%	0.8%
Texas	29,145.5	39.3%	11.8%	0.3%	5.4%	0.1%	0.4%	3.0%
US	331,449.3	18.7%	12.1%	0.7%	5.9%	0.2%	0.5%	4.1%

NOTE: Discrepancies in the total are due to rounding. *Source: US Census Bureau Table P9 (Decennial Census 2020).*

English Proficiency

English proficiency is a critical factor in accessing various services and opportunities, including employment, education, and healthcare. In border regions, where bilingualism is common, English proficiency can still pose challenges for residents, especially recent immigrants and older adults. Limited English proficiency (LEP) poses a barrier to access and faireness and has been correlated with lower educational attainment and income levels. LEP individuals in the study area are primarily Spanish speakers. The percentage of LEP persons in the study area is twice that of Texas. Ensuring language access in transportation planning is a critical component of developing projects that reflect the community needs. See **Table 7**.

Table 7: Languages Spoken at Home and LEP, Texas Study Area 2022 (in thousands)

Region	Population	Languages Spoken at Home				Limited English Proficiency Speakers
		Spanish	Other Indo-European languages	Asian and Pacific Islander languages	Other languages	
West	861.2	66.1%	0.8%	0.9%	0.3%	27.8%
Central	292.5	45.5%	0.4%	0.2%	0.4%	15.9%
South	1,677.9	76.1%	0.3%	0.5%	0.1%	28.3%
Texas Border Region	2,831.6	69.9%	0.5%	0.6%	0.2%	26.9%
Texas	27,319.9	28.5%	2.4%	3.1%	1.1%	13.0%
USA	312,092.7	13.3%	3.7%	3.5%	1.2%	8.2%

NOTE: Discrepancies in the total are due to rounding. *Source: US Census Bureau Table DP02 Selected Characteristics in the United States: Languages Spoken at Home for the Population Aged 5 and Over (ACS 2022 – 5 Year Estimates)*

Employment

The border region represents roughly 8% of Texas's total employment (**Table 8**). Employment hubs are concentrated around the high population centers depicted in **Figure 3**. The number of jobs in the Texas region has been steadily increasing for over a decade, with an additional 81,500 jobs between 2010 and 2021 (**Table 9**). This growth has been concentrated in the South region of the study area (**Figure 9**), which accounted for 74,000 of the new jobs in this period and makes up over half of total employment in the region.

Table 8: Study Area Employment for All Industries by Region, Texas Study Area 2022 (in thousands)

Region	Employment	% of Border Region	% of Texas/Mexico
West	480	32.0%	3.0%
Central	160	11.0%	1.0%
South	840	57.0%	5.0%
Texas Border Region	1,480	32.0%	8.0%

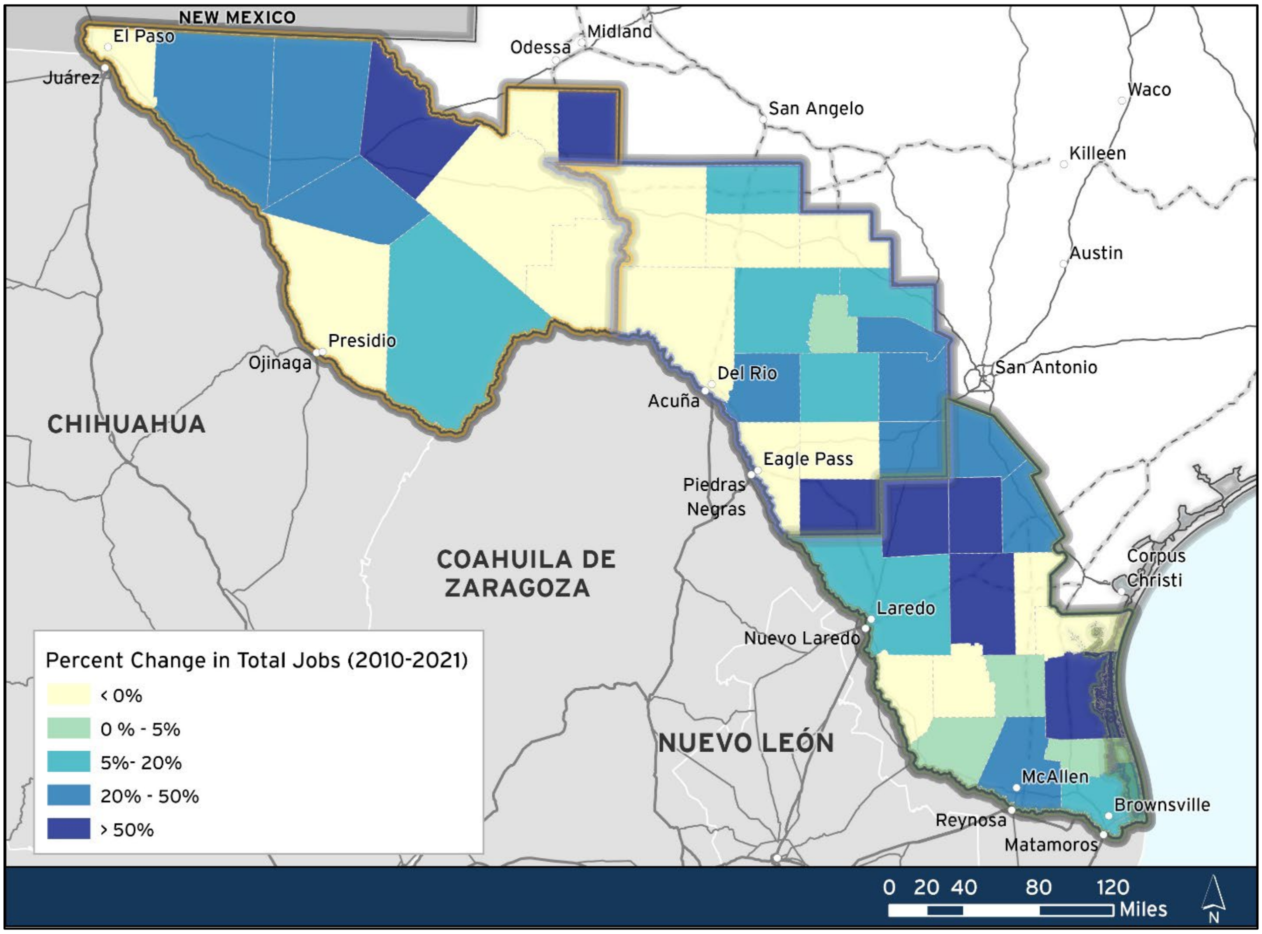
NOTE: Discrepancies in the total are due to rounding. *Source: U.S. Census Bureau. LEHD Origin-Destination Employment Statistics (2022)*

Table 9: Change in Total Jobs, Texas Study Area 2010 – 2021 (thousands)

Region	Total Jobs 2010	Total Jobs 2019	Total Jobs 2021	Change in Jobs (2010-2021)	% Change (2010-2021)
South	484.4	570.1	558.5	74.1	15.3%
Central	80.3	92.9	85.2	4.8	6.0%
West	335.9	345.5	338.4	2.5	0.7%
Study Area	900.6	1,008.5	982.1	81.5	9.0%
Texas	10,152.4	12,433.1	12,222.0	2,069.6	20.4%

NOTE: Discrepancies in the total are due to rounding. *Source: U.S. Census Bureau. LEHD Origin-Destination Employment Statistics (2002-2021)* **NOTE:** Discrepancies in the total are due to rounding errors.

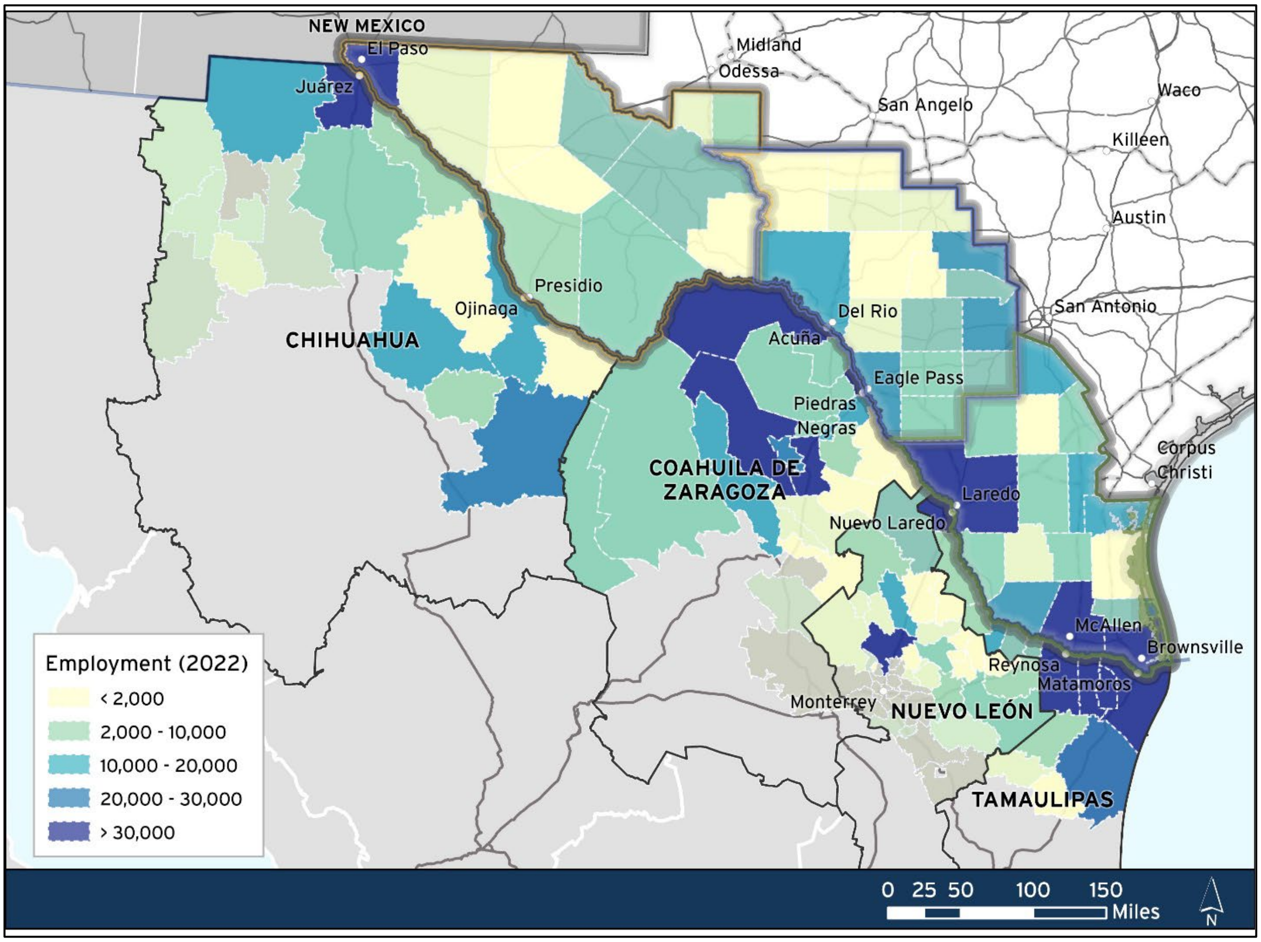
Figure 9: Change in Employment, Texas Study Area 2010 - 2021



Source: U.S. Census Bureau. LEHD Origin-Destination Employment Statistics (2002-2021)

The West, Central, and South regions make up 35% of total employment in the study area. Along the border, major employment centers in Texas are mirrored by high employment in Mexico (e.g. El Paso/Juarez, Laredo/Nuevo Laredo, McAllen/Reynosa, and Brownsville/Matamoros) (**Figure 10**). In addition to these areas, Coahuila's high employment region extends from the middle of the state up towards the border. Monterrey, Nuevo Leon is the only high-employment region that is not adjacent to the Texas-Mexico border.

Figure 10: Study Area Employment, 2020 Mexico and 2022 Texas



Source: Quarterly Census of Employment and Wages (QCEW) 2022 Q4; Labor Indicators for the Municipalities of Mexico (ILMM)

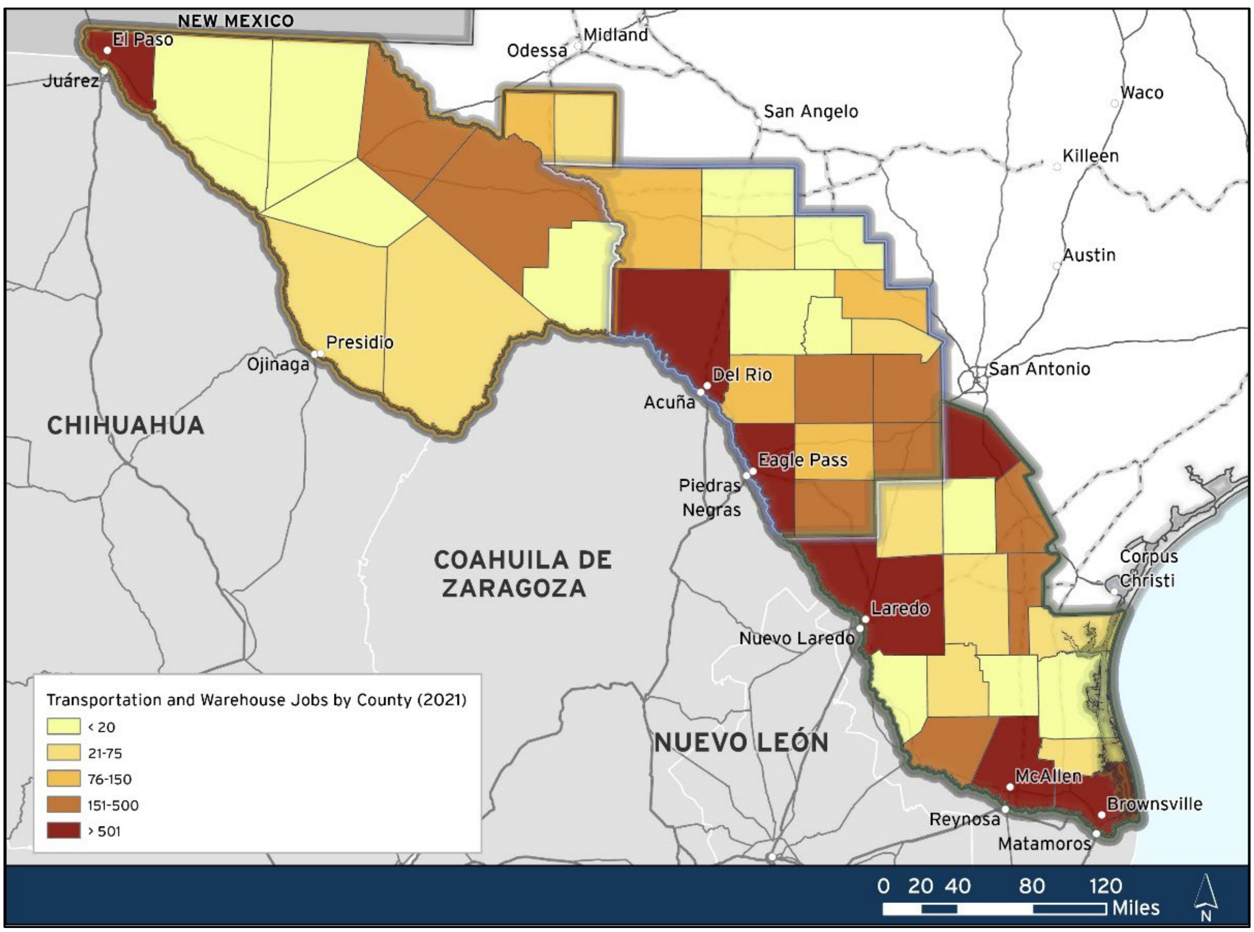
There are over 50,000 transportation and warehouse jobs in the Texas study area (**Table 10**), with most jobs in the Central region. The study area is the center of international trade between the U.S. and Mexico, and with transportation and warehouse growth focused along the border (**Figure 11**), the connection between the region and to other major road networks is imperative to maintain economic competitiveness.

Table 10: Change in Transportation/Warehouse Jobs, 2010-2021 (in thousands)

Region	Transportation Warehouse Jobs 2010	Transportation Warehouse Jobs 2019	Transportation Warehouse Jobs 2021	Change in Transportation Warehouse Jobs	Percent Change in Transportation Warehouse Jobs
South	23.4	30.3	30.4	6.9	29.6%
Central	2.1	3.5	3.1	1.0	48.4%
West	17.5	18.7	19.1	1.6	9.1%
Study Area	43.0	52.5	52.5	9.5	22.2%
Texas	382.8	530.7	570.3	187.6	49.0%

NOTE: Discrepancies in the total are due to rounding. *Source: U.S. Census Bureau. LEHD Origin-Destination Employment Statistics (2002-2021)*

Figure 11: Transportation & Warehouse Jobs, Texas Study Area 2021



Source: U.S. Census Bureau. LEHD Origin-Destination Employment Statistics (2002-2021)

Economic and Freight Profiles

Gross Domestic Product (GDP) Growth

Real gross domestic product (GDP) growth in the study area has outpaced Texas between 2017-2022, growing by 57.7% in 2024 dollars, while Texas's GDP grew by 44.1% (**Table 11**). The West region has been the driver of GDP growth within the study area. The West Region saw a 91.9% GDP increase in the five-year period, while both the South and Central regions saw GDP growth below the overall Texas growth rate. In Mexico, the four states within the study area saw a similar GDP growth of 52.1% and, like the Texas region, outpaced Mexico as a whole, which grew by 42.3%.

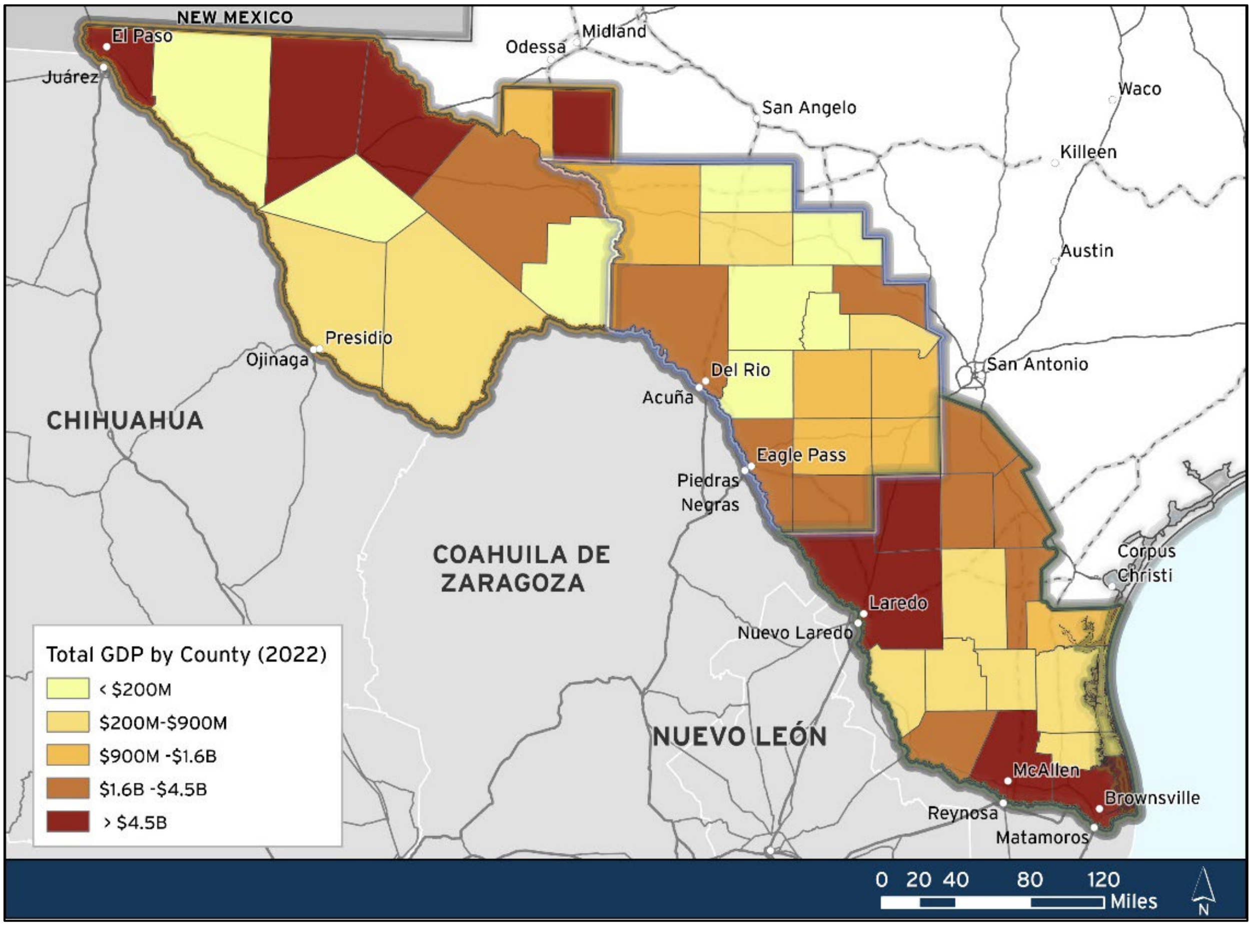
Table 11: Change in Total Gross Domestic Product, 2017-2022 (in billions USD)

Region	GDP 2017	GDP 2022	Change in GDP	Percent Change in GDP
South	57.6	79.8	22.2	38.5%
Central	14.1	18.6	4.5	32.0%
West	42.8	82.1	39.3	91.9%
Texas Border Region	114.5	180.5	66.0	57.7%
Texas	1,667.3	2,402.1	734.8	44.1%
Chihuahua	42.6	67.4	24.8	58.4%
Coahuila	46.7	69.2	22.5	48.3%
Nuevo Leon	93.9	141.9	48.0	51.1%
Tamaulipas	36.3	53.2	16.9	46.6%
Mexico Border States	219.5	331.8	112.3	52.1%
Mexico	1247.2	1774.3	28,205.6	42.3%

NOTE: Due to data availability, GDP for Chihuahua, Coahuila, Nuevo Leon, and Tamaulipas is for the whole state, including *municipios* that are excluded from the study area. 16.6 MXN/USD conversion factor used. *Source: U.S. Bureau of Economic Analysis, "CAGDP9 Real GDP by county and metropolitan area" and INEGI, "Producto Interno Bruto Por Entidad Federativa 2017" and "Producto Interno Bruto Por Entidad Federativa 2022."*

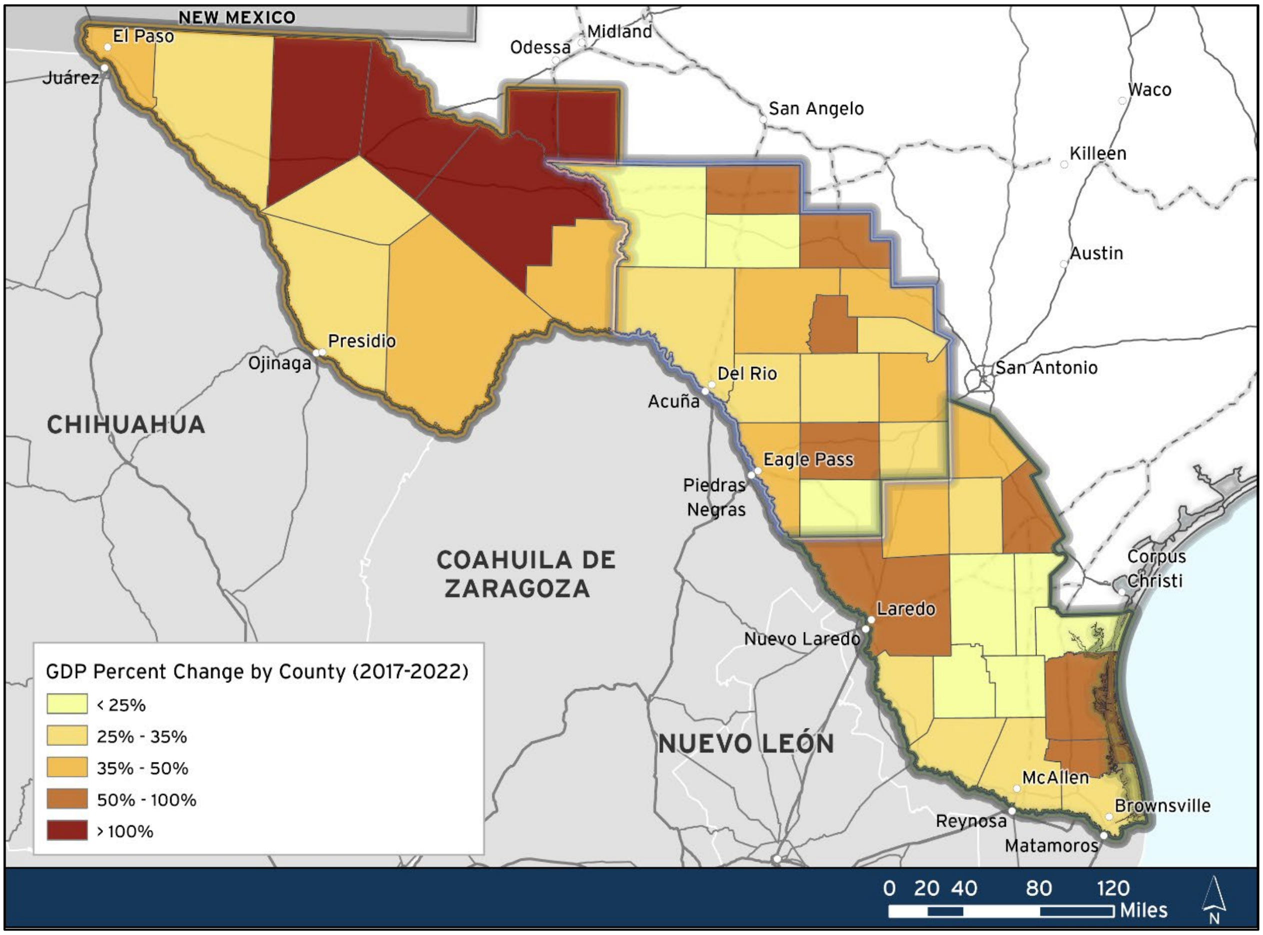
The Texas study area makes up over 7% of total Texas GDP, concentrated primarily in the West and South regions. The counties with the highest GDPs are spread throughout the region and positively correlated with high population counties (**Figure 12**). Conversely, GDP growth is concentrated in just one area, with the five fastest growing counties all in the West Region (**Figure 13**).

Figure 12: Total GDP by County, Texas Study Area 2022



Source: U.S. Bureau of Economic Analysis, "CAGDP9 Real GDP by county and metropolitan area"

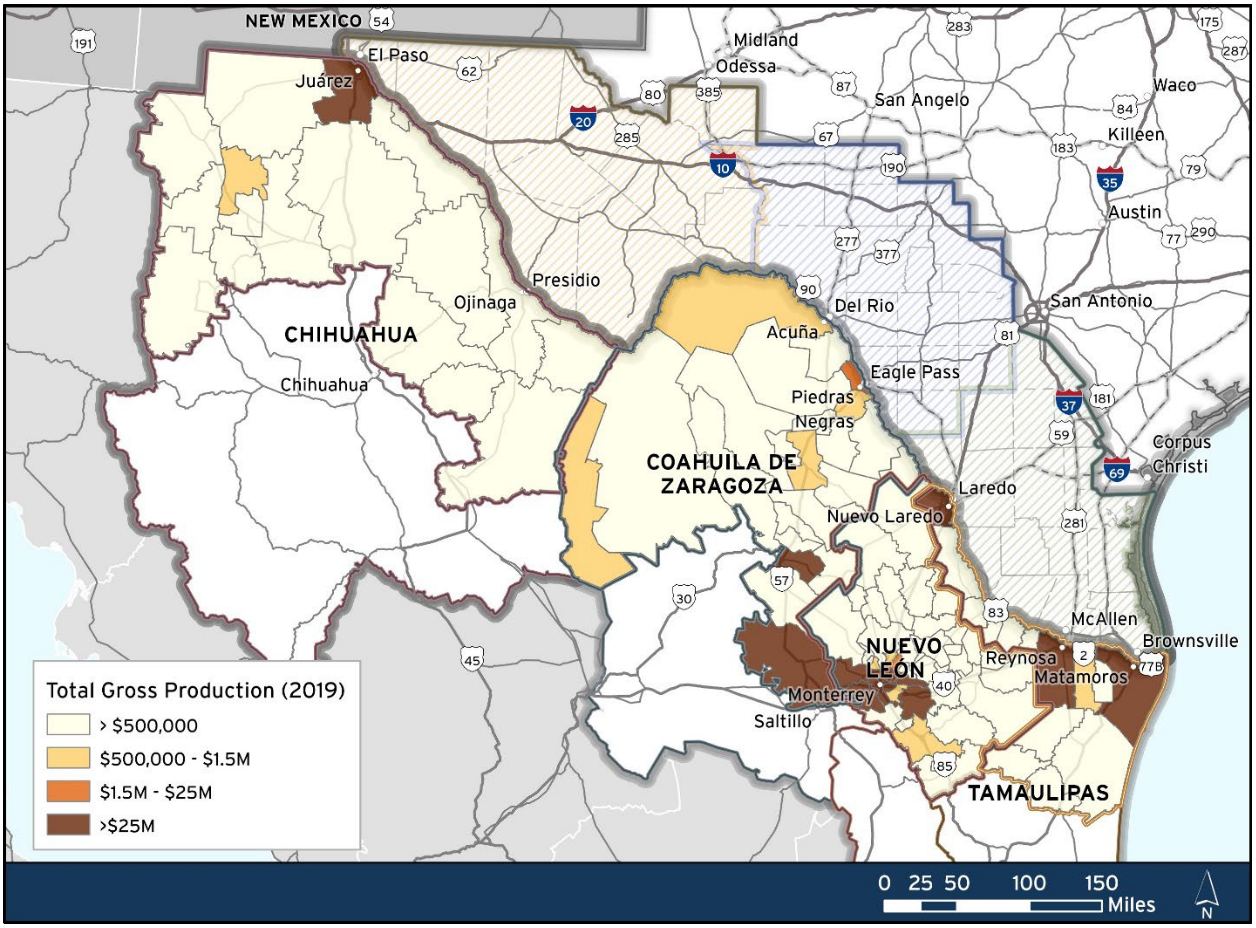
Figure 13: GDP Percent Change by County, Texas Study Area 2017 – 2022



Source: U.S. Bureau of Economic Analysis, "CAGDP9 Real GDP by county and metropolitan area"

The total gross production (TGP) in Mexico shows similar trends to that of Texas, with production concentrated around high urban areas and along the Texas-Mexico border (**Figure 14**).

Figure 14: Total Gross Production, Mexico Study Area 2019



Source: Mexico Economic Census, 2019. Unit Value US Dollars (16.6 pesos/dollar)

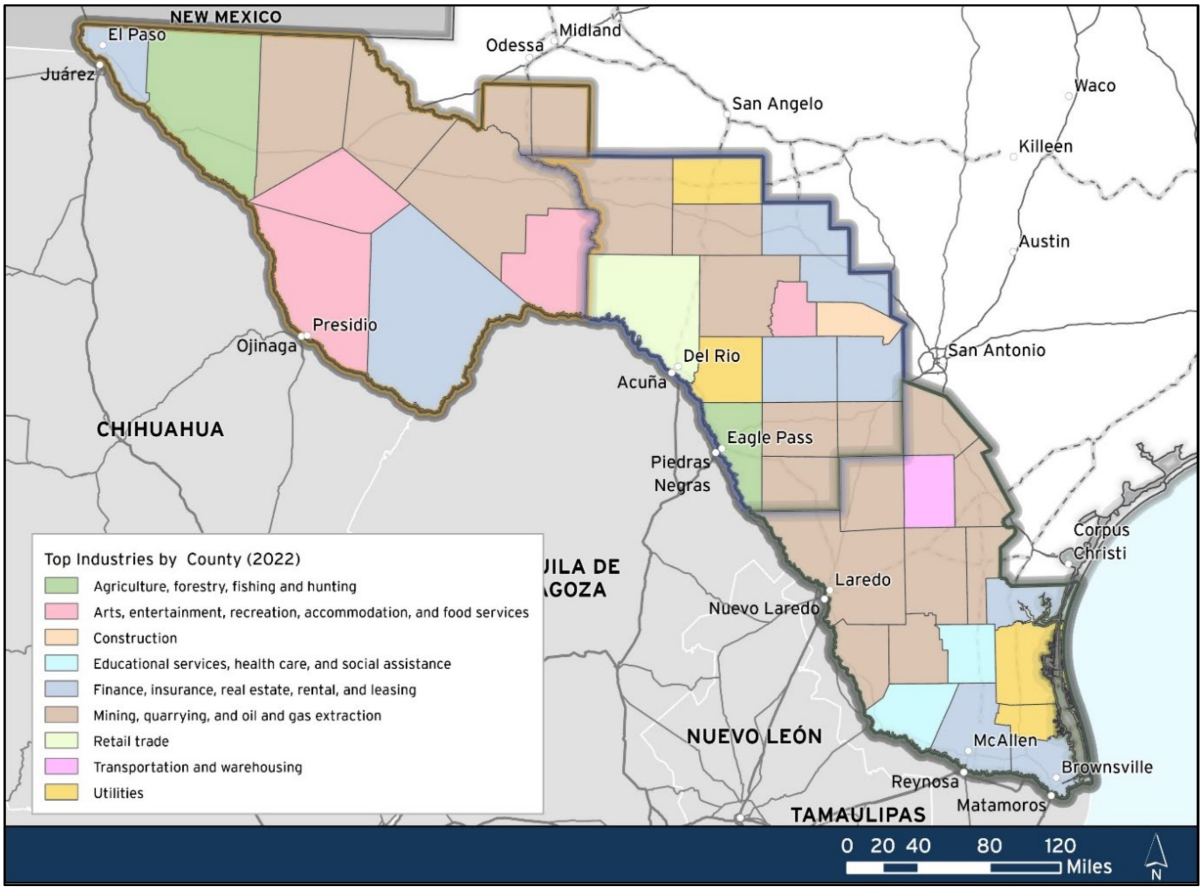
Table 12 shows GDP by industry throughout the Texas study area for the five most prevalent industries. Mining, quarrying, and oil and gas extraction is the largest industry across all regions. In addition to being the largest, mining, quarrying, and oil and gas extraction is the top industry by GDP in 19 counties, the most of any industry in the study area. Finance, insurance, real estate, rental, and leasing is the top industry in nine counties, the second most in the study area, and is concentrated in counties in or near a large urban area (**Figure 15**).

Table 12: GDP by Industry, Texas Study Area 2022 (in billions)

Industry	GDP 2022 in Study Area	GDP 2022 in South Region	GDP 2022 in West Region	GDP 2022 in Central Region
Mining, quarrying, and oil and gas extraction	56.9	15.5	35.1	6.3
Finance, insurance, real estate, rental, and leasing	18.5	9.9	7.2	1.5
Retail trade	11.6	6.5	3.9	1.2
Educational services, health care, and social assistance	11.6	7.6	3.1	0.9
Manufacturing	8.7	2.5	5.6	0.6

NOTE: Some county totals are not shown to avoid disclosure of confidential information; estimates are included in higher-level totals. *Source: U.S. Bureau of Economic Analysis, "CAGDP2 Gross domestic product (GDP) by county and metropolitan area"*

Figure 15: Largest Industries by GDP, Texas Study Area 2022



Source: U.S. Department of Commerce, Bureau of Economic Analysis, Gross Domestic Product by County and Metropolitan Area

In addition to being the top industry by GDP in the region, mining, quarrying, and oil and gas extraction is also the fastest growing industry between 2017 and 2022. As shown in **Table 13**, its GDP more than doubled in the 5-year timespan. Other growing industries in the region include utilities, manufacturing, transportation and warehousing, and professional and business services.

Table 13: Five Fastest Growing Industries, Texas Study Area 2017-2022 (in billions)

Industry	GDP 2017	GDP 2022	Change in GDP	Percent Change in GDP
Mining, quarrying, and oil and gas extraction	26.9	56.9	30.0	111.3%
Utilities	1.5	2.9	1.3	87.7%
Manufacturing	5.3	8.7	3.4	63.6%
Transportation and warehousing	4.8	7.8	3.0	63.4%
Professional and business services	5.3	8.1	2.8	52.6%

Source: U.S. Bureau of Economic Analysis, "CAGDP2 Gross domestic product (GDP) by county and metropolitan area"

This memo places a specific focus on the transportation and warehouse industry, the fourth fastest growing industry in Texas by GDP. Transportation and warehouse GDP growth in the study area outpaces that of Texas by almost 20%. **Table 14** details GDP growth of the transportation and warehouse industry in Texas, the study area, and each of the Texas regions within the study area.

Table 14: Transportation/Warehouse GDP Growth, Texas Study Area 2017-2022 (in billions)

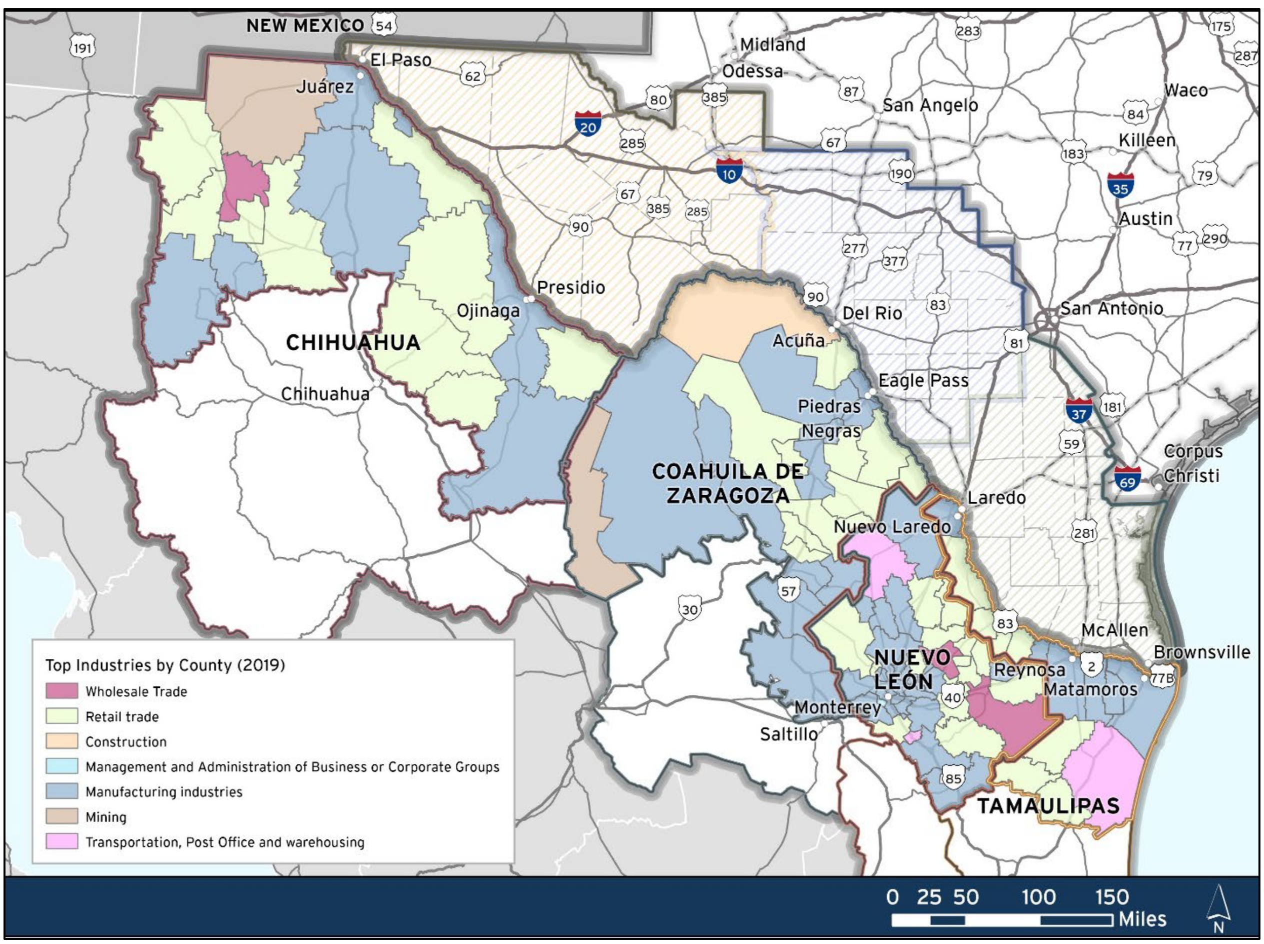
Region	GDP 2017	GDP 2022	Change in GDP	Percent Change in GDP
South	2.8	4.8	2.0	70.1%
Central	0.4	0.6	0.2	58.0%
West	1.5	2.3	0.8	50.6%
Study Area	4.8	7.8	3.0	62.8%
Texas	64.2	93.6	29.4	45.9%

NOTE: Some county totals are not shown to avoid disclosure of confidential information; estimates are included in higher-level totals. *Source: U.S. Bureau of Economic Analysis, "CAGDP2 Gross domestic product (GDP) by county and metropolitan area"*

In Mexico, the economic prowess of its border states shines through diverse sectors. Nuevo Leon leads nationally in secondary economic activities, producing 10.1% of the country's output, underscored by its robust manufacturing base, exceeding USD 80 Million gross production in 2019. It also ranks fourth in tertiary activities, contributing 7.2% to national production. Coahuila de Zaragoza follows closely, ranking third in secondary activities with 6.6%. Chihuahua stands out in both primary (6.6%, sixth nationally) and secondary activities (6.6%, seventh nationally). Tamaulipas, while ranking lower in secondary activities (11th nationally with 3.85), plays a crucial role in manufacturing and energy industries.

The manufacturing industry plays a pivotal role in border economies, it involves the transformation of material, assembly of parts, reconstruction of machinery, and the refinement of products through industrial processes, and it stands as the predominant industry in terms of total gross production, covering 49 out of the 99 counties in the study area, followed closely by retail trade with 40 counties. The counties where manufacturing is the leading industry are strategically located along key highways as seen in **Figure 16**, connecting urban areas to border regions. This position helps in efficient distribution and trade activities. The state of Nuevo Leon ranked highest in gross production within the manufacturing industry among all Mexican states.

Figure 16: Top Industries by County, Mexico Study Area 2019

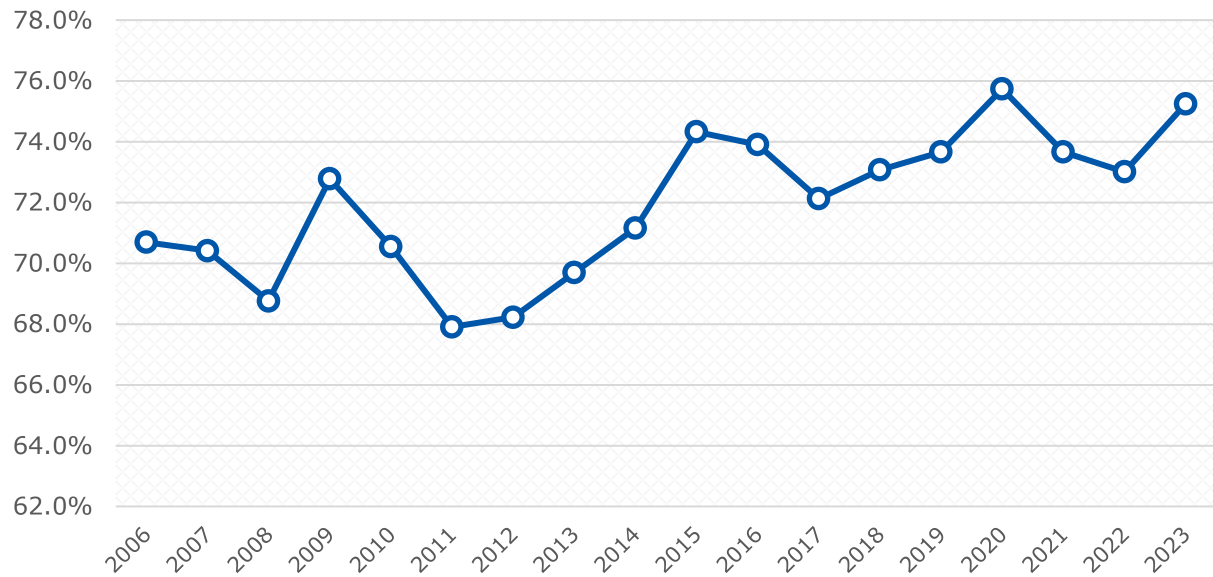


Source: Mexico Economic Census, 2019

Texas-Mexico Trade

The Bureau of Transportation Statistics (BTS) TransBorder Freight program reports that the value of Texas-Mexico trade has increased substantially over the years, increasing by 147.6% between 2006 and 2023. Texas is central to trade between the United States and Mexico, with over 70% of trade between the nations passing through the Texas border. Approximately 75% of trade (based on value) across the Texas-Mexico border was via freight truck in 2023, which is the highest reported ratio in the period between 2006-2023. **Figure 17** displays the percent of freight between Texas and Mexico transported via truck has remained steady in this almost 17-year period, staying between 67% and 76%, and continues to trend upwards.

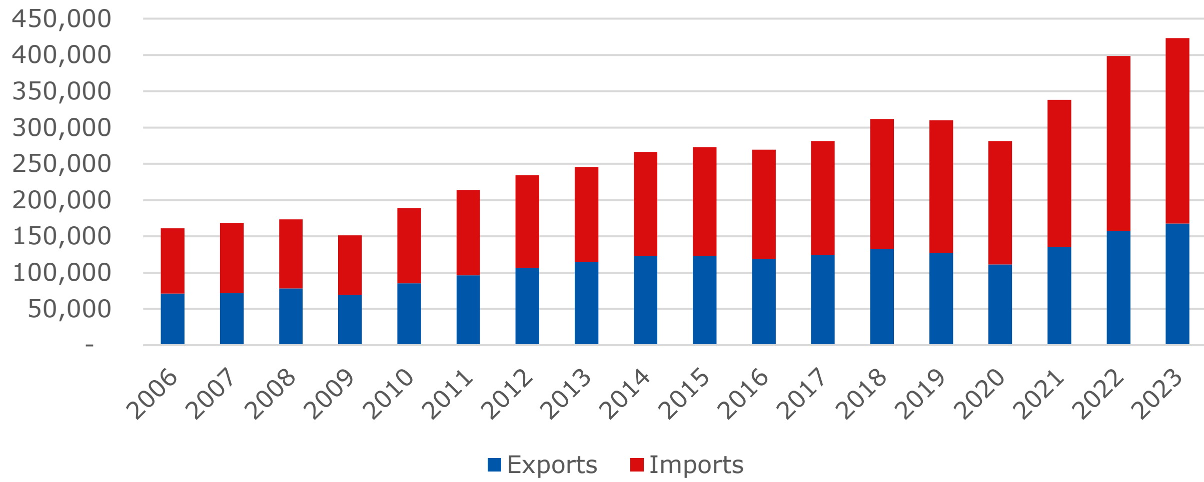
Figure 17: Percent of Texas-Mexico Freight Transported Via Truck



Source: The Bureau of Transportation Statistics (BTS) TransBorder Freight program

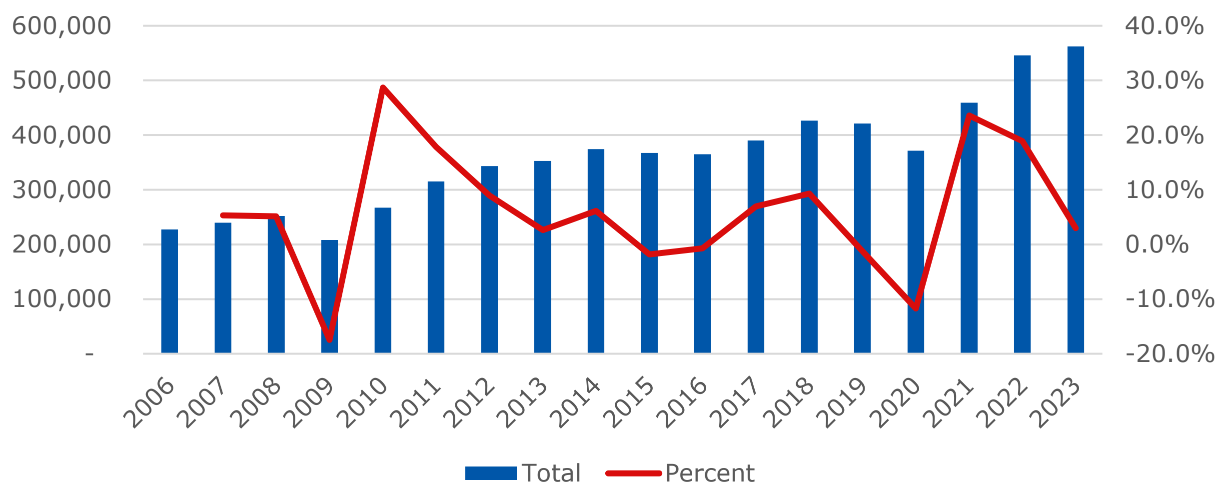
Figure 18 and **Figure 19** summarize the total value of goods traveling across the Texas-Mexico border between 2006 and 2023. In 2023, approximately 58% of the value of goods transported across the Texas-Mexico border were imports into the United States, while 42% were exports into Mexico. The balance of trade in 2006 was also approximately 42% exports and 58% imports along the Texas-Mexico border. Growth in trade between Texas and Mexico has remained positive for all but five years between 2006-2023. The only two years of significant decline (i.e., greater than 1%) were 2009 (Great Recession) and 2020 (Covid-19 Pandemic). The value of trade between Texas and Mexico has since recovered and is up 33.5% from 2019 numbers.

Figure 18: Texas-Mexico Truck Freight Flows by Exports & Imports Values (in Millions)



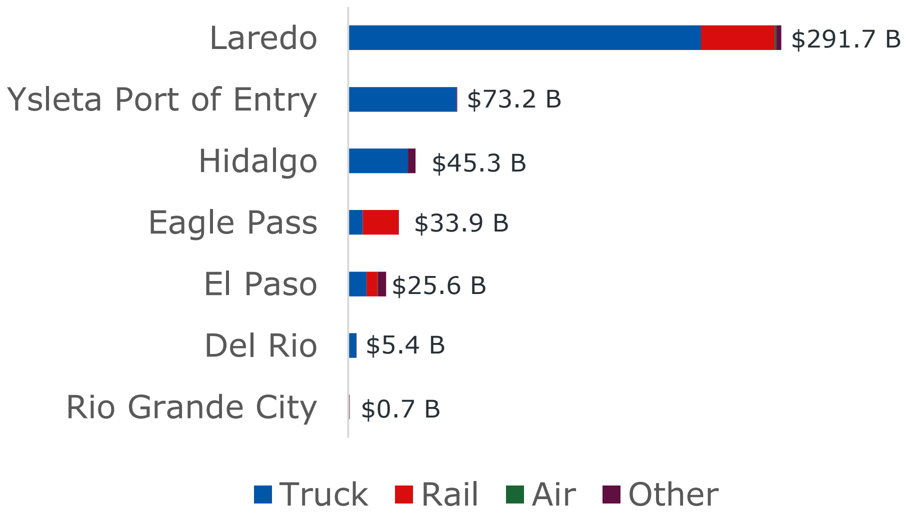
Source: The Bureau of Transportation Statistics (BTS) TransBorder Freight program

Figure 19: Total Texas-Mexico Freight Flows by Value (in Millions) & Yearly Percent Change



Source: The Bureau of Transportation Statistics (BTS) TransBorder Freight program

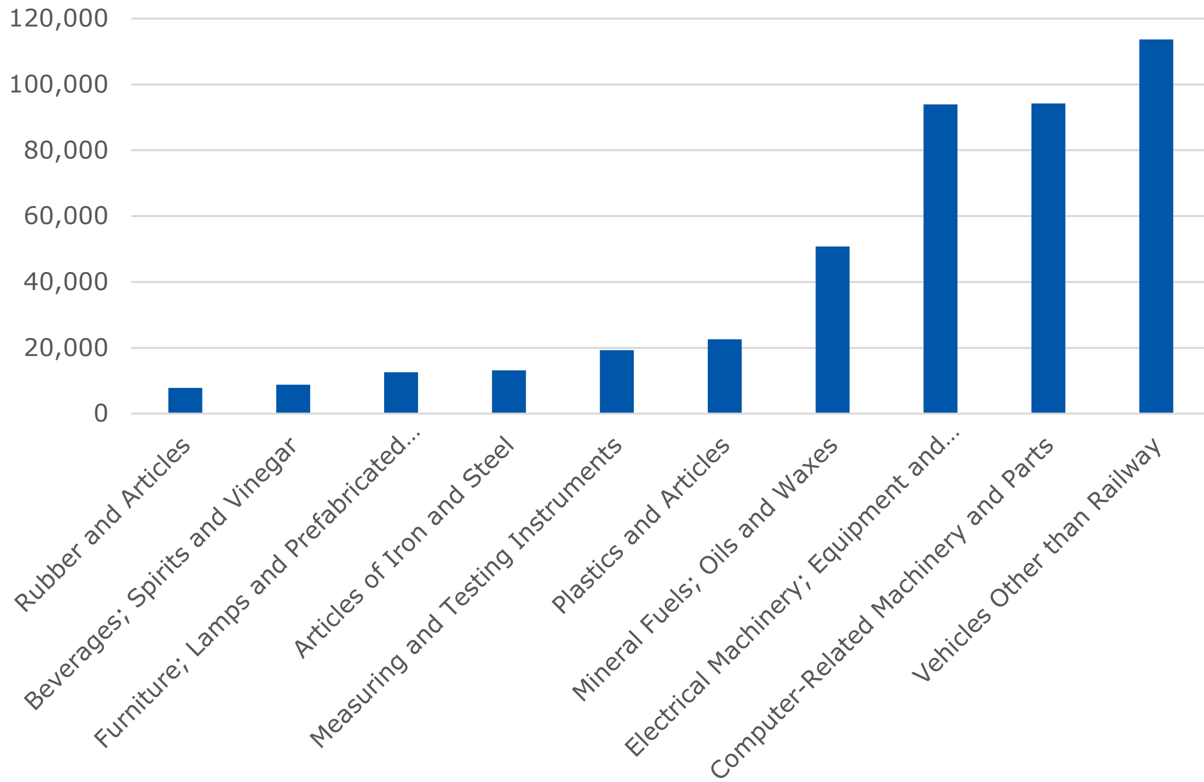
Figure 20. Port of Entry (POE) by Value and mode, 2022



Source: The Bureau of Transportation Statistics (BTS) TransBorder Freight program

Figure 21 displays the top commodities by value crossing the Texas-Mexico border. As seen in the graph, the top 3 commodities (i.e., electrical machinery, equipment and parts; computer-related machinery and parts; and vehicles other than railway) account for the majority of the value of commodities crossing the border. Vehicles other than railway was the largest commodity group by value traded across the Texas-Mexico border in 2023, at approximately $114 billion making up 20.2% of total trade between them. Vehicles other than railway is also reported to have the greatest growth in trade value of any of the top ten commodity groups from 2022-2023, increasing by 17.4%.

Figure 21: Top Commodities (by Values in Millions) Crossing Texas-Mexico Border, 2023



Source: The Bureau of Transportation Statistics (BTS) TransBorder Freight program

Transearch Freight Analysis of Texas Study Area

This section analyzes data collected in Transearch analyses conducted in 2019 and 2022. The Transearch analyses measured tonnage and value of commodities transported in the study area categorized by standard commodity code.

Note that Transearch data excludes fresh water, sand, and wastewater. In 2019, approximately 165 million tons of the three excluded commodities traveled by truck in the study area. The value of these three goods is marginal, making up approximately 0.2% of the total value of commodities transported via truck within the study are in 2019.

Table 15 shows that in 2022, 113.5 million tons of freight traveled by truck on roads within the study area. This is a slight decrease from the 118.9 million tons in 2019. While tons of commodities via freight truck have decreased during this period, the value of commodities via freight truck have increased during this time (see **Table 16**).

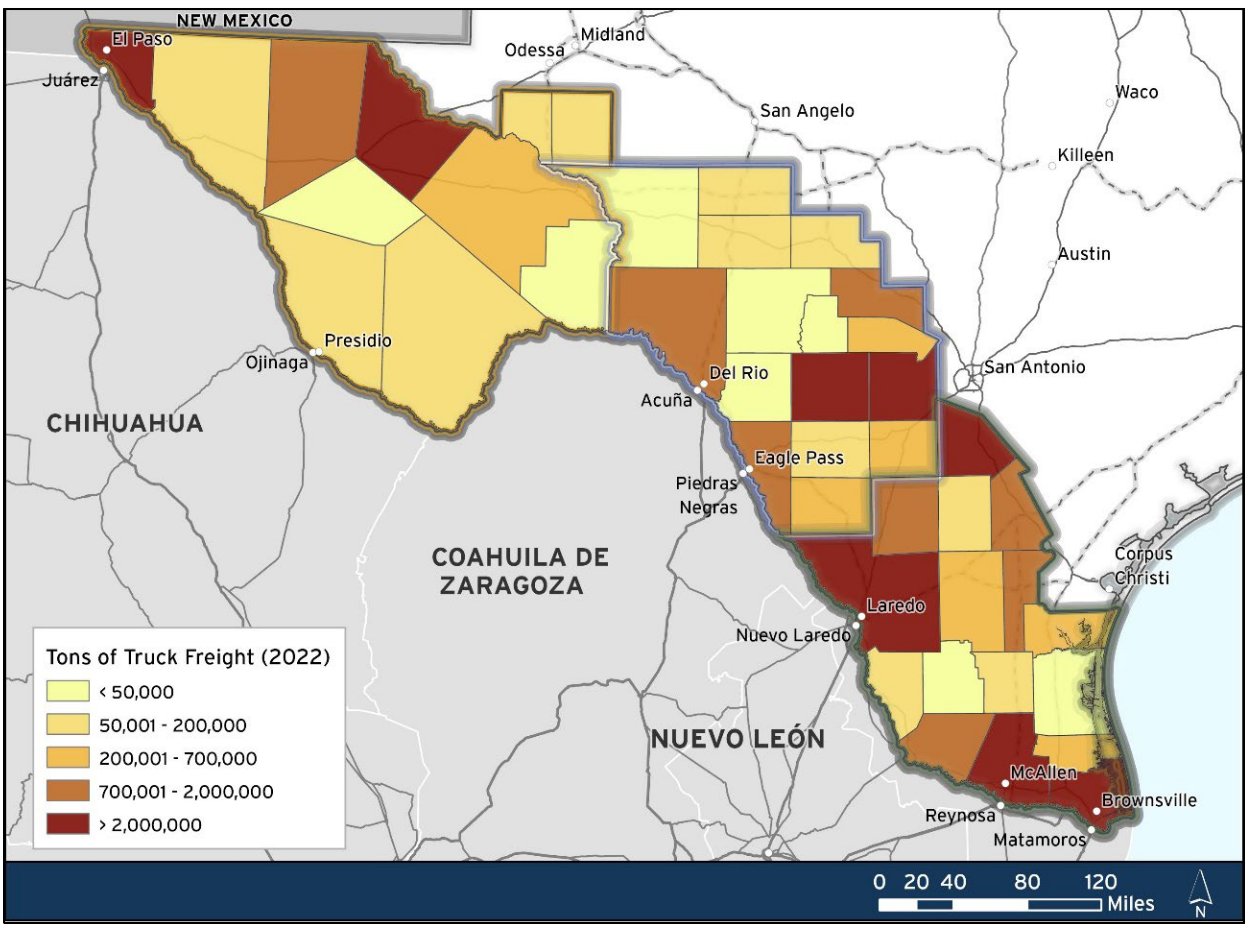
Table 15: Tons of Commodities via Freight Truck, Texas Study Area 2019-2022 (in millions)

Region	Tons of Commodities via Freight Truck 2019	Tons of Commodities via Freight Truck 2022	Absolute Change	Percent Change
South	70.9	70.4	-0.5	-0.7%
Central	20.0	16.2	-3.8	-19.1%
West	28.0	26.9	-1.1	-3.0%
Study Area	118.9	113.5	-5.4	-4.5%

Source: Analysis of Transearch Commodity Flow data

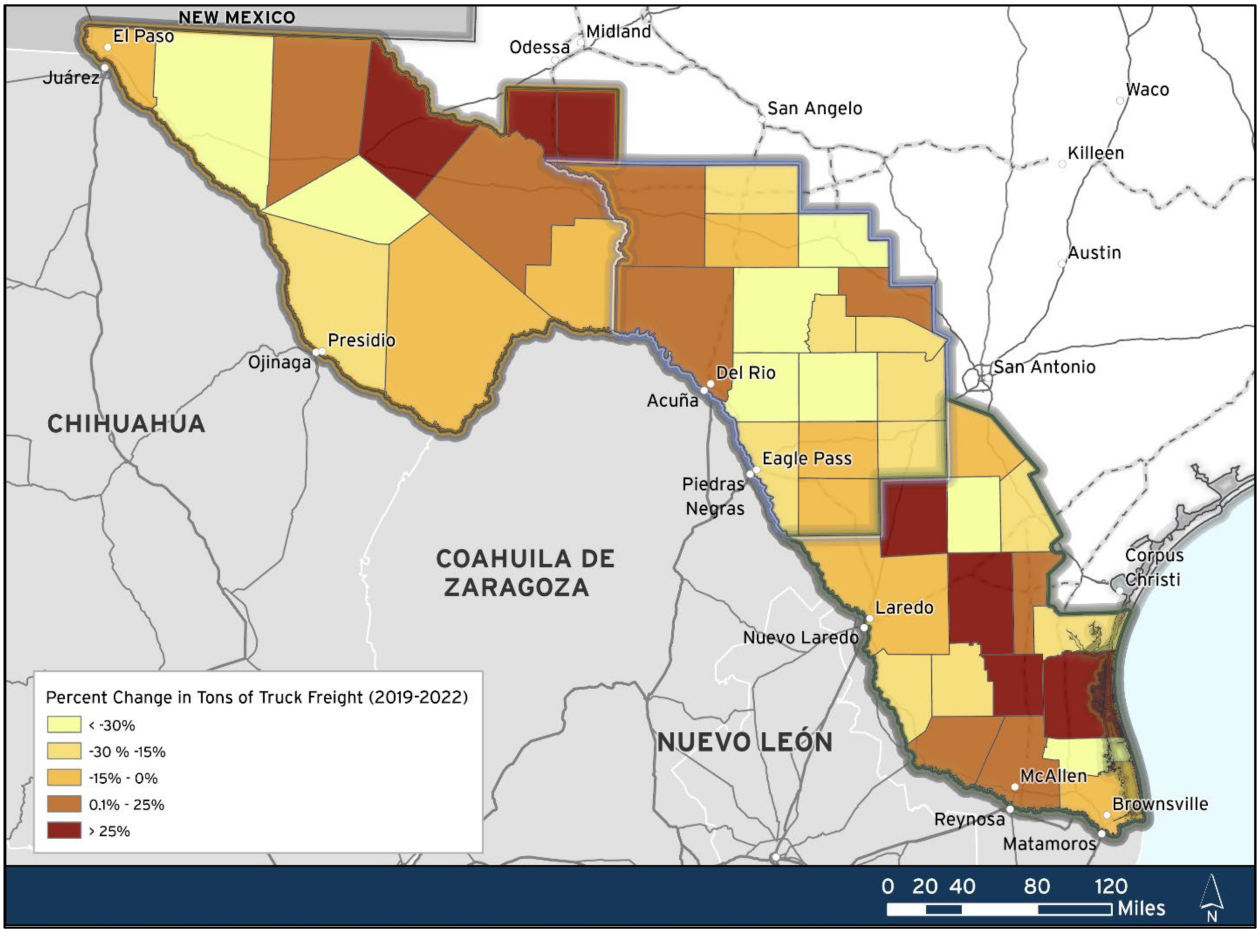
As seen in **Figure 22**, Hidalgo (26,281,136), Webb (21,021,969), El Paso (21,011,258), Cameron (11,432,671), and Atascosa (5,394,616) counties had the highest tonnage of commodities for 2022. **Figure 23** displays that La Salle (975%), Crane (106%), Upton (78%), Reeves (56%), and Duval (48%) counties reported the greatest percent increase in tonnage between 2019 and 2022. Even with La Salle County's significant growth in a 3-year period, it still fell behind other counties in terms of total tonnage of commodities via freight truck, demonstrating the significant presence of freight trucking in these counties.

Figure 22: Truck Freight Tonnage, Texas Study Area 2022



Source: Analysis of Transearch Commodity Flow data

Figure 23: Percent Change in Truck Freight Tonnage, Texas Study Area 2019 – 2022



Source: Analysis of Transearch Commodity Flow data

According to **Table 16**, approximately $158.5 billion in commodities traveled via truck in the service area in 2022. This is an 18.8% increase from the value of commodities reported in 2019 and can be juxtaposed with **Table 15**, which reported a decrease in the tonnage of commodities transported via freight truck. One potential explanation for this contradiction is the COVID-19 pandemic, which slowed production and increased prices of goods worldwide.

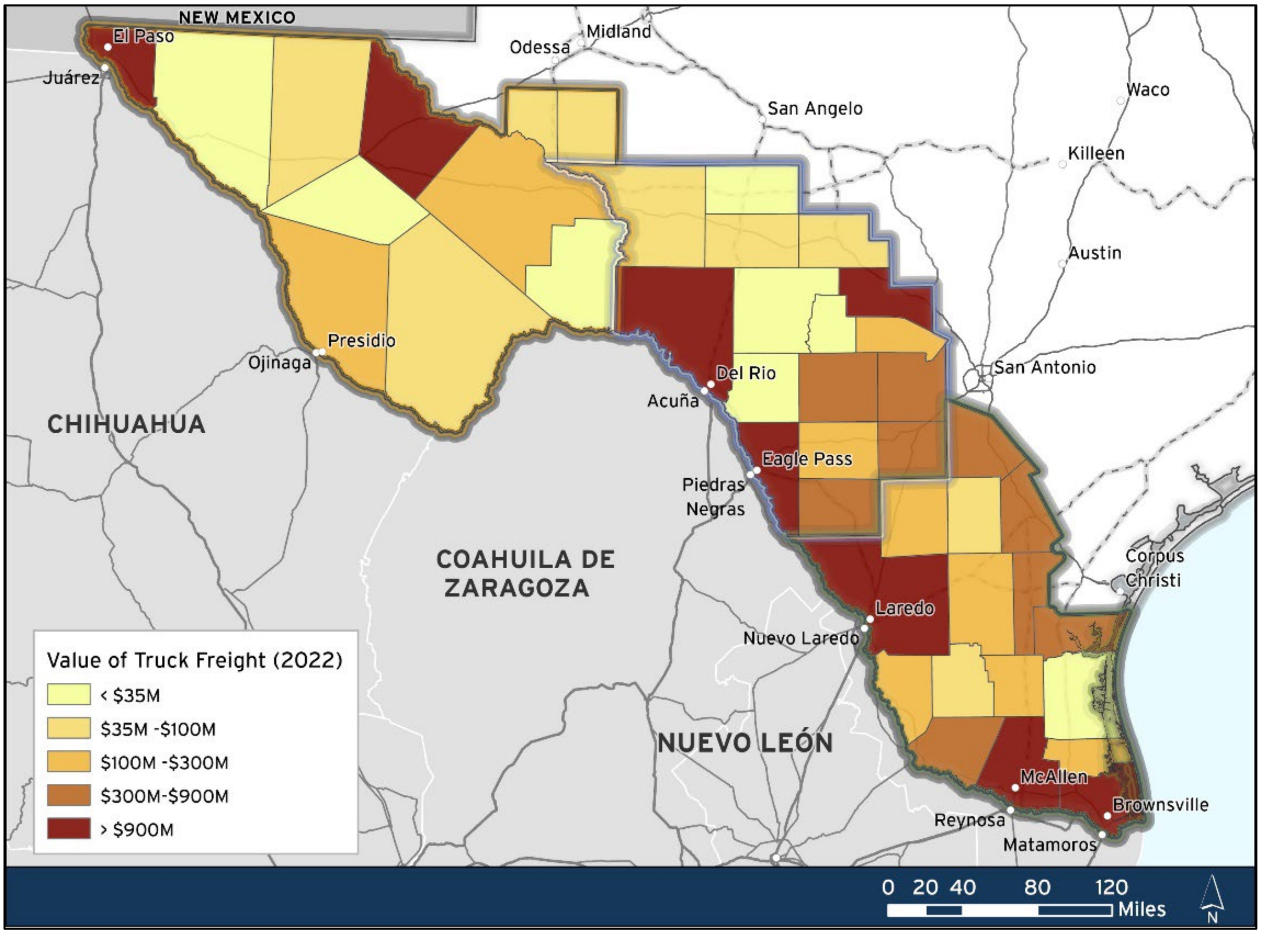
Table 16: Value of Commodity via Freight Truck, Texas Study Area 2019-2022 (in millions)

Region	Value of Commodities via Freight Truck 2019	Value of Commodities via Freight Truck 2022	Absolute Change	Percent Change
South	$95,318.8	$96,998.5	$1,679.7	1.8%
Central	$6,899.6	$7,643.2	$743.6	10.8%
West	$48,484.3	$53,838.0	$5,353.6	11.0%
Study Area	$150,702	$158,479.5	7,776.8	5.2%

Source: Analysis of Transearch Commodity Flow data

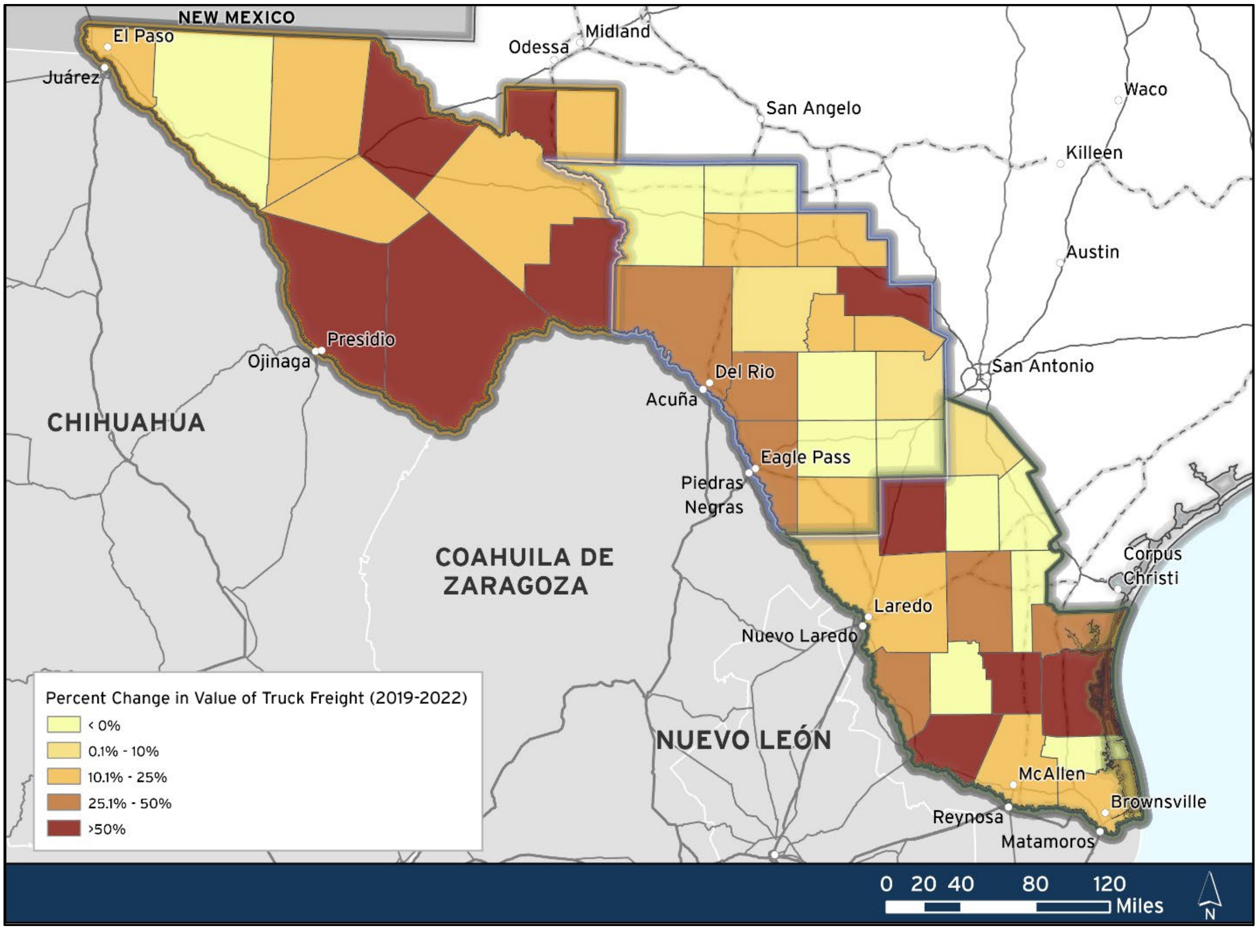
Figure 24 shows that the counties of El Paso ($50,565,969,341), Hidalgo ($24,124,293,199), Cameron ($17,317,870,292), Reeves ($2,621,267,278), Val Verde ($2,394,439,398), and Maverick ($1,804,922,531) reported the highest value of commodities transported via truck in 2022, with a large portion of value concentrated in El Paso. **Figure 25** displays that Reeves (353%), La Salle (176%), Brooks (89%), Crane (88%), and Presidio (58%) counties have the greatest reported increase in commodity value transported via truck between 2019 and 2022. This growth is spread across the total study area, with significant growth (i.e., greater than 50%) found across the West, Central, and South regions.

Figure 24: Value of Commodity via Truck Freight, Texas Study Area 2022



Source: Analysis of Transearch Commodity Flow data

Figure 25: Percent Change in Value of Commodity via Truck Freight, Texas Study Area 2019 – 2022



Source: Analysis of Transearch Commodity Flow data

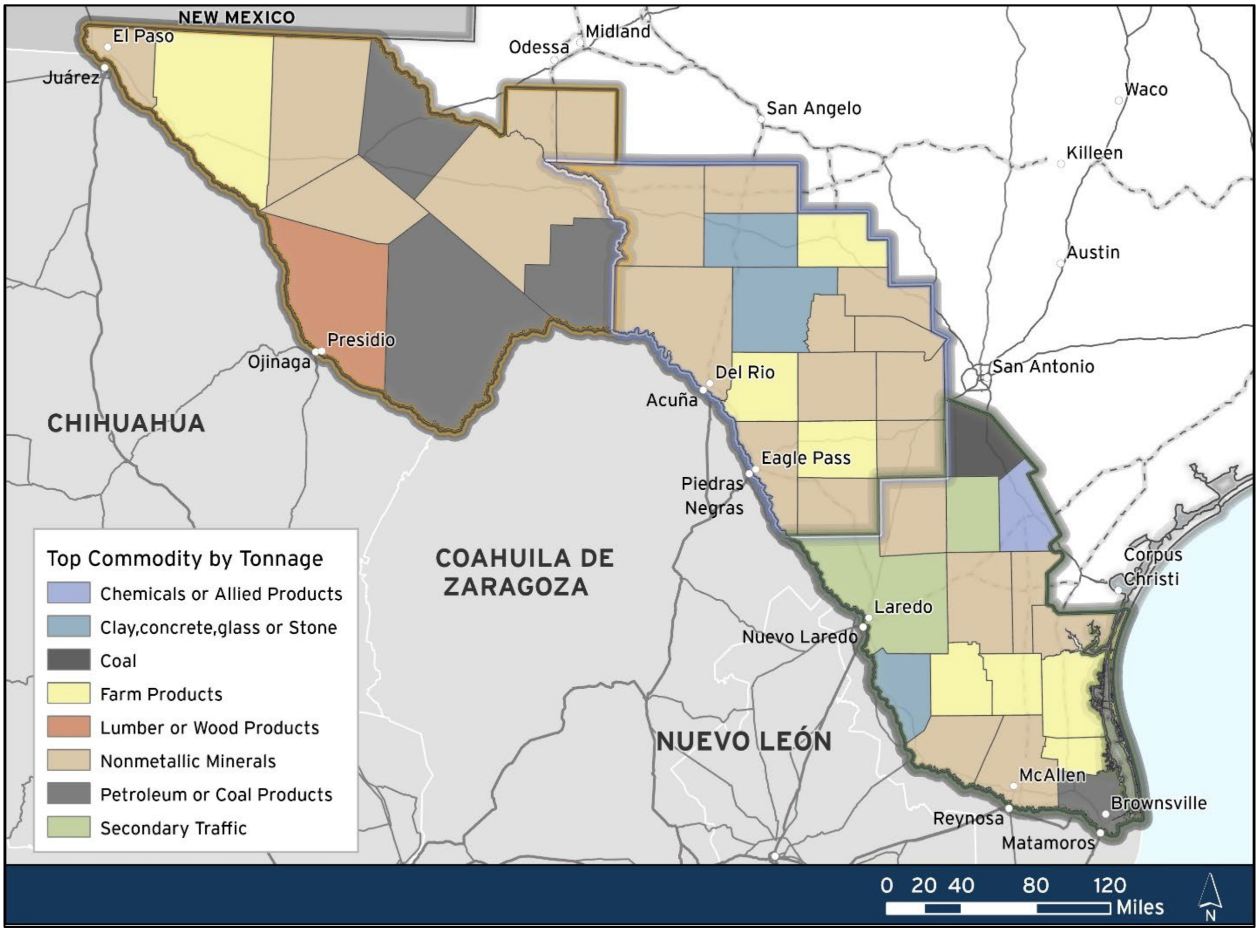
Despite a reduction in tonnage transported via freight truck (**Table 17**), **Figure 26** shows that non-metallic minerals were the top commodity group in tons within all three regions within the study area in 2022.

Table 17: Top Commodity by Tonnage, Texas Study Area 2022 (in millions)

Commodity	Tons 2019	Tons 2022	Absolute Change	Percent Change
Non-metallic Minerals	40.1	37.5	-2.7	-6.6%
Petroleum or Coal Products	20.7	17.8	-2.9	-14.1%
Secondary Traffic	16.5	17.6	1.1	6.6%
Clay, Concrete, Glass, or Stone	9.0	9.2	0.2	2.0%
Food or Kindred Products	7.9	6.0	-1.8	-22.9%

Source: Analysis of Transearch Commodity Flow data

Figure 26: Top Commodity by Tonnage, Texas Study Area 2022



Source: Analysis of Transearch Commodity Flow data

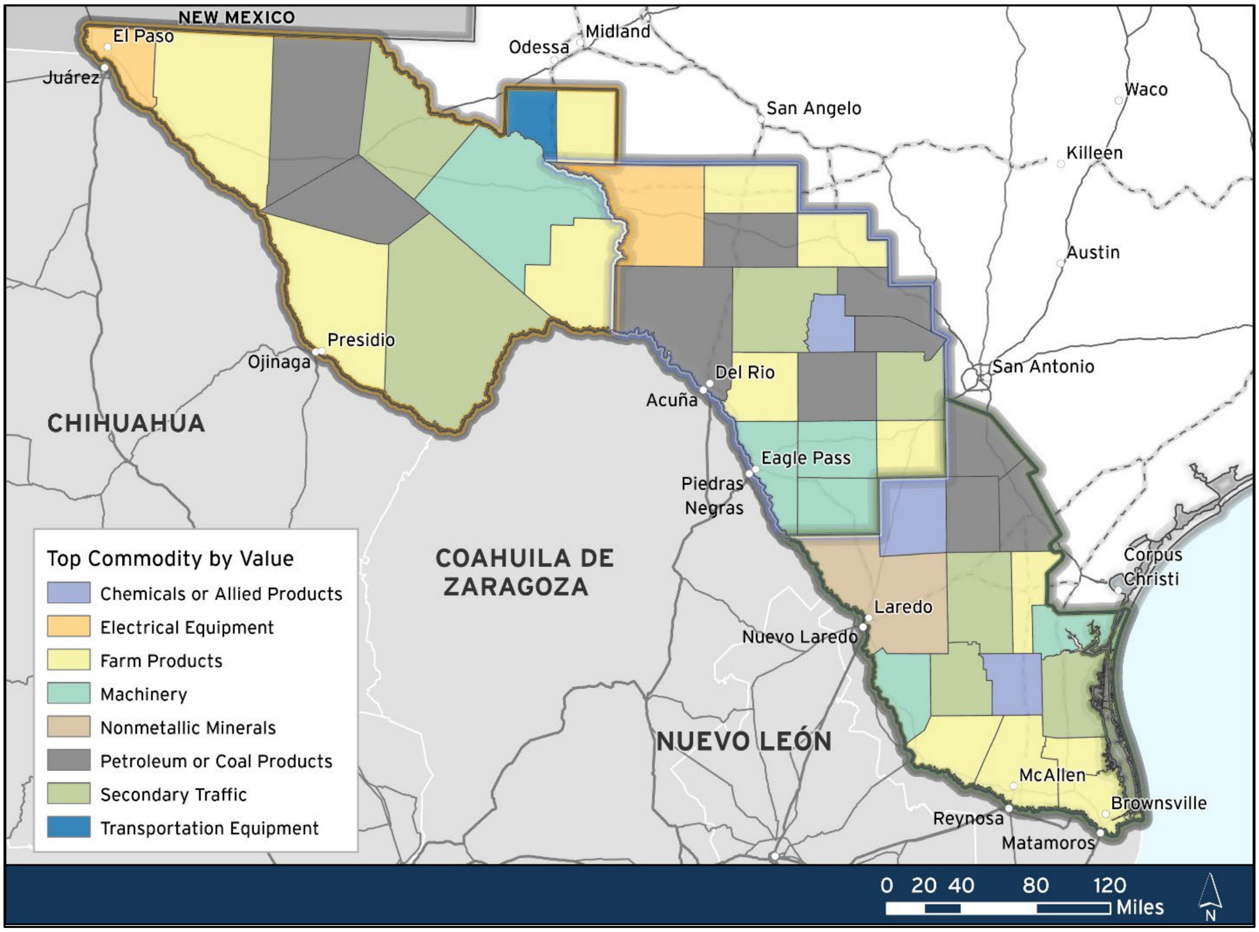
Secondary traffic, or the transportation of goods from one mode of transportation to another, was the number one commodity by value in the study area, South Region, and Central Region in 2022. The top commodity in the West Region was machinery.

Table 18: Top Commodity by Value, Texas Study Area 2019-2022 (in millions)

Commodity	Value 2019	Value 2022	Absolute Change	Percent Change
Secondary Traffic	47,801.8	44,436.8	-3,365.0	-7.0%
Machinery	11,691.4	18,377.8	6,686.4	57.2%
Electrical Equipment	14,102.2	16,861.8	2,759.6	19.6%
Petroleum or Coal Products	7,936.3	16,485.6	8,549.3	107.7%
Transportation Equipment	10,475.8	10,599.4	123.7	1.2%

Source: Analysis of Transearch Commodity Flow data

Figure 27: Top Commodity by Value, Texas Study Area 2022

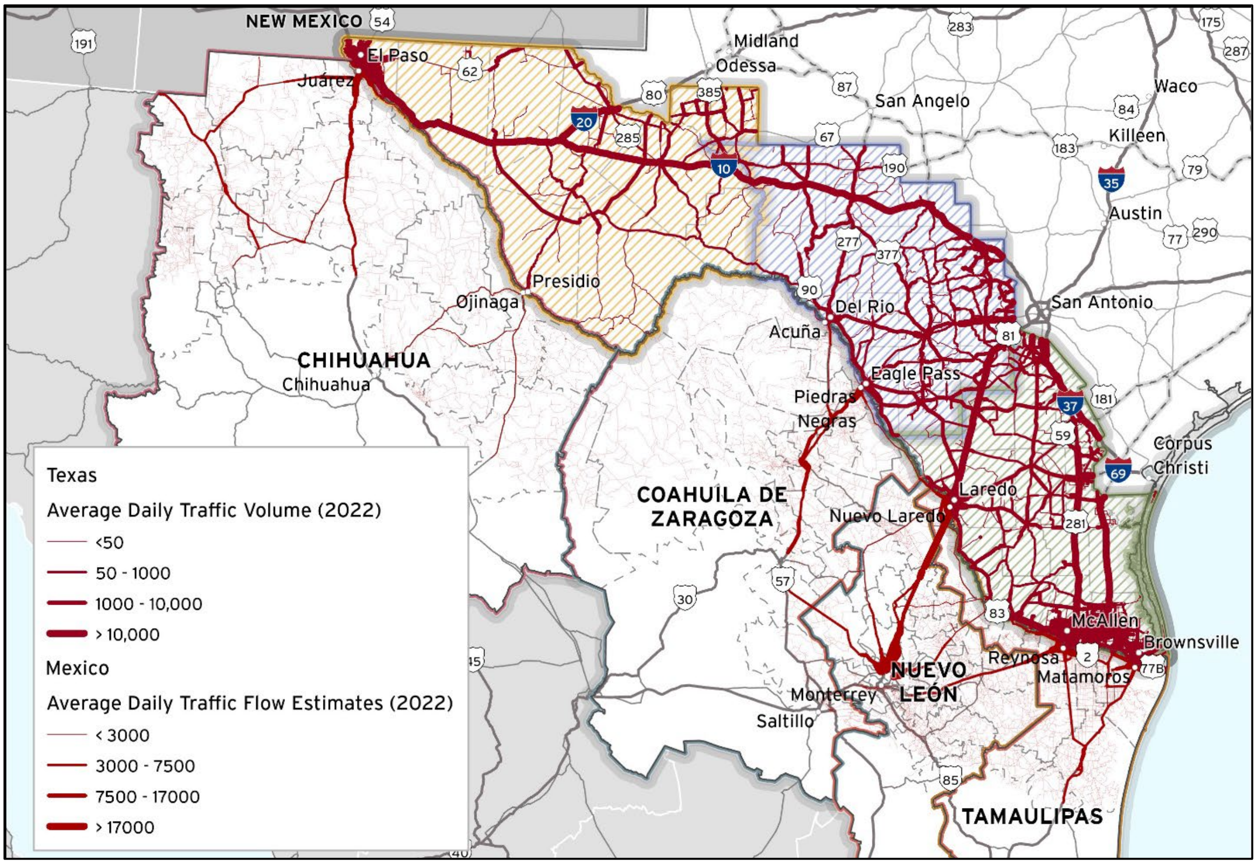


Source: Analysis of Transearch Commodity Flow data

Border Region Connectivity Network Demand

Region-to-Region Study Area Travel

Figure 28: Average Daily Traffic Volume, Study Area 2022



Source: TxDOT, Statewide Analysis Model. Secretaria de Comunicaciones y Transportes (SCT) ADT Mexico Counts

Within the Region-to-Region study area, the most active routes between all three regions are concentrated along major interstates and principal arterials, as shown in **Figure 28**. The average daily traffic (ADT) from 2022 in the study area exceeds an average of 10,000 vehicles per day on I-10, I-35, I-37, I-69C/US-281, and I-69E/US-77. From the same data, the total vehicle miles traveled (VMT) in the study area—which measures the total miles traveled by all vehicles in a geographic area over a specific period—was estimated at 66 million miles across the three Texas regions. This figure represents 9.3% of the entire state's total VMT. Additional key findings for the study area's total VMT include:

- West Region total VMT is 23.2 million (35.2%).
- Central Region was found to have the smallest VMT total at 11 million (16.6%).
- South Region accounts for the largest share of the border region, a total of 31.8 million VMT (48.2%).

The states of Chihuahua, Coahuila de Zaragoza, Nuevo Leon, and Tamaulipas provide critical corridors for the movement of both people and goods to and from Texas' southern border. Some of the most significant ADT flows observed from the data include:

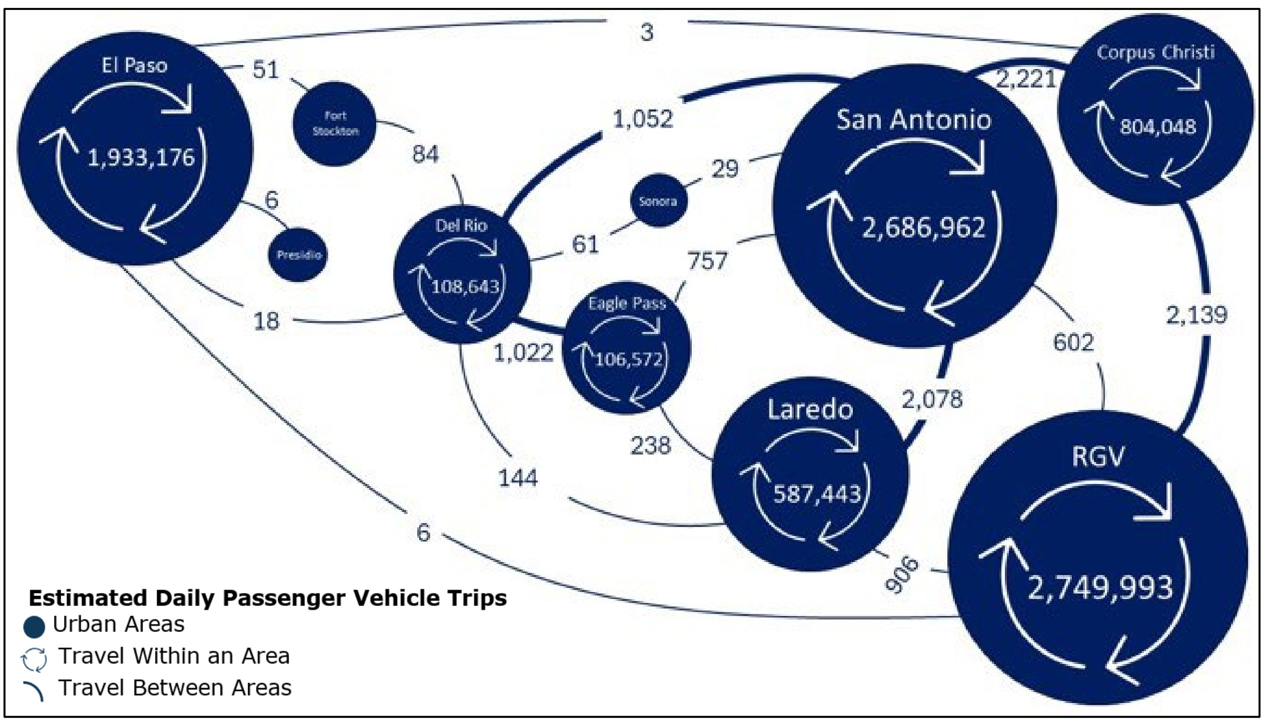
- MX-45 from Juarez to MX-10 (Chihuahua), with an average ADT flow of 9,821.3; max ADT of 18,075.
- MX-57 from Piedras Negras to Monclova, Coahuila de Zaragoza, with an average ADT of 10,542.7; max ADT of 17,938.
- MX-85 from Nuevo Laredo to Monterrey, Nuevo León, with an average ADT of 15,804.7; max ADT of 18,055.
- MX-40 from Reynosa to Monterrey, Nuevo León, with an average ADT of 8,932.9; max ADT of 15,014.

Within Texas' border region, much of the commercial ADT is focused along interstates and arterials, such as I-10, I-35, US-377, US-90, US-281, US-77, and SH-16. These are predominately north-to-south corridors connecting major cities like San Antonio, Midland, and Corpus Christi to the border regions. In total, 13.6 million commercial VMT was estimated to occur within 2022, or 20.5% of the total 66 million VMT in the study area. Other key findings from study area commercial VMT include:

- West Region was estimated to have the largest share of commercial VMT, at 5.3 million (39%)
- Central Region showed the least amount VMT of the three Regions, at 3.7 million (27%)
- South Region was estimated to be 4.6 million (34%)

The South Region's ADT, concentrated within the Rio Grande Valley (RGV), represents the highest demand for travel along I-69C and E, US-83, US-77, and US-281.This data correlates with the largest estimated traffic volumes from the Mexico border states to be coming from the adjacent State of Tamaulipas, Mexico; estimated around 9.5 million VMT, or 34% of the total VMT among Mexico's border states.

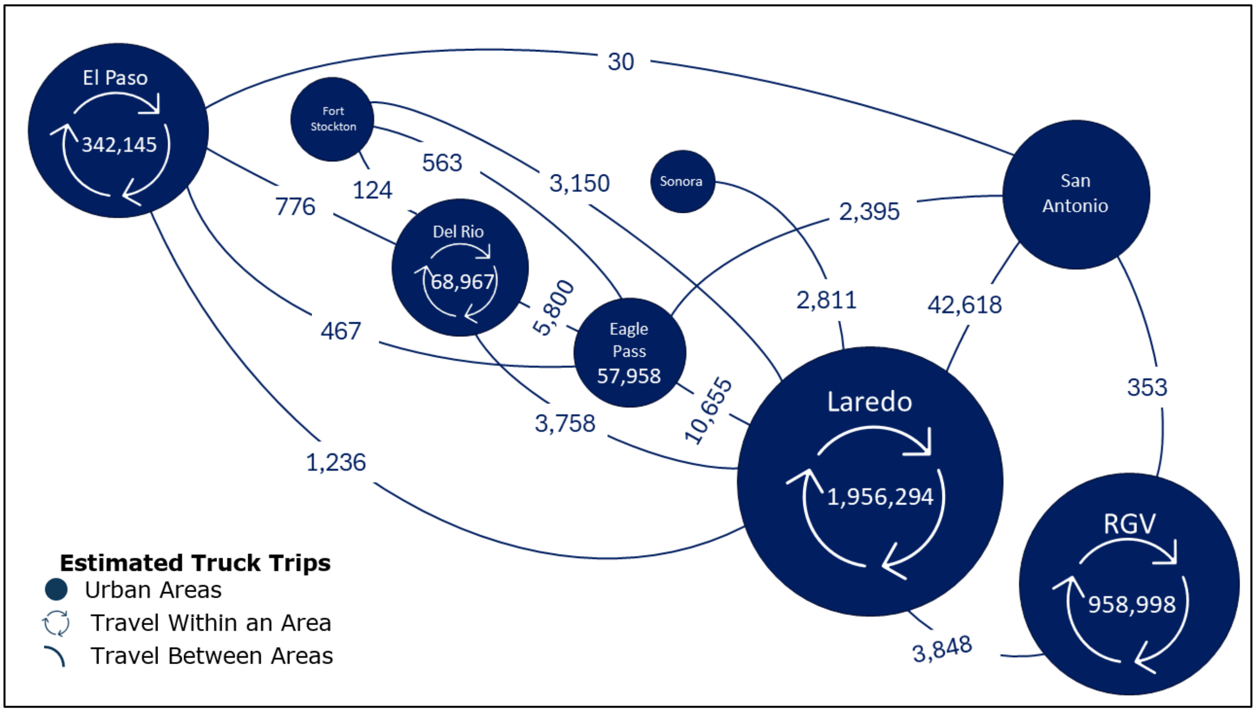
Figure 29: Regional Passenger Vehicle Trips Origins and Destinations, Texas 2022



Source: Regional Integrated Transportation Information System (RITIS); 2022 INRIX Probe Data

Reviewing the regional passenger vehicle origins and destinations, Figure 29 symbolizes the most significant intra-state travel between the regions and major cities in the border zone, with most numerous travel focused between San Antonio in the north to cities in the south. The most significant connections to the border region include travel between San Antonio and Laredo, RGV and Corpus Christi, and Del Rio and Eagle Pass.

Figure 30: Regional Commercial Vehicle Travel Trips Origins and Destinations, Texas 2022 (6 Months)



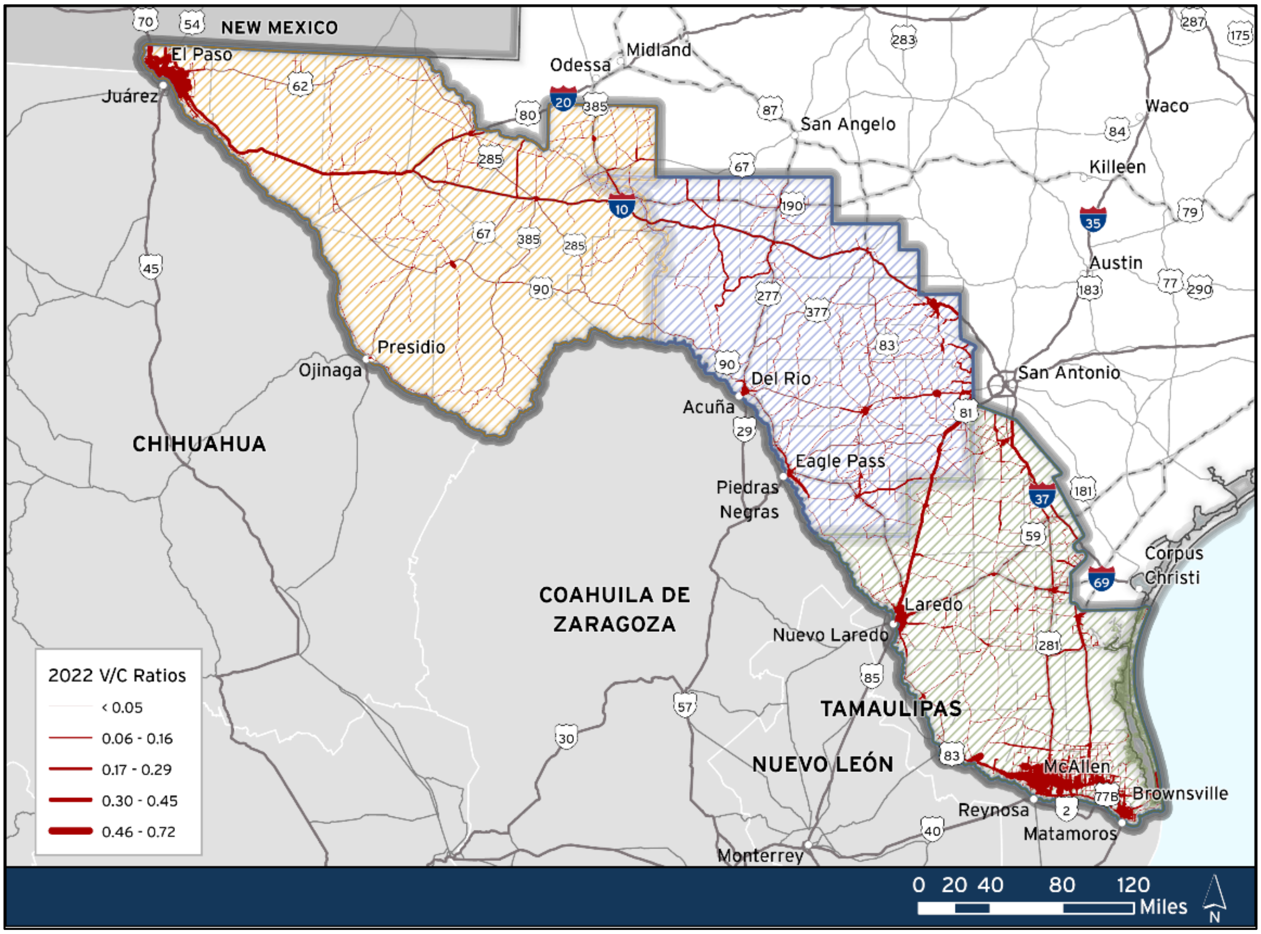
Source: Regional Integrated Transportation Information System (RITIS); 2022 INRIX Probe Data

Separately, the amount of commercial freight passing through the border region of Texas for intra-state travel is significant (**Figure 30**), totaling approximately 78,000 inter-regional commercial truck trips within six months of 2022. The heaviest traffic occurred along I-35 and most connections to or through Laredo. The most numerous of these trips recorded within the 6-month period occurred between Laredo and San Antonio, Laredo and Eagle Pass, and Eagle Pass and Del Rio.

Volume-to-Capacity Measurements

Volume-to-Capacity (V/C) ratios are critical metrics used in transportation engineering to evaluate the performance and efficiency of roadways. The V/C ratio compares the volume of traffic (V) using a road segment to the road's capacity (C) to accommodate that traffic. A low V/C ratio indicates that the traffic flow is adequate and well within the road's capacity, while a high V/C ratio suggests that the road is approaching or exceeding its capacity, leading to potential congestion and delays. **Figure 31** represents the V/C ratios per 2022 volumes.F

Figure 31: Volume-to-Capacity (V/C) Ratios, Texas Study Area 2022



Source: TxDOT, Statewide Analysis Model (2022)

West Region

Within the West Region, much of the higher rated V/C ratios are either contained to interstates (e.g., I-10 and I-20) and various State and US Highways within El Paso and Reeves counties. The highest ratios in terms of east-to-west connections are found along I-10 near Sheffield in the east and continues to El Paso in the west. Additionally, among regional routes connecting north-to-south within the West Region, SH-18 near I-20 has the highest V/C ratio.

Central Region

Heavier congestion outside urban areas is focused along east-to-west connections, primarily along I-10 and US-57, with traffic continuing south along US-277, US-83, SH-163. Along with segments of I-35 within the Central Region, US-277 and FM-1021 near Eagle Pass were found to have highest V/C ratio among north-to-south connections within the Central Region.

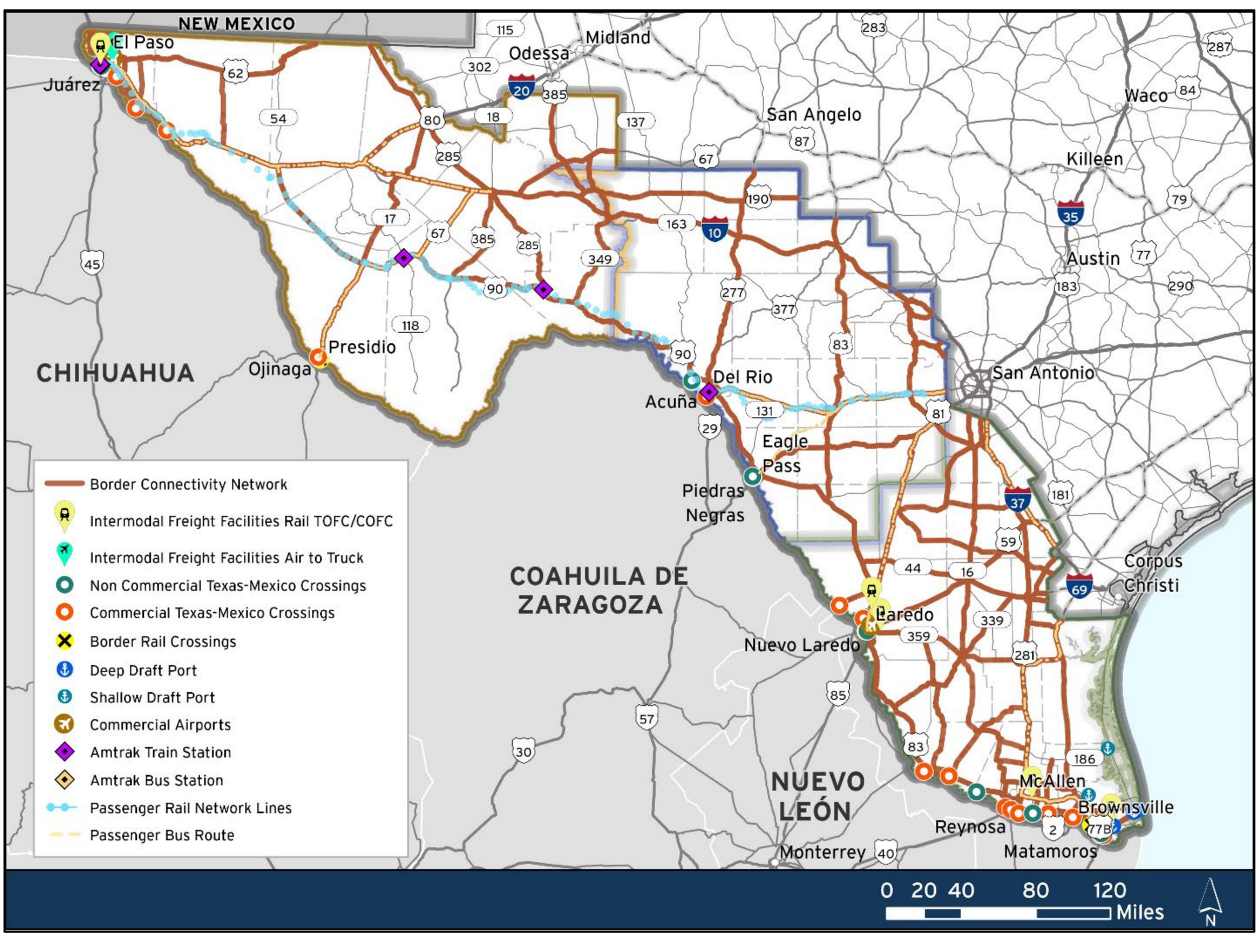
South Region

Like the Central Region, I-35 shows consistently high V/C ratios, along with I-37, US-281, and US-77, for the highest congested north-to-south regional connections. Outside SH-285 and I-2/US-83, congestion along east-to-west connections is not as persistent within the South Region. Most higher values of V/C ratio are concentrated within the RGV's urban areas and the City of Laredo.

Network Existing Conditions

The diverse existing infrastructure facilitates both commercial and non-commercial crossings, allowing for active trade and travel between the US and Mexico. shows important connectivity and infrastructure locations along the Texas–Mexico border, which includes various crossing types, including 28 Points of Entry (POEs) crossings, 24 pedestrian (ped) crossings, 14 commercial motor vehicle (CMV) crossings, and six freight rail crossings. In addition to these border crossings, there are five rail intermodal Trailer-on-Flatcar Car/Container-on-Flatcar Car (TOFC/COFC) facilities in the West and South regions. Additionally, there are four intermodal freight facilities in the West region, all located in El Paso. The study area features three shallow draft ports and two deep draft ports, enhancing maritime accessibility for varying vessel sizes. International commercial air traffic is supported by airports in El Paso and Laredo. Amtrak's passenger rail route from San Antonio to El Paso includes key stations spread across the region, with stations in Del Rio, Sanderson, Alpine, and El Paso. Towns without passenger rail service access Greyhound bus services, with eight stops in the West region, five in the Central region, and fourteen in the South region, ensuring extensive intercity travel options. This infrastructure collectively supports efficient logistics and enhances economic connectivity across Southeastern Texas.

Figure 32: Major crossings on Regional Border Connectivity Network (RBCN)



Source: Bureau of Transportation Statistics, (2022)

Urban-Rural Network Designation

The RBCN is primarily rural in nature. Urban facilities are generally designed to move high volumes of traffic at higher speeds than their rural counterpart. Approximately 84% of the lane mileage in study area network is designated as rural facilities. In general, rural facilities lack design features for the safe and efficient movement of high volumes of traffic, especially commercial vehicles. **Table 19** shows the distribution of urban and rural designated facility in the three regions.

Table 19: Distribution of Lane Mileage Based on Rural-Urban Designation, Texas Study Area

Region	Study Network		Rural Designation		Urban Designation	
	Lane Mileage	% of Lane mileage	Lane Mileage	% of Lane mileage	Lane Mileage	% of Lane mileage
Central	3343.10	24%	3339.63	28%	3.47	1%
South	6192.88	44%	4679.51	40%	1513.37	64%
West	4559.06	32%	3721.38	32%	837.67	35%
Total	**14095.04**	**100%**	**11740.53**	**100%**	**2354.51**	**100%**

Source: TxDOT Roadway Inventory Data, 2022

Cross section

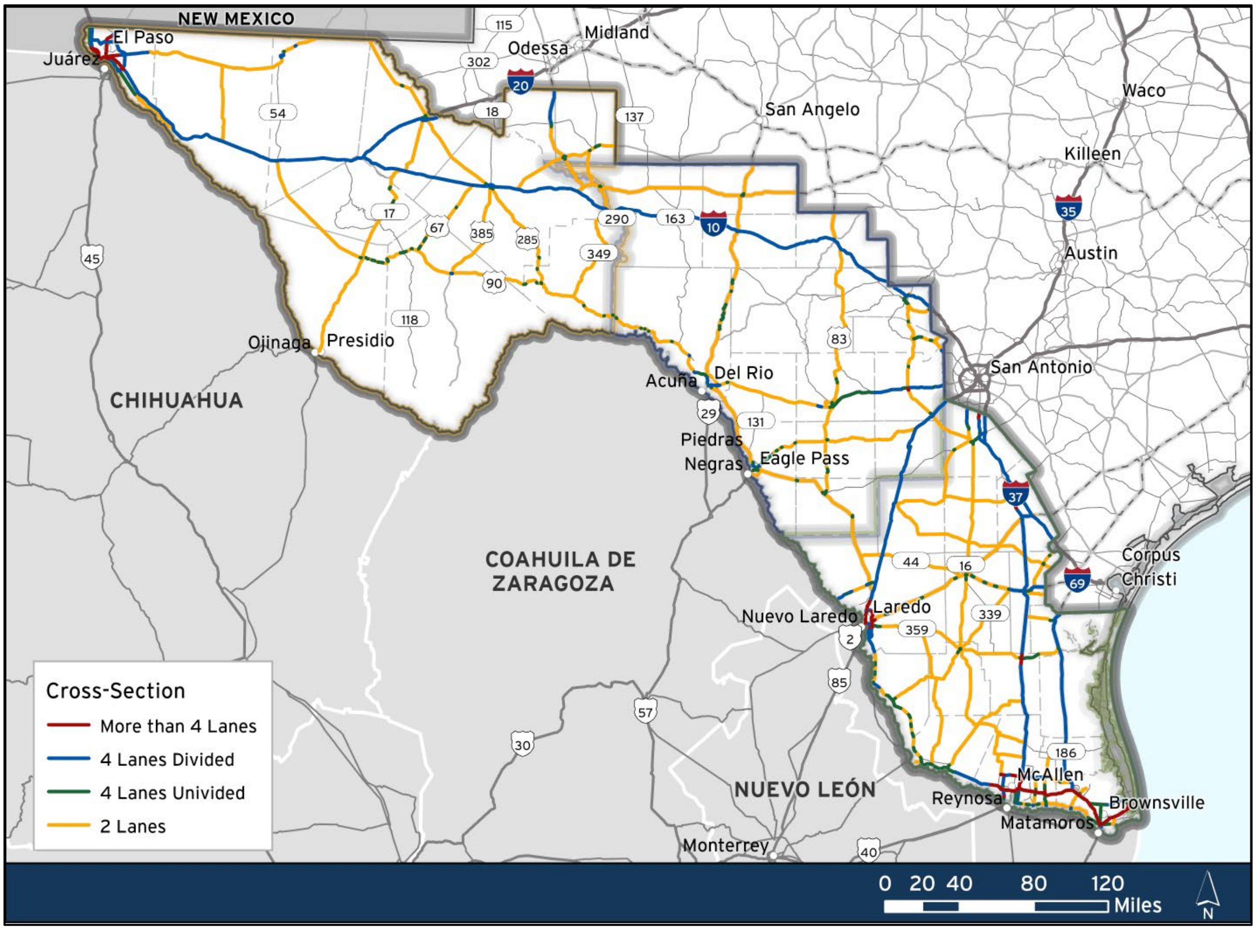
Facility cross section is important to understanding and managing the current road network. **Table 20** summarizes the distribution of highway design types across three regions. 2-lane roadway makes up 69% of the Central region's roads, 57% in the South, and 63% in the West. In contrast, 4-lane, divided roads are more prevalent in the West (29%) and South (26%). The Central Region has very few roadways with five or six lanes. In the South Region, 6% of the roadways have more than four lanes, with some extending up to 13 lanes. The West Region includes roads with up to 10 lanes. illustrates the facility cross-sections, including the highway design.

Table 20: Highway Design and Facility Cross-Section (Length of Road Segment in Miles), Texas Study Area 2022

Highway Design	Central		South		West	
	Length	Percentage	Length	Percentage	Length	Percentage
2-lanes	857.93	69%	1184.70	57%	990.06	63%
4-lanes Undivided	108.80	9%	213.56	10%	82.26	5%
4-lanes Divided	281.38	23%	535.67	26%	455.65	29%
More than 4 lanes	0.77	0%	133.07	6%	52.728	3%
Total	1248.88	100%	2067.0	100%	1580.70	100%

Source: TxDOT Roadway Inventory Data, 2022

Figure 33: Facility Cross-Section, Texas Study Area 2022

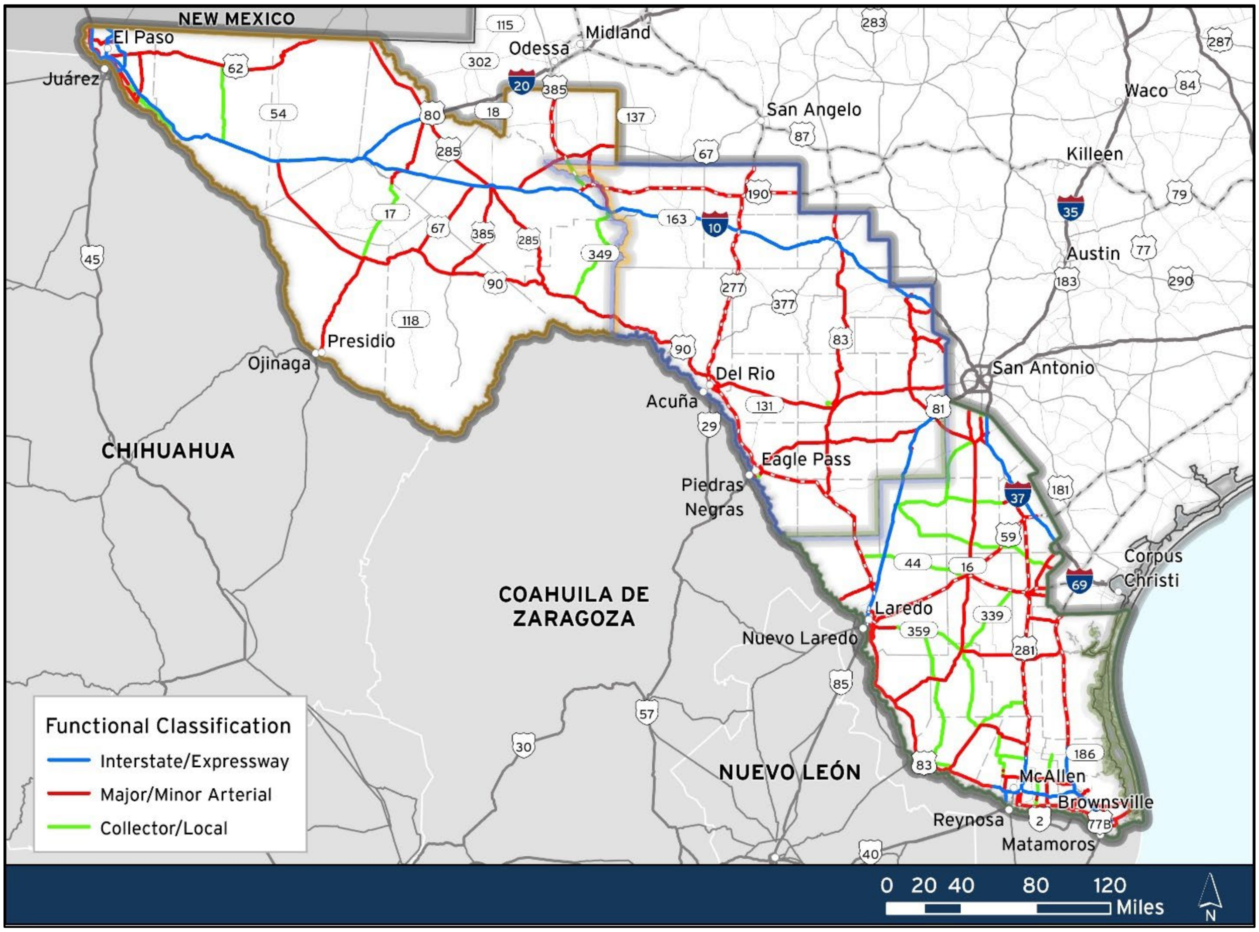


Source: TxDOT, Roadway Inventory Data (2022)

Functional Classification

Figure 34 displays the major functional classification categories of the study area. 81% of the roadways have been classified as non-expressway, arterial or collectors. 55% of the vehicular demand occurs on the arterial and collector systems. The demand is projected to increase by 25% from 2022 to 2050, whereas commercial vehicle demand is expected to increase by 65%, and it is anticipated to become the largest portion of overall traffic by 2050. This points to increasing demand for key north-south arterials and collectors accessing I-10 to make the east/west movement between border regions.

Figure 34: RBCN Functional Classifications, Texas Study Area 2022



Source: TxDOT, Roadway Inventory Data (2022)

Roadway Design

Access Control

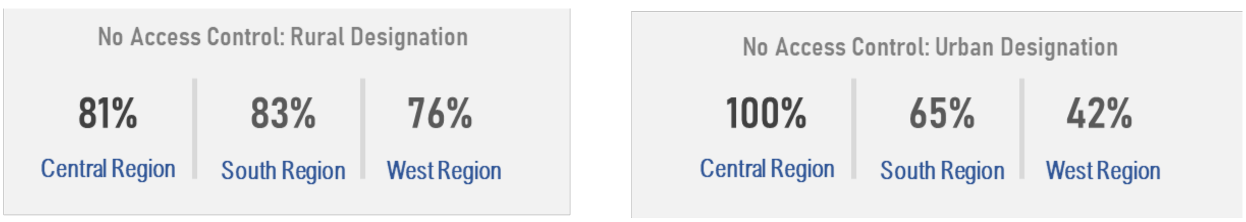
The infrastructure profile highlights significant differences in access control of the roadways across the regions. Access control has been shown to improve traffic flow and reduce crashes. **Table 21** summarizes the lane mileage of the RBCN with type of access control in the three regions. In roads with rural designation, the South Region exhibits the highest proportion of networks with no access control, while the Central Region has the highest proportion of road network with no access control in urban designated roads (**Figure 35**).

Table 21: Distribution of Roadway Access Control, Texas Study Area 2022

Region	Full Access Control		Partial Access Control		No Access Control	
	Lane Mileage	% of Lane mileage	Lane Mileage	% of Lane mileage	Lane Mileage	% of Lane mileage
Central	951.33	23%	0.00	0%	2391.78	25%
South	1346.23	32%	505.05	100%	4341.60	46%
West	1851.39	45%	2.23	0%	2705.44	29%
Total	4148.95	100%	507.28	100%	9438.81	100%

Source: TxDOT, Roadway Inventory Data, 2022

Figure 35: RBCN with No Access Control – Rural and Urban Designated Portion



Source: TxDOT Roadway Inventory Data, 2022

Presence of Medians

Median type is a fundamental aspect of the existing highway network. **Table 22** presents a summary of median types across the three regions. The predominant median type in all regions is "No median," accounting for 77% of the total roadway length in the Central Region, 68% in the South Region, and 68% in the West Region. Unprotected medians also constitute a significant portion, with 19% in both Central and West Regions and 20% in the South Region. The Positive Barrier Flexible median type is more prevalent in the West (7%) compared to the Central (3%) and South (4%).

Table 22: Median Type Present in RBCN (in miles), Texas Study Area 2022

Median Type	Central		South		West	
	Length	Percentage	Length	Percentage	Length	Percentage
No median	966.6	77%	1408.29	68%	1074.03	68%
Unprotected/ Striped	238.94	19%	408.29	20%	304.59	19%
Positive Barrier Flexible	36.2	3%	80.48	4%	109.96	7%
Positive Barrier Semi-Rigid	3.86	0.3%	1.63	0.1%	4.72	0.1%
Positive Barrier Rigid	1.81	0.3%	134.75	7%	58.76	4%
Curbed	1.47	0.3%	33.57	2%	28.64	2%
Total	1248.88	100%	2066.99	100%	1580.7	100%

Source: TxDOT Roadway Inventory Data, 2022

Bridge Condition

Bridge condition data was sourced from a statewide point dataset of bridge locations maintained by the Bridge Division of TxDOT. There are 1,898 bridges on the RBCN, almost half of them are in the South Region. Out of these, 132 bridges are identified by TxDOT as either Structurally Deficient or Functionally Obsolete. Structural deficient bridges have extreme restrictions on load-carrying capacity or require immediate rehabilitation, whereas functionally obsolete bridges possess inadequate features that prevent them from operating at full capacity. **Table 23** provides a detailed breakdown of the number of deficient and obsolete bridges by region, highlighting that majority of the obsolete bridges are located in the West Region.

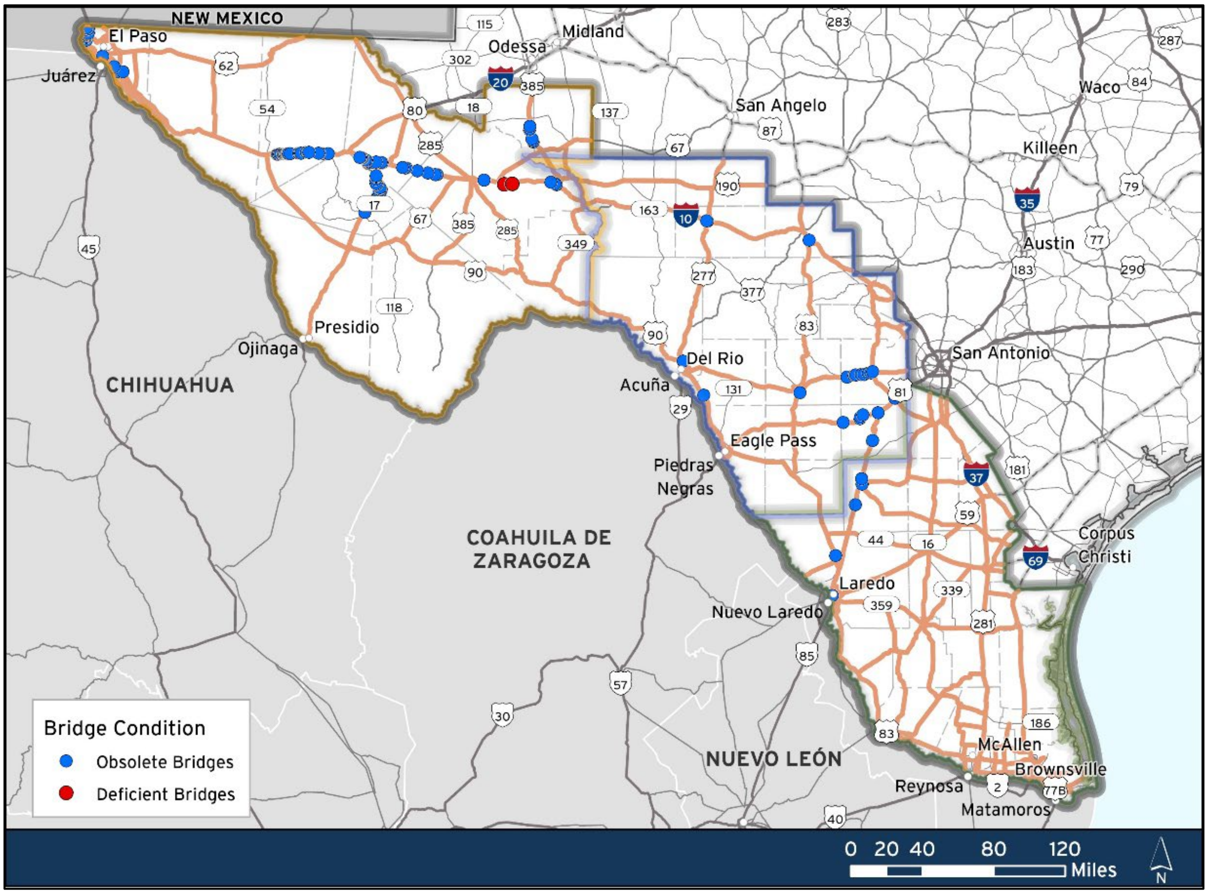
Table 23: Bridge Condition, Texas Study Area 2024

Region	Structurally Deficient Bridges	Functionally Obsolete Bridges	Total Number of Bridges
Central	0	30	428
South	0	5	553
West	2	95	917
Total	2	130	1,898

Source: TxDOT Bridge Inspection Database

Figure 36 displays the locations of the obsolete and deficient bridges. There are only two structurally deficient bridges in the study area. Both are in West Region and located on I-10. The map also shows that obsolete bridges in the West Region are mainly concentrated around El Paso area, with a large concentration on I-10. In the Central region, they are mostly seen on US 57 and US 90. South region has the least proportion of obsolete bridges, four of them are on I-35 and the remaining one is on US 83.

Figure 36: Conditions of Study Area Bridges, Texas Study Area 2024



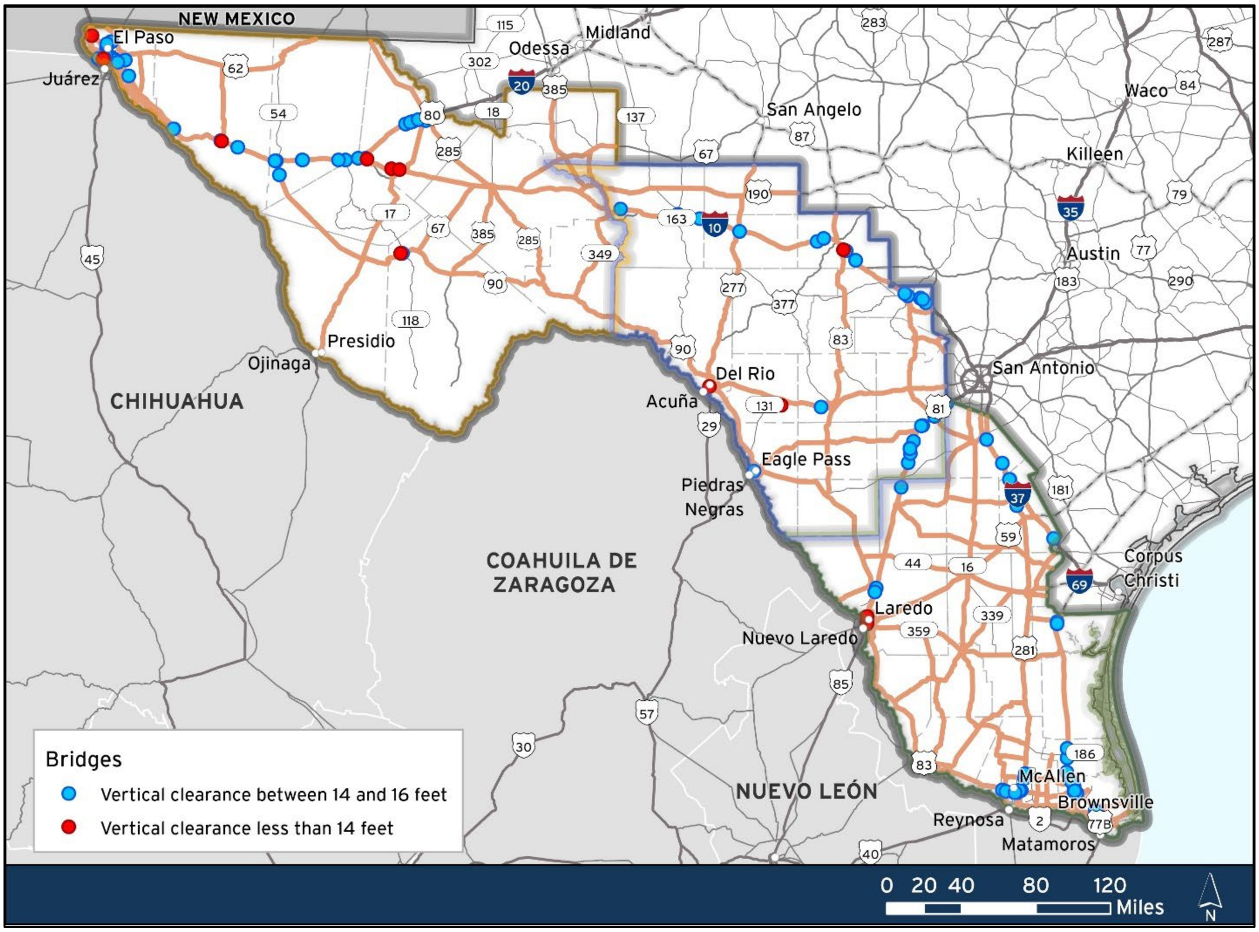
Source: TxDOT, Bridge Inspection Database (2024)

Vertical Clearance

Vertical clearances of bridges are crucial in the existing infrastructure profile because limited vertical clearance restricts network accessibility for trucks. **Figure 37** highlights bridges with critical height restrictions. In the study area, 324 bridges have a clearance between 14 and 16 feet, which represents the 6% of bridges in Texas under this height, and 22 bridges have a clearance of less than 14 feet, which represents the 10% of all bridges under these conditions.

Most of the bridges are in the West Region. Insufficient bridge heights can not only be a hazard, but also force the diversion of commercial vehicles and oversize/overweight loads to other routes. These alternate routes can add unnecessary travel time and distance to those affected vehicles. Often those alternative routes were never intended nor designed to support that demand.

Figure 37: Critical Vertical Clearance of Study Area Bridges, Texas Study Area 2024



Source: TxDOT, Bridge Division (2024)

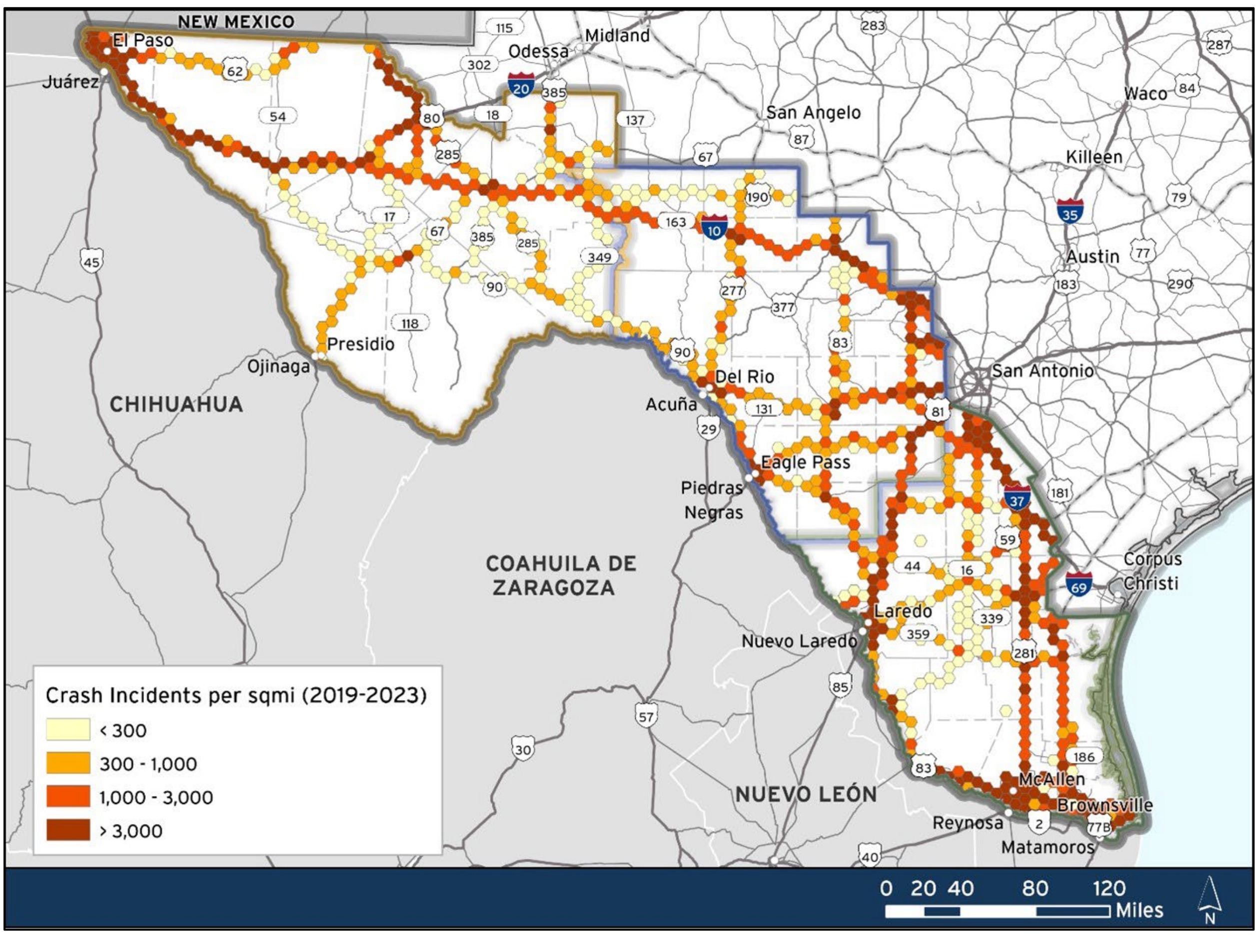
Safety

Safety on the Texas highway network is a top priority for TxDOT. This analysis utilized TxDOT's Crash Record Information System (CRIS) database to collect data on crashes occurring on the RBCN between 2019 and 2023. This timespan provides the most recent data available, and it captures important trends in crashes before and after the disruptions associated with the COVID-19 pandemic.

Reviewed crash data included crash severity, commercial vehicle involvement, bicycle and pedestrian crash activity, reported leading cause of crashes, and number of crashes across the three regions of the study area.

Figure 38 provides an overview of crash density on the RBCN. A handful of corridors stand out for the highest crash densities: I-10 between El Paso and San Antonio, I-35 from Laredo to San Antonio, I-37 south of San Antonio, and the parallel US 281 and US 77 highways north of the McAllen/Brownsville metro area. Generally, crash densities within urban areas are significantly higher than along rural corridors.

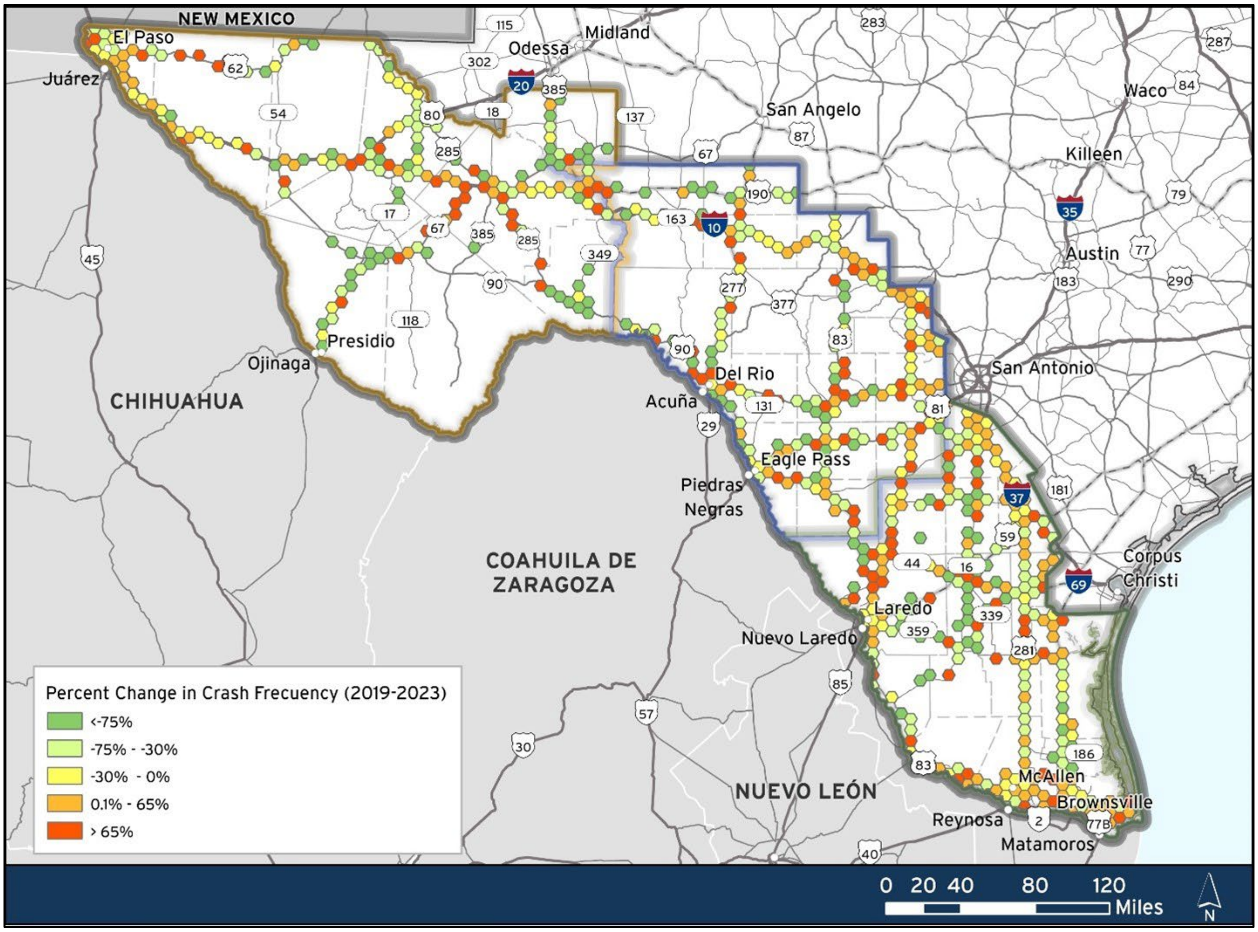
Figure 38: Crash Densities, Texas Study Area 2019 - 2023



Source: TxDOT Crash Records Information System, 2019 – 2023

Beyond looking at cumulative crashes between 2019 and 2023, it is helpful to see changes in crash activity over the course of those five years. **Figure 39** provides this additional context by showing changes in crash activity between 2023 and 2019. While I-35 north of Laredo is experiencing an increase in crashes, the other corridors highlighted by **Figure 38** reveal crash activity decreasing generally and increasing at specific points on the corridor. Using this data, decisionmakers can focus continued analysis and improvement efforts within more defined segments of the corridors.

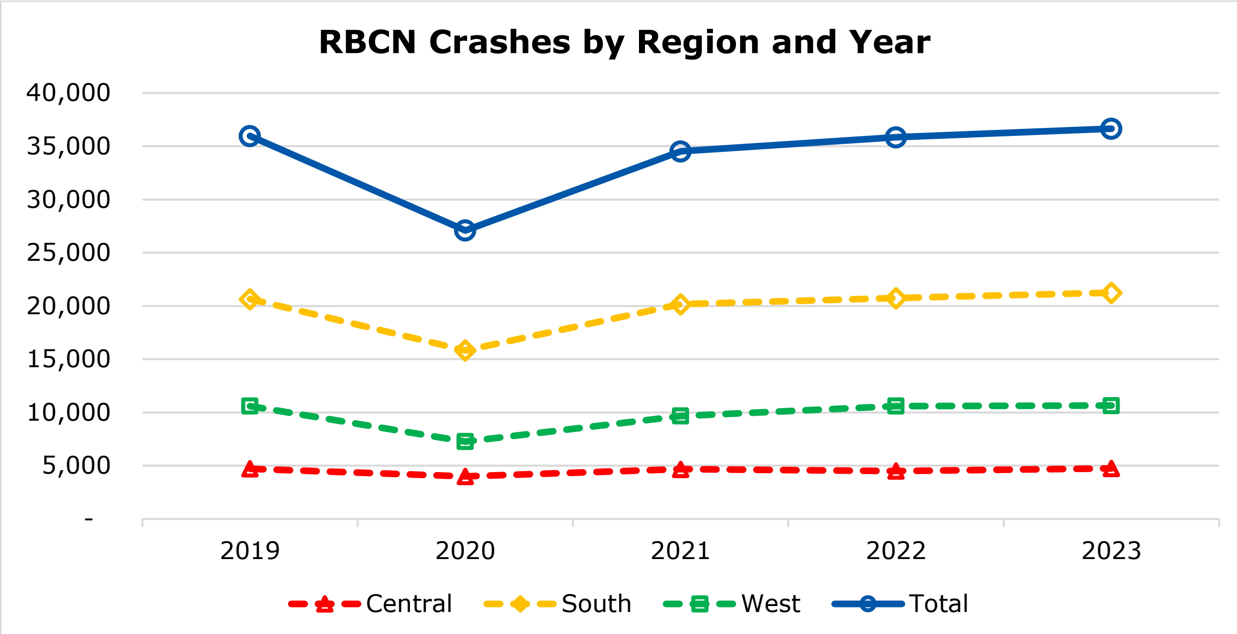
Figure 39: Graph of Crashes by Month, Texas Study Area 2019 - 2023



Source: TxDOT Crash Records Information System, 2019 – 2023

Breaking the data down by vehicle type, crash contributing factors, and changes over time reveal trends that will be significant in developing recommendations of the plan. While the changes in crashes seen in **Figure 39** show increases in crashes have been concentrated to specific roadway segments, cumulatively, crashes quickly rebounded from their COVID-19 associated drop and have steadily increased 7% beyond 2019 levels. As seen in **Figure 40,** the South Region of the study area experiences significantly more crashes than either the Central or West Regions (see dashed lines), representing 58% of all crashes in the study area. Overall trends in crash activity parallel one another across regions. The West Region exhibits a higher incidence of fatal incidents involving commercial vehicles.

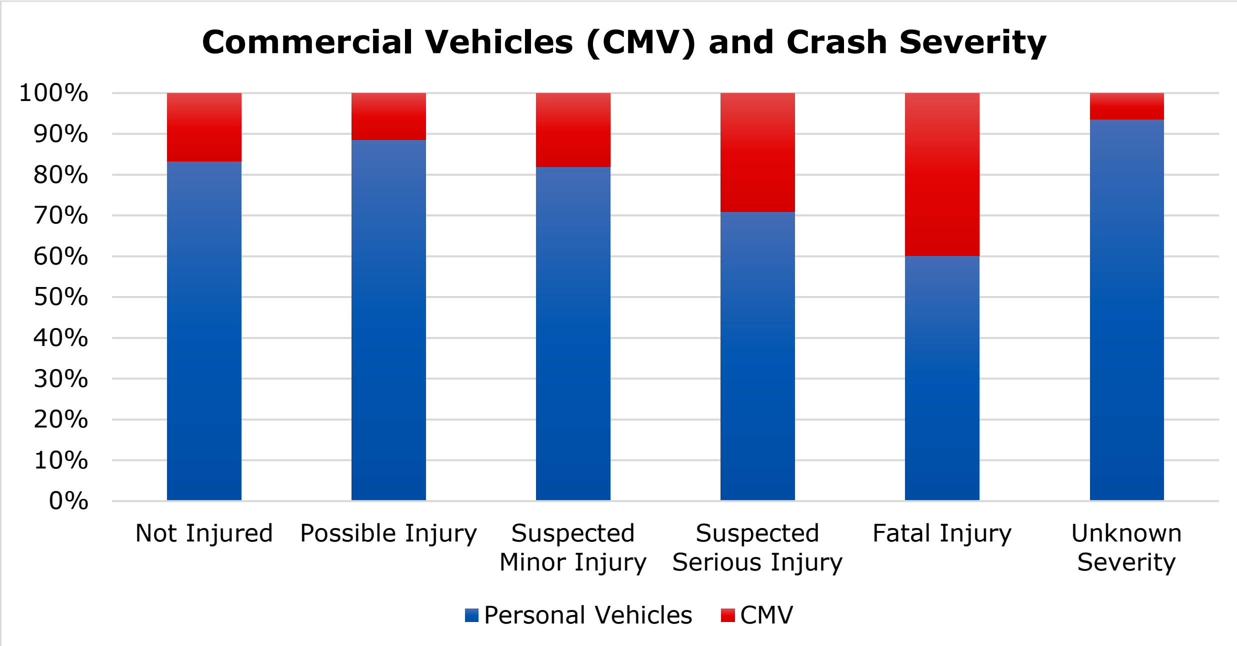
Figure 40: Reported Crashes Throughout Study Area, 2019 - 2023



Source: TxDOT Crash Records Information System (2019 – 2023)

As a whole crashes involving commercial motor vehicles (CMVs) are likely to be more severe than crashes between personal vehicles (**Figure 41**). This is likely because the average size and weight of commercial vehicles. This trend also helps decisionmakers plan for safety improvement projects, suggesting that roadways and corridors with especially high shares of CMVs should be prioritized for safety improvement efforts because they will represent a higher share of serious and fatal injury crashes. First and foremost, these crashes carry immense personal and human cost, however, they are also likely to significantly impact the travel time reliability of freight goods on the corridor.

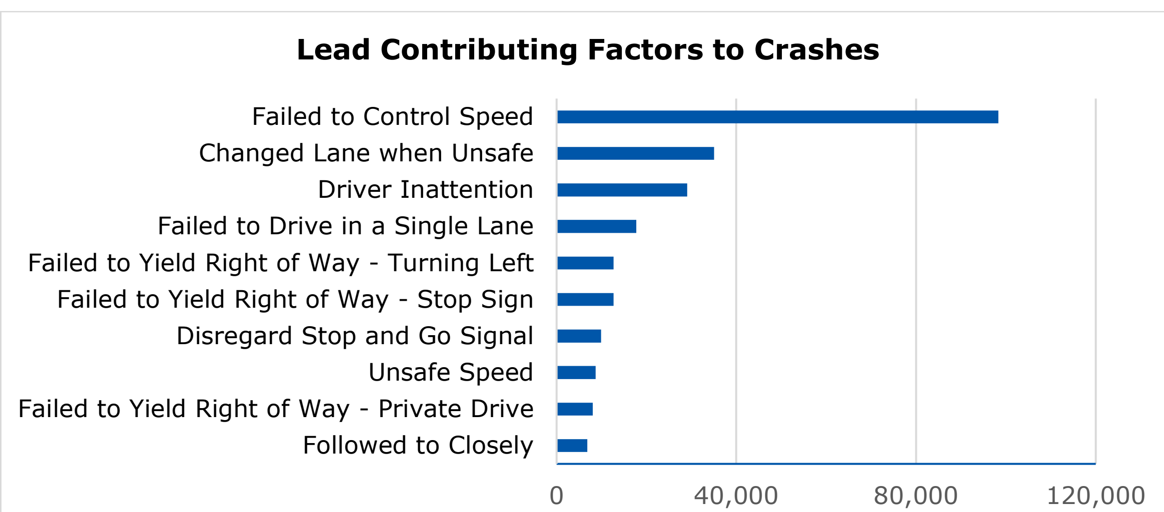
Figure 41: Commercial Vehicles (CMV) and Crash Severity on the RBCN, 2019 - 2023



Source: TxDOT Crash Records Information System, 2019 – 2023

When planning safety improvement efforts, it is important to target interventions that combat the most common causes of crashes. Ideally this is done on the roadway or corridor level on a project-by-project basis. Across the entire study area there are a series of reported crash causes that consistently appear at the top of the list. Some of these causes, such as failure to control speed, can be affected by roadway design decisions and interventions. Others, like driver inattention, are more difficult to design against. But tested and proven safety improvement projects documented in easily accessible databases, such as the Crash Modification Clearinghouse, provide safety intervention for each of the causes of crashes listed in **Figure 42** below.

Figure 42: Reporting Leading Causes of Crashes on the RBCN, 2019 - 2023



Source: TxDOT Crash Records Information System, 2019 – 2023

Next Steps

The next steps to advance the Region-to-Region Connectivity Study are:

1. **Forecast Future Demand:** Trends and data to forecast future demand for transportation and connectivity in the study area will be analyzed. Another memo will be prepared to synthesize our findings and prepare for the evolving needs of this area.
2. **Compare Needs to Planned Projects:** The identified needs will be compared with the planned projects on the Regional Border Connectivity Network (RBCN). This comparison will be used to pinpoint any gaps and prioritize projects that address the most pressing needs.
3. **Quantify Impacts of Lack of Connectivity:** A thorough analysis to quantify the impacts of inadequate connectivity will be conducted. This will be guided by the goals and objectives, including economic, and safety implications.
4. **Incorporate Input from Stakeholder Workshops:** Insights and feedback will be gathered from various groups, including local communities, freight and warehouse industry leaders, local government representatives, and other regional transportation experts.
5. **Engage Districts and Stakeholders:** Ongoing engagement with TxDOT Districts and Mexican stakeholders will be vital for the success of our initiatives. This collaboration will help refine our strategies and ensure alignment with regional and local priorities.

This technical memo will be used as a baseline to identify existing needs and as a comparison to forecasted future demands. The needs assessment will be used to compare the needs to the planned projects in the Border Region Connectivity Network Plan.

Texas-Mexico Border Region Connectivity Plan

Region-to-Region Existing & Future Needs Assessment Technical Memorandum

Texas Department of Transportation

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Introduction

Study Overview

The most recent Texas-Mexico Border Transportation Master Plan (BTMP) was published in March 2021. The Texas Department of Transportation (TxDOT) completed this effort in collaboration with various stakeholders and community members to develop a long-range plan for the Texas-Mexico Border Region that facilitates the efficient movement of people and goods. The plan produced 22 policy recommendations, 153 programs, and 661 project recommendations for future consideration and implementation.

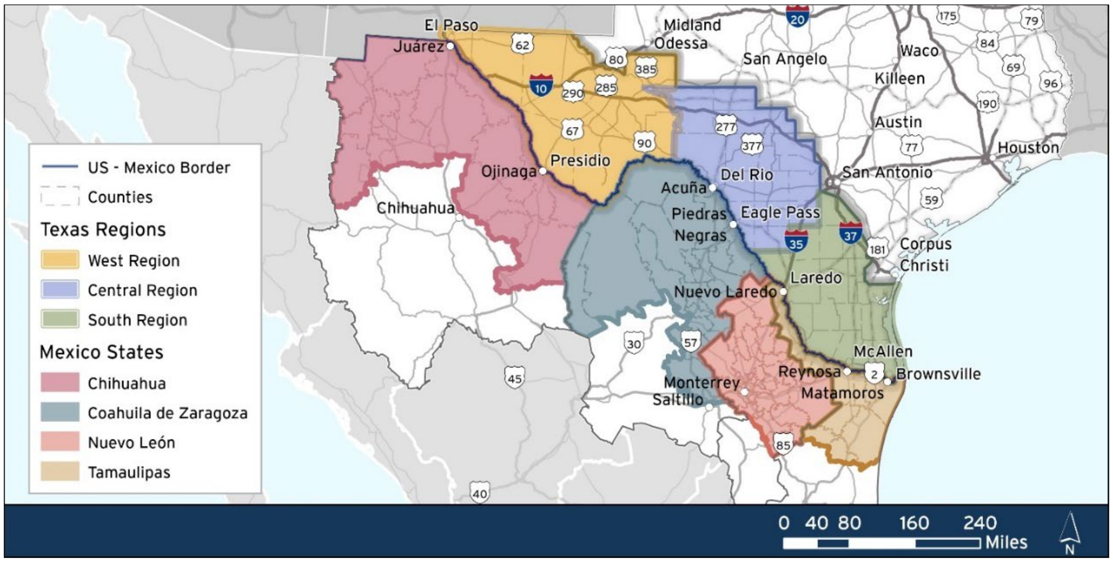
One of the 22 policy recommendations of the BTMP was to "provide multimodal connectivity between border crossings to provide enhanced network redundancy for efficient Border Region trips." The Region-to-Region Connectivity Study is a continuation of this policy consideration and will identify needs and make recommendations to improve multimodal connectivity in the Border Region. The Region-to-Region Connectivity Study is made up of the memos listed in **Table 1** below.

Table 1: Previous, Ongoing, & Future Memos Informing the Region-to-Region Study

Memo	Status
Draft Network Designation	Submitted
Draft Goals and Objectives	Submitted
Draft Network Needs Methodology	Submitted
Existing Conditions	Submitted
Existing and Future Needs Assessment	**This Memo**
Border Region Connectivity Plan	Submitted

Figure 1 identifies the Texas-Mexico Border Region considered for this study which consists of an area that is within approximately 100 miles of the Texas-Mexico border. This region is home to 13.6 million people and includes the West, Central, and South Border Regions of Texas and parts of Chihuahua, Coahuila de Zaragoza, Nuevo Leon, and Tamaulipas in Mexico (Texas Demographic Center, 2022; Mexico National Institute of Statistics and Geography (INEGI), 2020). In total, there are 43 counties in Texas and 99 municipalities or second-level administrative divisions in Mexico (*municipios*).

Figure 1: Region to Region Study Area



Current Tech Memo

This memorandum builds on the performance and conditions metrics and existing conditions developed in the Network Needs Methodology Memorandum and the Existing Conditions Memorandum. It presents the forecast conditions and needs assessment and includes descriptions of future demographics, Border Region activity profiles, process for identifying the Regional Border Connectivity Network (RBCN), and the existing and future needs assessment for the segments and corridors included in the RBCN.

Future Demographics

This section summarizes the demographic characteristics in the Region-to-Region Study Area. The demographic characteristics include 2050 population, household, and employment forecasts.

Population Forecasts

Texas Demographic Center Population Projections

Table 2 and **Figure 2** depict the 2050 population projections from the Texas Demographic Center. Hidalgo and El Paso counties are expected to continue having the largest populations in the Texas Border Region. Suburban areas near urban centers are projected to grow, while rural areas are likely to experience population decline.

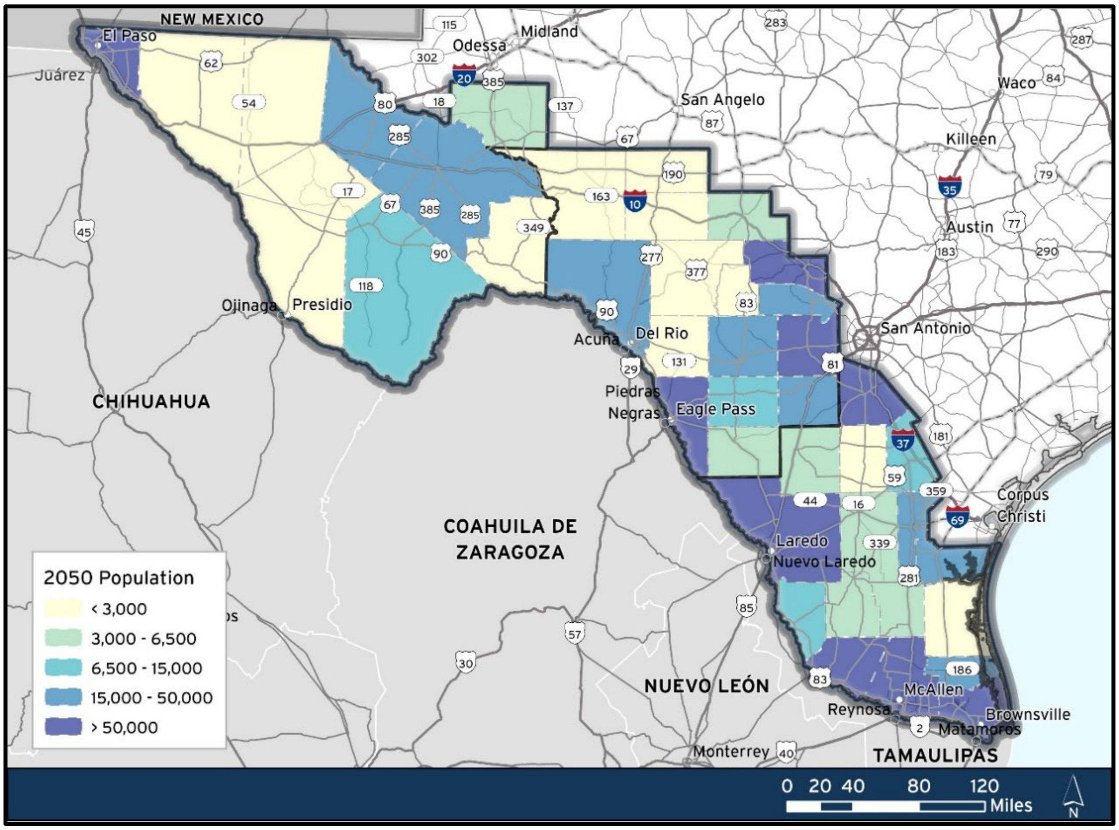
The counties in the West and South Regions have the largest population and will see higher growth than the Central Region. The counties of Reeves and Crane in the Permian Basin area are projected to have the most growth along with Atascosa County just south of San Antonio.

Table 2: Study Area Population in Millions by Region, 2050

Region	2022	2050	% Change
West	0.9	1.0	8%
Central	0.3	0.3	1%
South	1.8	1.9	6%
Border Region	**3.1**	**3.3**	**6%**
Texas	**29.9**	**40.6**	**36%**

Source: Texas Demographic Center, Texas Population Projections 2020 to 2050, 1.0 Migration Scenario

Figure 2: Study Area Population in Millions, 2050



Transportation Demand Model Population Projections

Sociodemographic projections were calculated based on historic growth rates developed by the Texas Demographic Center (TDC). **Table 3** and **Table 4** illustrate the total population, and **Figure 3** shows overall compounded annual growth rate (CAGR) of the population within the study area from 2022 to 2050 aggregated by county. The projection was developed by running a travel demand model which apportioned growth by the transportation analysis zone (TAZ). These population projections were then totaled by county.

The map indicates that the highest population growth is generally projected to occur in the most populous counties, including areas surrounding San Antonio and Midland-Odessa, as well as El Paso, Eagle Pass, and McAllen. This growth trajectory aligns with historical trends indicating that most of the population growth is expected to occur in or near these major urban centers.

Conversely, counties further from these major urban centers are projected to experience population decline, highlighting an ongoing demographic shift from rural to urban regions in the future. It is important to note that the growth rates, which have declined over the last two decades, are projected to continue declining through 2050. Despite this general slowdown in growth, the regional population is projected to increase at a reduced rate with most rural counties experiencing slight population declines.

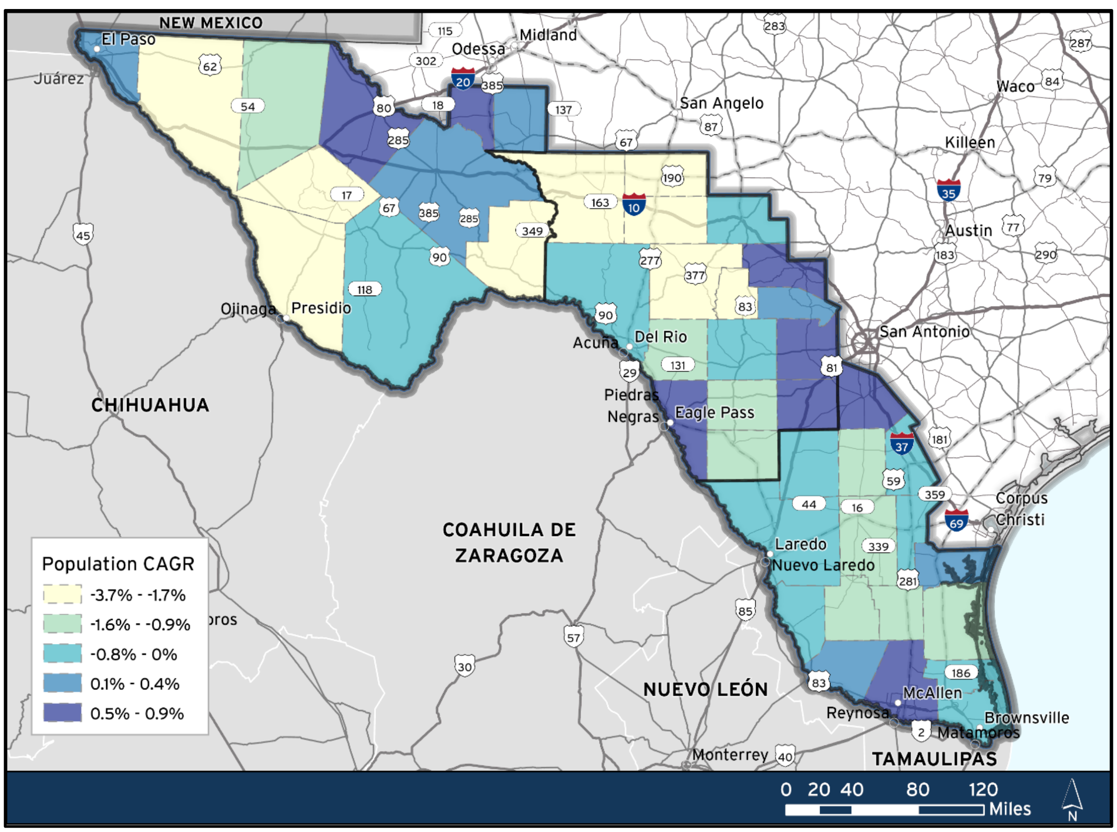
Table 3: Population in Most Populous Counties, 2022-2050

County	Population (rounded to the nearest thousand)	
	2022	2050
Hidalgo	889,000	1,006,000
El Paso	870,000	947,000
Cameron	423,000	418,000
Webb	271,000	262,000
Starr	66,000	73,000
Maverick	58,000	65,000
Kerr	54,000	61,000
Medina	52,000	60,000

Table 4: Study Area Population in Millions by Region, 2022-2050

Region	Population	
	2022	2050
West	0.9	1.0
Central	0.3	0.3
South	1.8	1.9
Border Region	**3.1**	**3.3**

Figure 3: Population CAGRs by County, 2022-2050



Household Forecast

Transportation Demand Model Household Projections

Table 5 and **Table 6** show the total number of households in the study area. **Figure 4** illustrates the overall household CAGRs for counties within 100 miles of the U.S.–Mexico border from 2022 to 2050. The map indicates that the highest growth in households is associated with counties that are expected to experience the highest growth in population. The map effectively highlights regions with varying growth rates, emphasizing areas with substantial household expansion alongside those with minimal or negative growth. In most cases, counties experiencing significant population growth are also forecasted to see corresponding household growth. Notably, household growth often outpaces population growth, reflecting a trend toward smaller household sizes in the region.

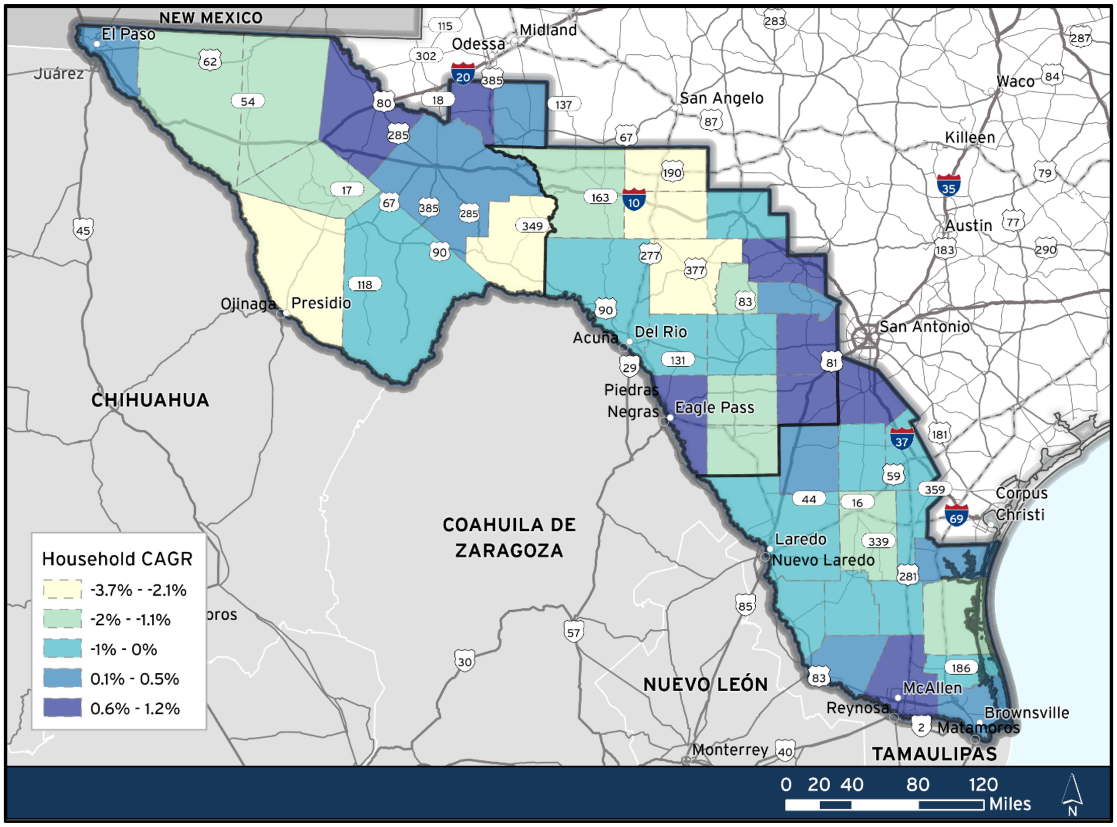
Table 5: Number of Households in Most Populous Counties, 2022-2050

County	Number of Households (rounded to the nearest thousand)	
	2022	2050
El Paso	320,000	352,000
Hidalgo	273,000	312,000
Cameron	143,000	142,000
Webb	80,000	79,000
Starr	20,000	23,000
Maverick	19,000	21,000
Kerr	23,000	27,000
Medina	17,000	20,000

Table 6: Study Area Households by Region, 2022-2050

Region	Households (rounded to the nearest thousand)	
	2022	2050
West	338,000	369,000
Central	109,000	112,000
South	581,000	620,000
Border Region	**1,028,000**	**1,102,000**

Figure 4: Household CAGRs by County, 2022-2050



Employment Forecast

Transportation Demand Model Employment Projections

Table 7 and **Table 8** narrow down the employment trends to the major counties within 100 miles of the U.S.–Mexico border. Notably, Hidalgo and Cameron Counties are expected to have the highest growth rates. Most of the counties along the border are expected to have a growth rate of more than 1.5% from 2022 to 2050, highlighting significant employment expansion in these regions.

Table 7: Employment in Major Counties, 2022-2050

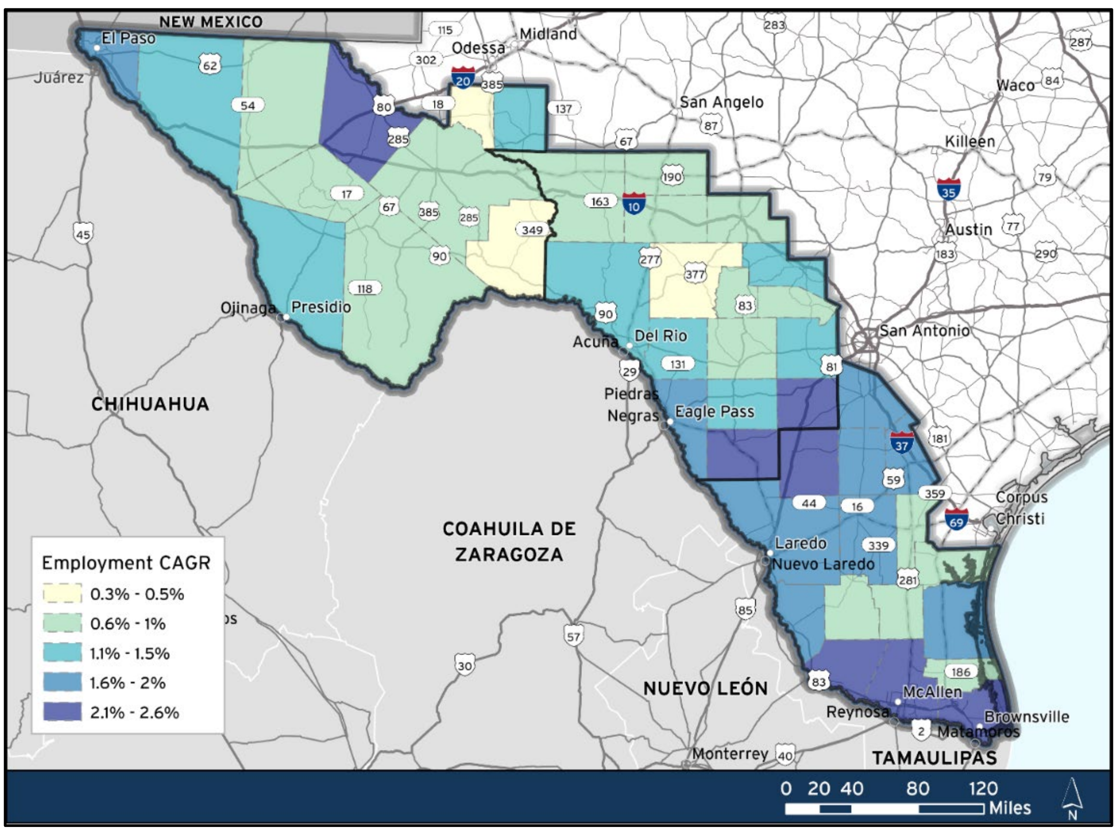
County	Number of Jobs (rounded to the nearest thousand)	
	2022	2050
Hidalgo	267,000	489,000
El Paso	291,000	470,000
Cameron	143,000	288,000
Webb	97,000	160,000
Starr	14,000	25,000
Maverick	12,000	21,000
Kerr	14,000	21,000
Medina	11,000	21,000

Table 8: Study Area Employment by Region, 2022-2050

Region	Number of Jobs (rounded to the nearest thousand)	
	2022	2050
West	311,000	501,000
Central	86,000	127,000
South	578,000	1,046,000
Border Region	**975,000**	**1,674,000**

Figure 5 illustrates the projected employment CAGRs for counties within 100 miles of the U.S.–Mexico border, from 2022 to 2050. The map indicates that all counties in the area are expected to experience some growth in employment numbers over the period of 2022 to 2050. Unlike with population and households, higher employment growth rates are expected in several counties further away from major urban centers, such as along the I-35 corridor between Laredo and San Antonio, as well as significant job growth predicted in the areas surrounding Brownsville and McAllen. In general, predicted CAGRs in employment exceed the predicted population growth rate throughout the region.

Figure 5: Employment CAGRs within 100 Miles of the U.S.-Mexico Border, 2022-2050



Border Region Activity and Profiles

This section summarizes updated Border Region activity and profiles for the Region-to-Region Study Area. The Border Region activity and profiles include the commodity flow analysis, cross border truck trips and major origins and destinations, and social and cultural components.

Commodity Flow Analysis

Regional Trade Profile

The 1,254-mile border that Texas shares with Mexico, particularly its border infrastructure, plays a vital role in supporting trade between the U.S. and Mexico. This infrastructure comprises 28 international bridges and border crossings, including two dam crossings and one hand-drawn ferry, distributed across the three Border Regions (West, Central, and South). Out of these crossings, 18 are equipped to handle trucks or commercial motor vehicles. Additionally, Texas is home to five of the seven railway crossings on the U.S.-Mexico border.

Table 9 lists the ports of entry in the Texas-Mexico border West, Central, and South Regions and the freight rail and truck infrastructure, organized from west to east.

Table 9: Port of Entry[1] and Cross Border Freight Truck and Rail Facilities by Region (2023)

Border Region	Port of Entry	Cross Border Freight Truck (●) and Rail (□) Facilities
West	El Paso	Bridge of the Americas● Union Pacific Railway□
	Ysleta	Ysleta Bridge●
	Tornillo	Tornillo-Guadalupe Bridge●
	Presidio	Presidio-Ojinaga International Bridge● Presidio–Ojinaga International Rail Bridge□ (currently not in operations)[2]
Central	Del Rio	Del Rio International Bridge●
	Eagle Pass	Camino Real International Bridge● Union Pacific International Railroad Bridge□
South	Laredo	Colombia Solidarity Bridge● World Trade Bridge● Kansas City Southern Railway□
	Roma	Roma–Ciudad Miguel Alemán International Bridge●
	Rio Grande City	Starr-Camargo Bridge●
	Hidalgo	Anzalduas International Bridge● McAllen-Hidalgo International Bridge● Pharr-Reynosa International Bridge●
	Progreso	Progreso International Bridge●
	Brownsville	Free Trade International Bridge● Brownsville & Matamoros Express Bridge● (also a rail bridge) Union Pacific Railway□ Veterans International Bridge at Los Tomates●

Source: TxDOT Border Crossing Facilities and BTS North America Rail Network Lines, 2024.

[1] In the context of cross-border activity, a Port of Entry is the official border crossing facility and legal entry point, while a bridge is a physical structure that may be part of a land-based POE's infrastructure.

[2] Presidio International Rail Bridge Project Pushed to Summer 2025. Jennifer McLawhorn, RT&S, December 4, 2023. Retrieved from https://www.rtands.com/track-construction/track-structure/bridges-tunnels/presidio-international-rail-bridge-project-pushed-to-summer-2025/. Accessed on April 15, 2024.

Figure 6 displays the northbound and southbound trade across the ports of entry in 2023. Key takeaways include:

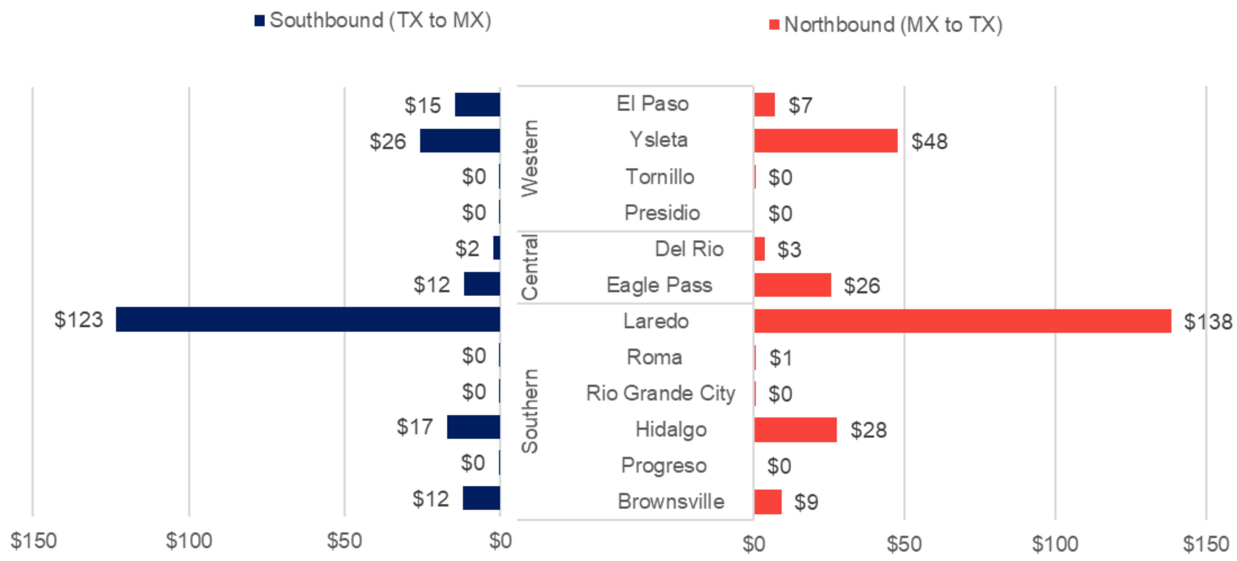
- **South Region's Predominance:** The South Region is preeminent, showcasing the highest trade volumes overall, with $366 billion in both southbound and northbound directions in 2023. This eclipses the trade in the West ($96 billion) and Central ($6 billion) regions. Within this region, the Laredo Port of Entry is particularly noteworthy, accounting for a substantial 60% of all southbound trade at $123 billion, and 52% of northbound trade at $138 billion. This high level of trade is facilitated by the World Trade Bridge between Laredo and Nuevo Laredo and the Colombia Solidarity Bridge between Laredo and Colombia. These two bridges support a large share of truck vehicle traffic, along with the Kansas City Southern Railway that handles rail freight. Following Laredo, the Hidalgo Port of Entry also sees significant trade, with $17 billion southbound and $28 billion northbound, utilizing three bridges that facilitate truck vehicle crossings: Anzalduas, McAllen-Hidalgo, and Pharr-Reynosa. At Brownsville, three international bridges—Brownsville & Matamoros, Free Trade at Los Indios, and Veterans at Los Tomates—alongside a Union Pacific rail bridge, facilitate goods movement, with higher southbound trade volume ($12 billion) compared to northbound ($9 billion).

- **Notable Activity in the West Region**: The West Region's Ysleta Bridge shows significant northbound trade activity with $47.6 billion versus $25.8 billion southbound. Also, the Bridge of the Americas and Union Pacific rail facility in El Paso serve southbound flows worth $15 billion and northbound flows worth $7 billion.

- **Central Region:** Eagle Pass, too, is a key entry point, with the Camino Real International Bridge and the Union Pacific International Railroad Bridge enabling $26 billion northbound and $12 billion southbound trade.

- **Other Ports with Modest Trade Impact**: Other ports, such as Tornillo and Presidio in the West Region, Del Rio in the Central Region, and Roma, Rio Grande City, and Progreso in the South Region, exhibit relatively modest trade volumes. Collectively, these locations contribute 2% to the overall trade value, reflecting their more limited roles in the cross-border trade dynamics.

Figure 6: Goods Movement by Direction and Border Region (in Billion Dollars), 2023



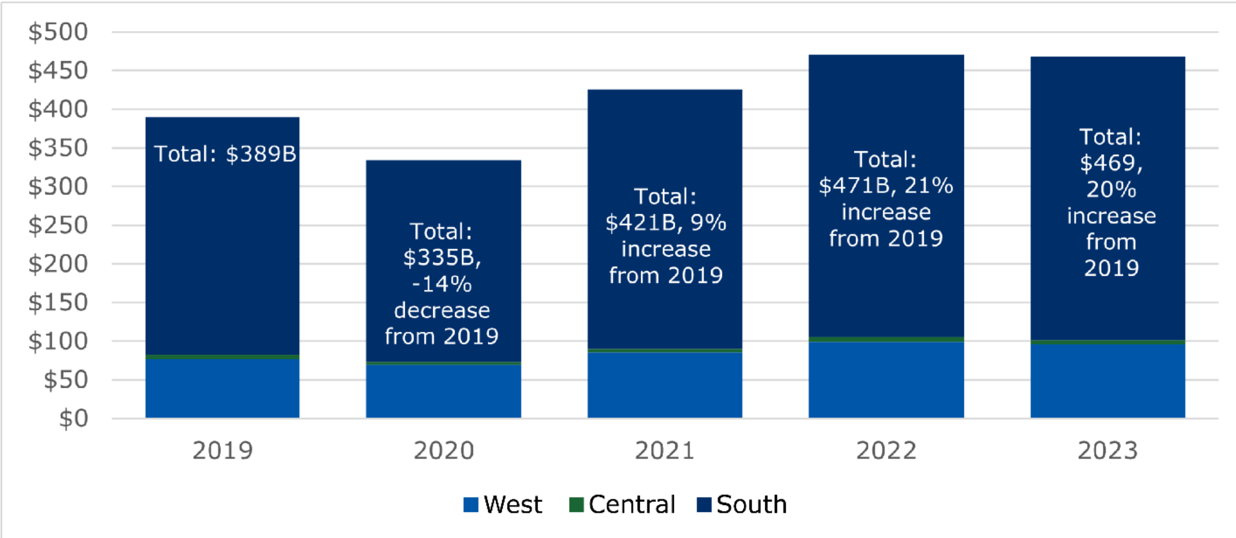
Source: Analysis of BTS TransBorder Freight Data.

Figure 7 highlights the growth in trade values across the West, Central, and South Regions since 2019. The main findings are:

- **Growth Driven by the South Region:** The South Region demonstrated not only the largest volume of trade but also significant growth since 2019. The South Region saw a 19% increase in trade value since 2019, accounting for 75% of the total growth in commodity value across the three Texas Border Regions. The West Region saw a 25% growth in trade value from 2019. Although its overall trade volume remains the smallest, the Central Region also experienced notable growth since 2019 at 10%.

- **Resilience and Growth Post-Pandemic:** All regions experienced a drop in trade value in 2020, due to the COVID-19 pandemic, with the South Region leading the drop at $46 billion, followed by the West Region at $8 billion and the West Region contracting from $5 billion in 2019 to $4 billion in 2020. Trade across all regions shows resilience and capacity for recovery post-pandemic, with each region not only recovering from the 2020 dip but also surpassing 2019 levels by 2023. The South Region added back $74 billion in 2021, followed by the West Region at $16 billion, and the Central Region returning to its pre-pandemic level.

Figure 7: Cross Border Commodity Flow Value (in Billion Dollars) by Texas Border Regions (2019-2023)



Source: BTS TransBorder Freight Data. Note, data for October through December 2020 is not available from BTS and was estimated by extrapolating from the modal distribution patterns observed in 2019 and from 2021 to 2023.

Cross Border Truck Trips and Major Origins and Destinations

This section discusses the key origins and destinations of cross-border freight truck trips. The data used for this analysis include GPS-enabled travel pattern data (INRIX), Bureau of Transportation Statistics (BTS) Border Crossing Data, and commodity flow data (TRANSEARCH). Together, these datasets provide a comprehensive view of vehicles and commodities moved across the Texas-Mexico border, mode of transportation, and their origins and destinations.

Figure 8 and **Figure 9** show the origins and destinations of freight truck trip counts through the border crossings, overlayed with the employee count of freight-related businesses in the region.

- **West Region:** In addition to the El Paso border crossings, freight truck trip origins and destinations are concentrated along I-10, and near the Pecos, Fort Stockton, and Sanderson areas.
- **Central Region:** In the Central Region, trips are primarily concentrated in Val Verde County where the Lake Amistad Dam Crossing and the Del Rio International Bridge are located. Sonora and Uvalde are also main truck trip origins and destinations.
- **South Region:** In the South Region, high trip counts are also observed near the border crossings. Communities along I-35, including Pearsall, Dilley, Cotulla, and Encinal are all major truck trip origins and destinations, connecting Laredo with San Antonio. In addition, Falfurrias, east of I-35, and Carrizo Springs, west of I-35, also saw a high number of freight trips.

Figure 8: Origins of Truck Trips Through Border Crossings

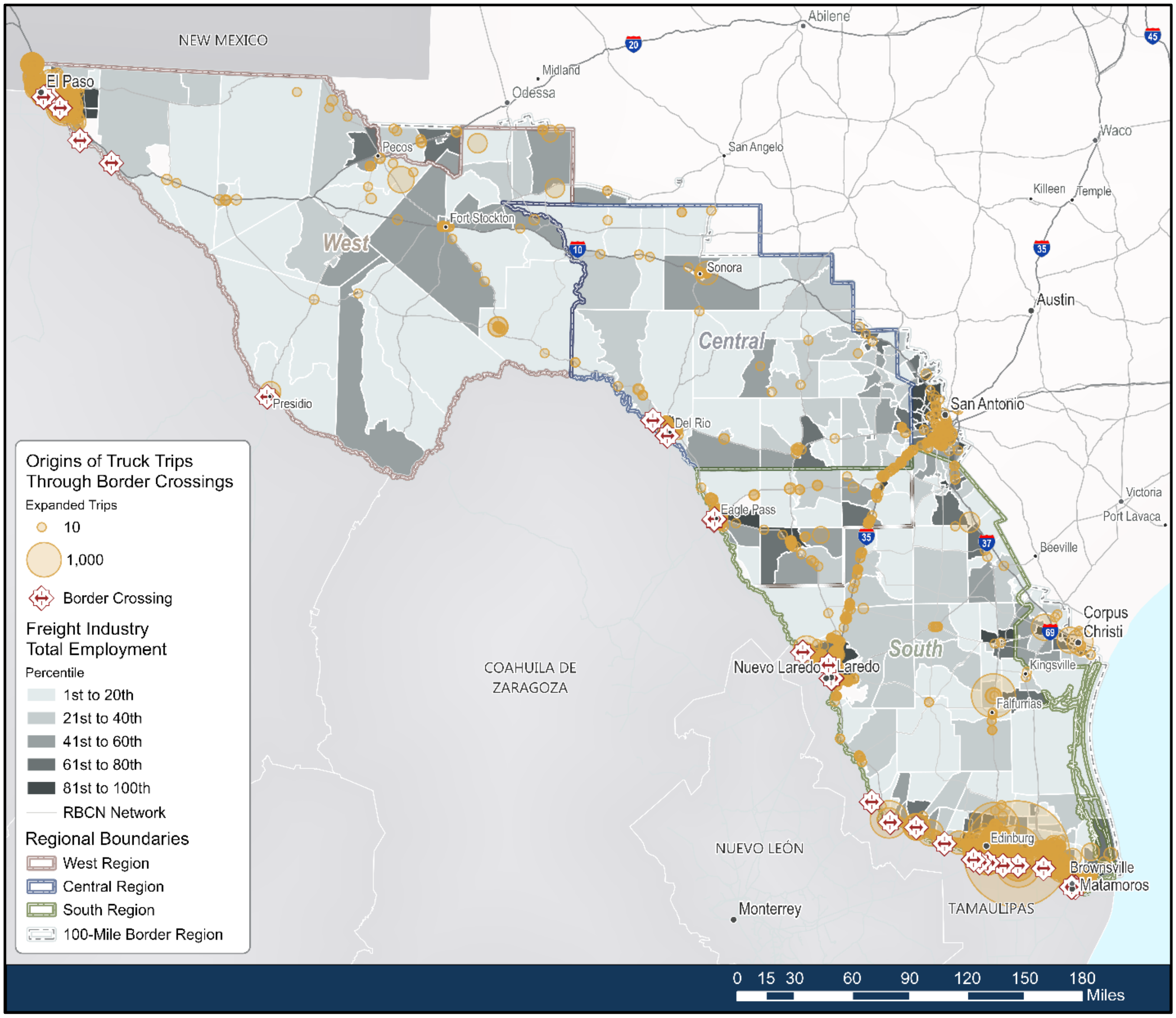
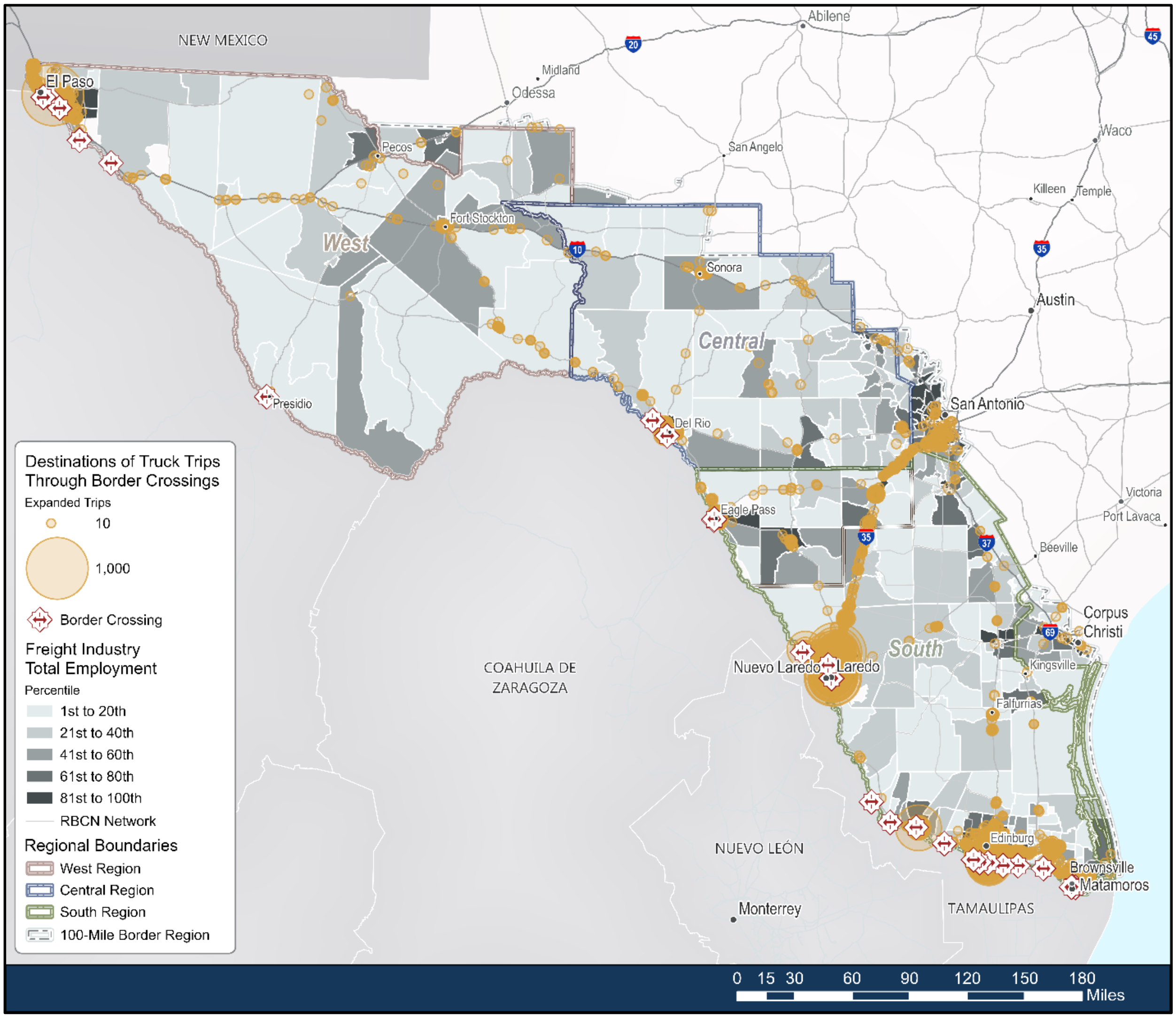


Figure 9: Destinations of Truck Trips Through Border Crossings



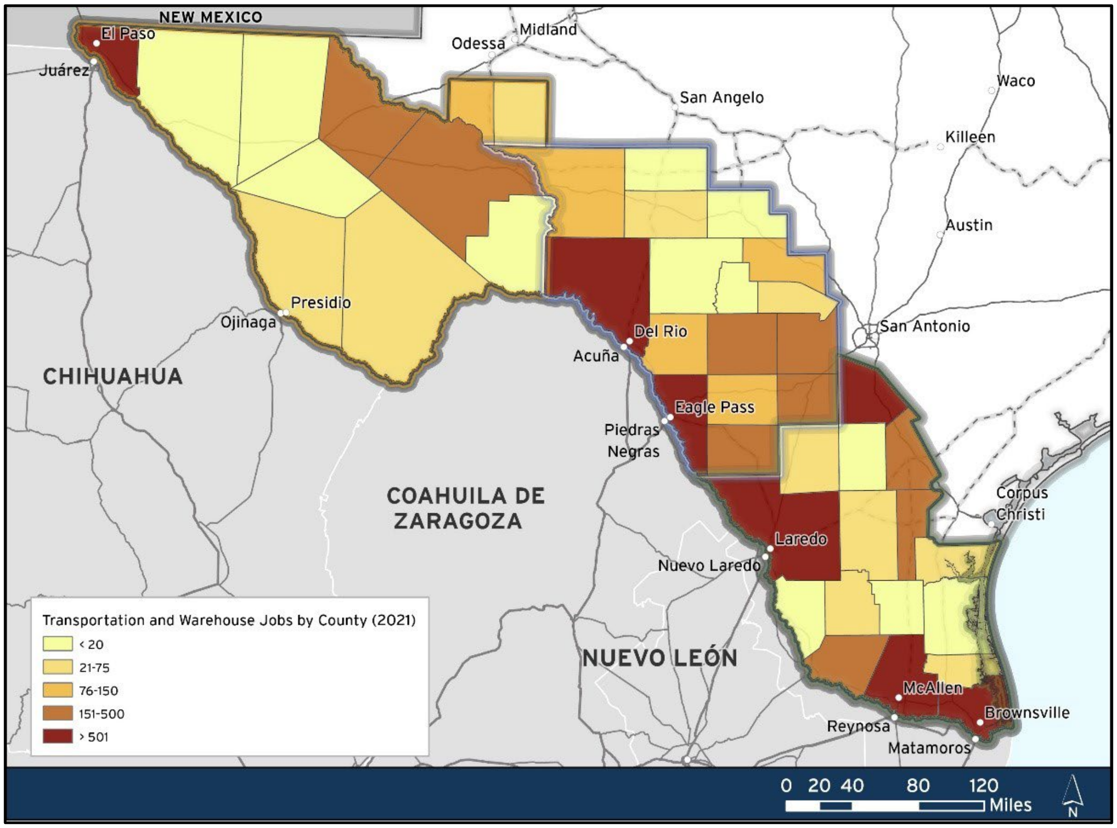
Transportation and Warehousing Jobs

Transportation and Warehousing Jobs

The concentration of transportation and warehouse jobs (**Figure 10**) serves as a proxy to represent common destination centers for truck vehicles and commodity generators. Data for this metric was sourced from the U.S. Census Bureau's Longitudinal Employer-Household Dynamics (LEHD) Origin-Destination Employment Statistics (2002-2021). The Texas study area hosts over 50,000 transportation and warehousing jobs, with the highest concentration in the South Region. Key counties with significant employment in this sector include El Paso in the West Region; Val Verde and Maverick in the Central Region; and Webb, Hidalgo, Cameron, and Atascosa in the South Region.

Investing in these regions is essential for supporting and enhancing cross-border trade and economic activity. These areas play a critical role in facilitating the efficient movement of goods between the U.S. and Mexico, making them strategic hubs for the regional supply chain. Strengthening infrastructure and fostering further development in these counties will improve connectivity, reduce bottlenecks, and ensure long-term economic competitiveness across the Texas-Mexico border.

Figure 10: Transportation & Warehouse Jobs, Texas Study Area 2021



Mode Analysis of the Goods Movement

Intermodal Facilities

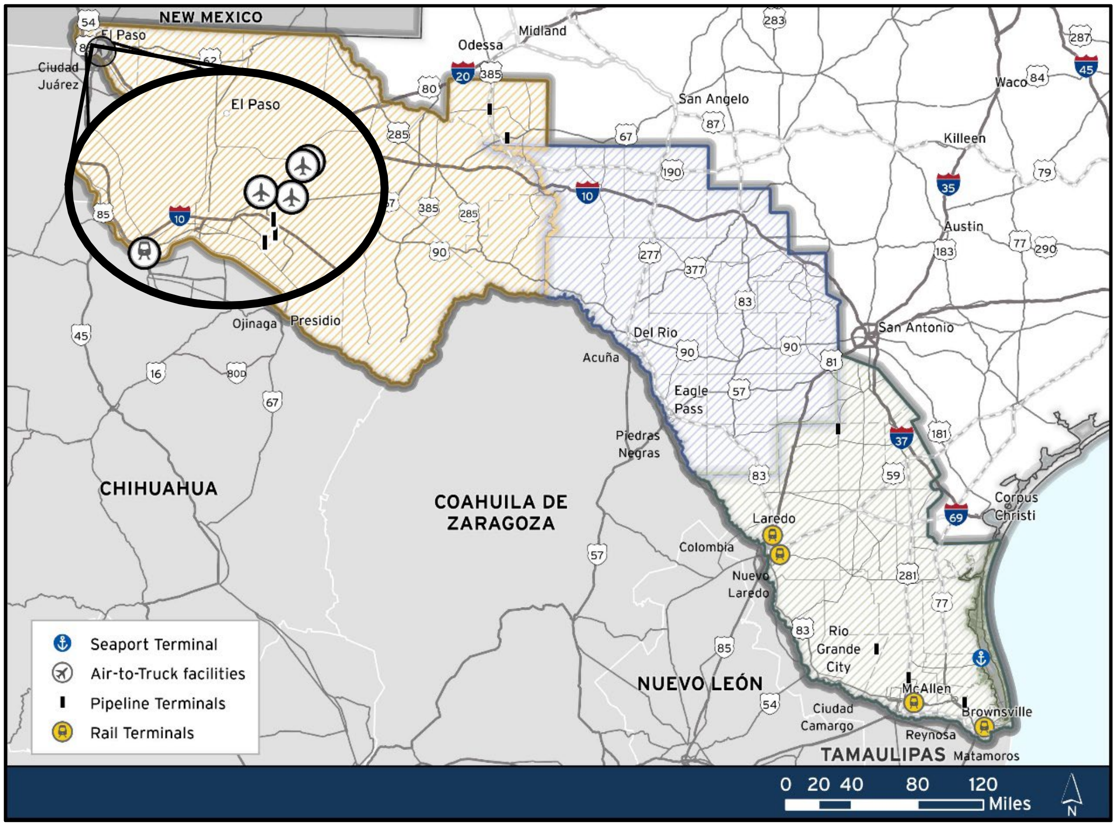
Intermodal facilities are crucial for the connectivity of goods movement and commodity flow because they serve as pivotal hubs where goods can seamlessly transition between different modes of transportation, such as trucks, trains, and ships. This integration enhances the efficiency and cost-effectiveness of goods movement throughout Texas and across the border by reducing handling times and minimizing the risk of damage. Considering the location of intermodal facilities can help optimize routes, reduce transit times, and improve access to markets, thereby supporting regional economic competitiveness.

The concentrations of intermodal facilities (**Figure 11**) represent key origins and destinations for trucks and commodity generators. The data was sourced from the U.S. Bureau of Transportation Statistics (2020-2021) and the TxDOT (2021). Within the study area, intermodal facilities are most concentrated in two areas: the West Region, specifically in El Paso County, and the South Region, particularly in Cameron County.

- **El Paso County:** Contains a total of 11 intermodal facilities, consisting of 6 pipeline terminals, 1 rail terminal, 4 air terminals and no sea terminals.

- **Cameron County:** Contains a total of 10 intermodal facilities, consisting of 5 pipeline terminals, 4 sea terminals, 1 rail terminal and no air terminals.

Figure 11: Intermodal Facilities within Study Area

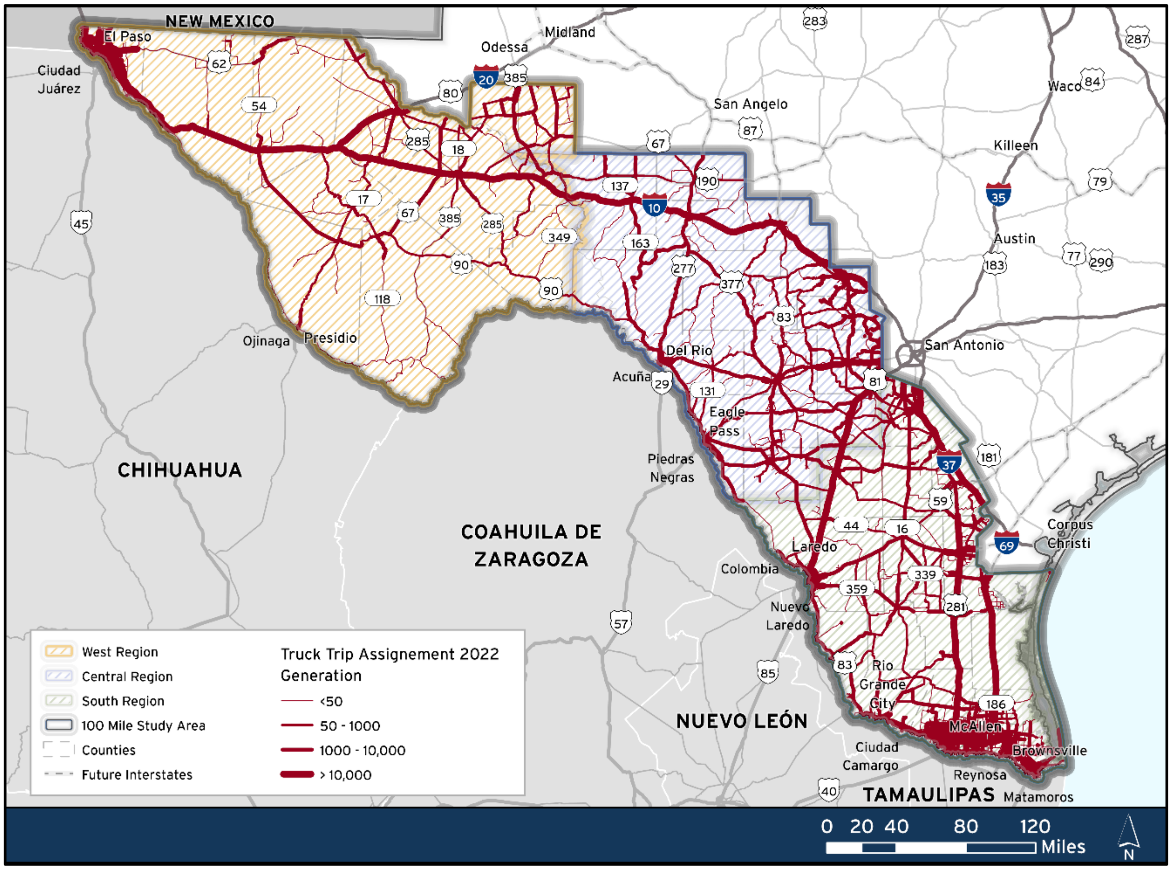


Truck Vehicle Miles Traveled (VMT)

Most goods movement within the region is facilitated by trucks. **Figure 12** on the next page shows the truck VMT (2022). Within Texas' Border Region, much of the truck VMT is focused along interstates and arterials, such as I-10, I-35, US 377, US 90, US 281, US 77, and SH 16. These are predominantly north-to-south corridors connecting major cities like San Antonio, Midland, and Corpus Christi to the Border Regions. In total, 13.6 million truck VMT was estimated to occur in 2022, or 20.5% of the total 66 million VMT in the study area. Other key findings include:

- West Region was estimated to have the largest share of truck VMT, at 5.3 million (39%)
- Central Region showed the lowest VMT among the three regions, at 3.7 million (27%)
- South Region was estimated to be 4.6 million (34%)

Figure 12: Regional Truck VMT, 2022



Inter-regional Traffic Volumes by Mode

Traffic Volumes

Volume-to-Capacity (V/C) Ratio

The volume-to-capacity (V/C) ratio is a crucial metric in transportation planning. It is used to assess roadway efficiency by comparing the traffic volume to the road's maximum capacity. A V/C ratio of less than 1.0 indicates smooth traffic flow, whereas values greater than 1.0 indicate overcapacity, leading to congestion and delays. This metric is essential in evaluating roadway performance, guiding infrastructure improvements, and planning for future traffic needs. It is widely used in traffic impact studies, roadway design, and traffic signal optimization to improve vehicle flow and reduce congestion.

The V/C ratio percent change from 2022 to 2050 is a key indicator of future traffic demand growth on various corridors along the Texas Border Region. **Figure 13** shows that although the highest percentage changes are clustered around major cities within the 100-mile buffer zone (Travel Demand Model provides detailed study area analysis), several regional corridors experience significant V/C ratio growth, particularly in the Central and West Regions.

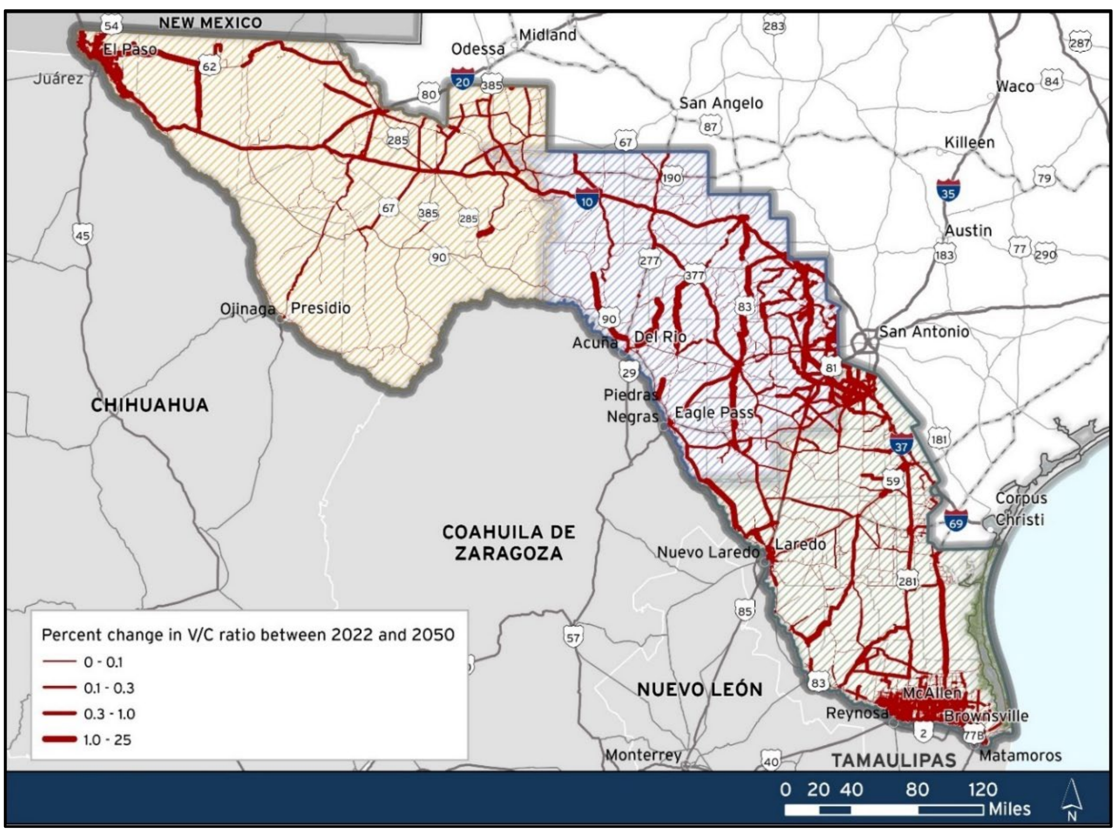
In the Central Region, the corridors with the highest growth—based on V/C ratio change—are primarily located between Eagle Pass, Del Rio, and San Antonio. Key corridors showing high growth include US 90 and FM 1024 through Val Verde County, US 83 through Zavala, Uvalde, Real, and Kerr Counties, and SH 173 through Medina and Bandera Counties. Additional high-growth corridors in this region include US 163 and US 137 through Crockett County, SH 55 through Edwards and Uvalde Counties and RM 2523 and RM 674 through Kinney and Edwards County. These corridors are expected to see substantial increases in traffic demand, making them priorities for future infrastructure improvements to accommodate growing congestion.

While the forecasted V/C ratio growth in the West Region is lower than in the Central Region, several key corridors are expected to see significant increases in traffic demand. Notable corridors include US 62 through El Paso, Hudspeth, and Culberson Counties, RM 1111 through Hudspeth County, SH 17 through Reeves County, and US 67 through Pecos and Brewster Counties. Additional corridors with notable V/C ratio growth include FM 1776, FM 1053, FM 385, and FM 305 through Pecos County.

In the South Region, the V/C ratio percentage change between 2022 and 2050 is significant but lower than in other regions. Key corridors expected to experience more than a 1% change in V/C ratio include US 281 through Hidalgo, Brooks, Jim Wells, and Live Oak Counties, SH 16 through Jim Hogg and Duval Counties, and FM 755 through Starr and Brooks Counties. Additional corridors with notable changes include FM 1472 through Webb County and SH 44 through Webb County.

The overall increase in V/C ratio by 2050 highlights significant growth in traffic demand, particularly around major cities, and along key corridors in counties such as Pecos and Uvalde. These trends underscore the need for targeted infrastructure improvements to support future traffic needs and reduce congestion along these vital corridors.

Figure 13: V/C Ratio Growth (2022-2050) – Texas Border Region



Annual Average Daily Traffic (AADT)

Two key measures in transportation planning are total annual average daily traffic (AADT) and truck AADT. Although truck AADT focuses on the effects of large vehicles on road infrastructure, safety, and freight transportation, total AADT examines total traffic levels to ensure roads are planned to satisfy current and future demand. These indicators are essential for directing financial allocation, safety enhancements, and maintenance, especially for corridors with high freight traffic.

Table 10 shows percentage change in total and truck volume in 2022 and 2050 for the Central, South, and West Regions. The Texas Border Region is expected to see substantial growth in both total vehicle at 27%, and truck traffic increasing at a much higher rate of 72%. The West Region is expected to see the largest increase in total traffic at 38%, given that the West Region has the smallest share of road length. The Central Region and South Region are expected to have a 22% and 20% increase in total volume.

In terms of truck traffic, projected change in volume percentage seems to align with the share of road length across regions. The South Region, with the largest share of corridors in the RBCN in the Texas Border Region, is projected to see the highest increase in truck volume at 77%. The Central Region follows with a 73% increase, and the West Region is projected to see a 67% rise in truck traffic. Overall, share of truck volume is expected to grow most significantly in the South and Central regions.

Table 10: Change in Total Traffic and Truck Traffic Volume, 2022-2050

Region	% Change in Annual Average Daily Traffic (AADT), 2022-2050	
	Total volume	Truck volume
Central	22%	73%
South	20%	77%
West	38%	67%
Border Region	**27%**	**72%**

Further analysis of traffic statistics for 2022 shows how AADT is projected to change in the corridors by 2050 (**Figure 14** and **Figure 15**). In the Central Region, US 90, US 83, and SH 173 are important corridors. It is anticipated that by 2050, the volumes on US 83 and SH 173 would increase significantly, reflecting a growing need for both passenger and freight transportation.

In the West Region, US 62 registers a high AADT in 2022 and is expected to see substantial growth in 2050. The corridor's increasing traffic volume underscores the need for targeted infrastructure investments to accommodate rising demand.

In the South Region, US 83, along with SH 107 and SH 44, shows high AADT in 2022. However, by 2050, SH 72 and US 83 are projected to see the most significant growth in total traffic volume, marking them as priority corridors for future capacity enhancements.

Figure 14: 2022 Total Vehicles AADT – Texas Border Region

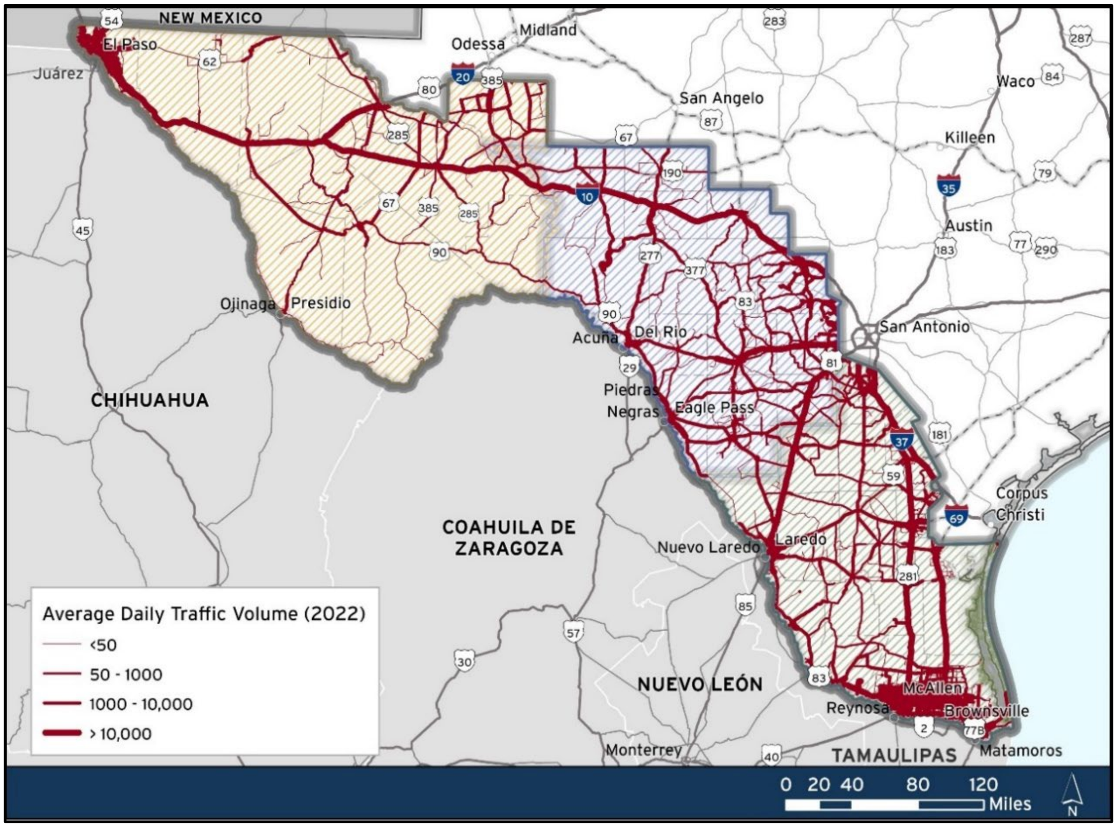
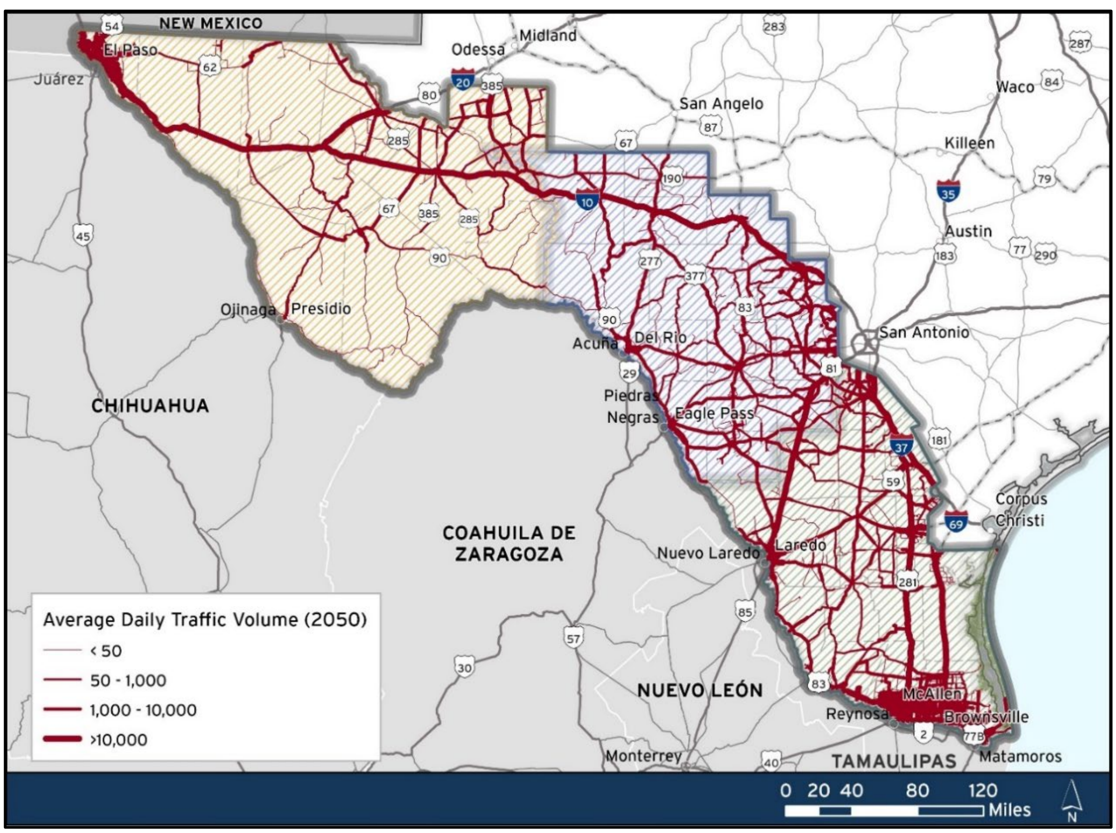


Figure 15: 2050 Total Vehicles AADT – Texas Border Region



For truck AADT, the Central Region again dominates with significant truck traffic in 2022 (**Figure 16**). Key freight corridors include US 83, SH 55, and SH 173, all of which are expected to see a considerable increase in truck volume by 2050. In the South Region, important truck corridors include SH 16, US 281, US 77, and US 83. Among these, SH 16 and US 83 are projected to experience the highest growth in truck traffic by 2050, highlighting the need for improvements to support increased freight movement in these areas (**Figure 17**).

Both total AADT and truck AADT projections show that strategic investments in roadway capacity and safety enhancements will be critical to accommodating future traffic demands, particularly in high-growth corridors across the Central, West, and South regions. More detailed and local AADT information is provided in the Travel Demand Model.

Figure 16: 2022 Truck AADT – Texas Border Region

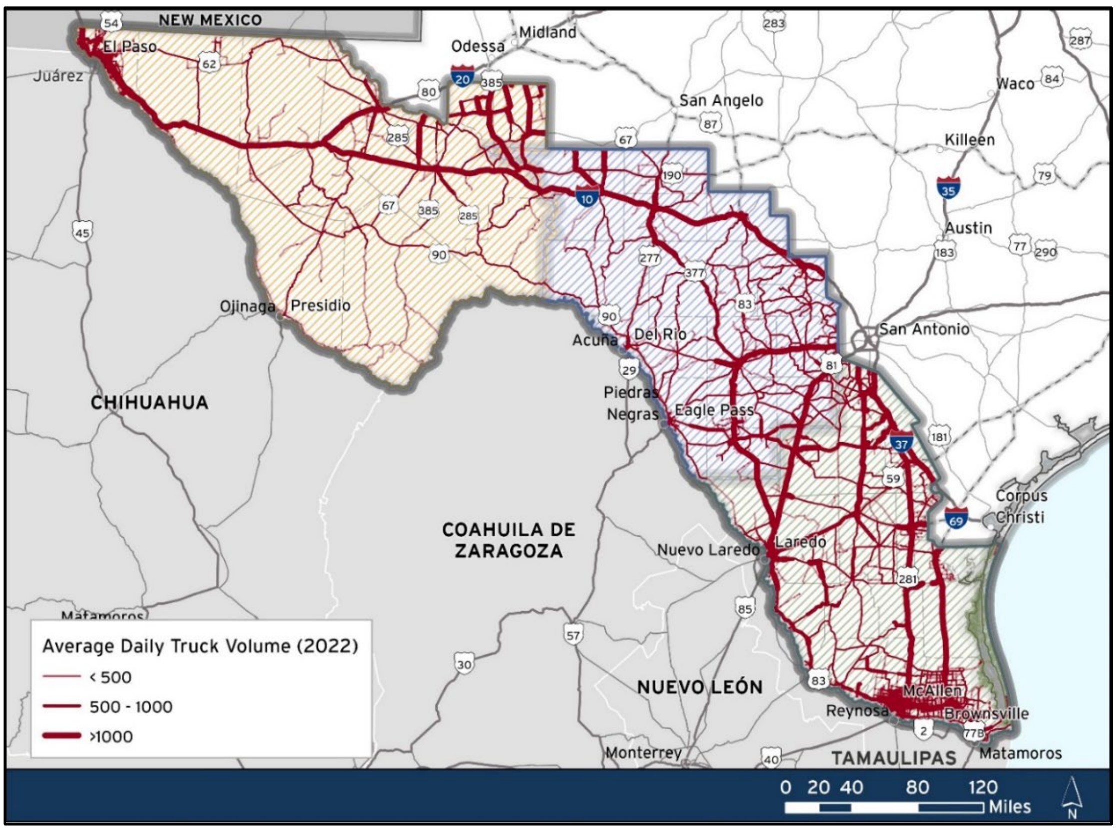
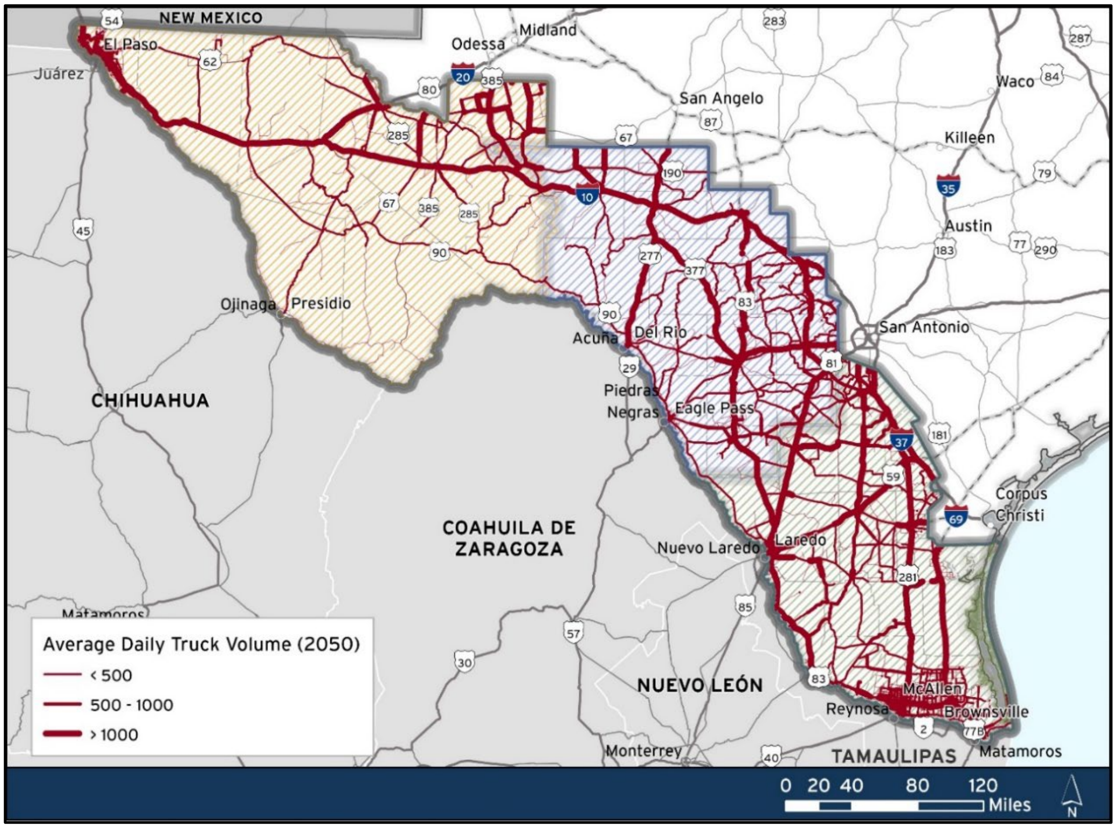


Figure 17: 2050 Truck AADT – Texas Border Region



On the Mexican side of the border, the highest total AADT in 2022 is concentrated around major cities such as Ciudad Juarez, Piedras Negras, Nuevo Laredo, Reynosa, and Matamoros, with AADTs ranging over 20,000 to almost 85,000 (**Figure 18**). By 2050, total AADT increases in these areas and extends to roads leading toward them, reflecting population growth and urban expansion beyond city boundaries.

In Tamaulipas, MEX 2, MEX 101, MEX 97, and MEX 40 see substantial traffic growth, with AADTs rising from a range of 3,000–7,500 in 2022 to 7,500–17,500 by 2050. Similarly, in Nuevo Leon and Coahuila de Zaragoza, traffic growth is primarily observed on MEX 85, MEX 53, and MEX 57/57D. In the Chihuahua region, MEX 45, MEX 45D, and MEX 10 exhibit the highest growth. For trucks, these corridors within the 100-mile Border Region in Mexico are expected to experience significant growth by 2050, highlighting the importance of these roads for freight movement between Mexico and the U.S. In 2022, most of the truck AADTs are below 3,000, with a few areas near the cities in the range of 3,000–7,500. MEX 85 is the only corridor on the Mexican side with a truck AADT over 7,500. In 2050, most of these corridors see growth to over 7,500 in truck AADT. MEX 85, however, exhibits a growth in truck AADT of more than 17,000 in 2050 (see **Figure 19**).

Figure 18: 2022 Total Vehicles AADT – Mexico Border Region

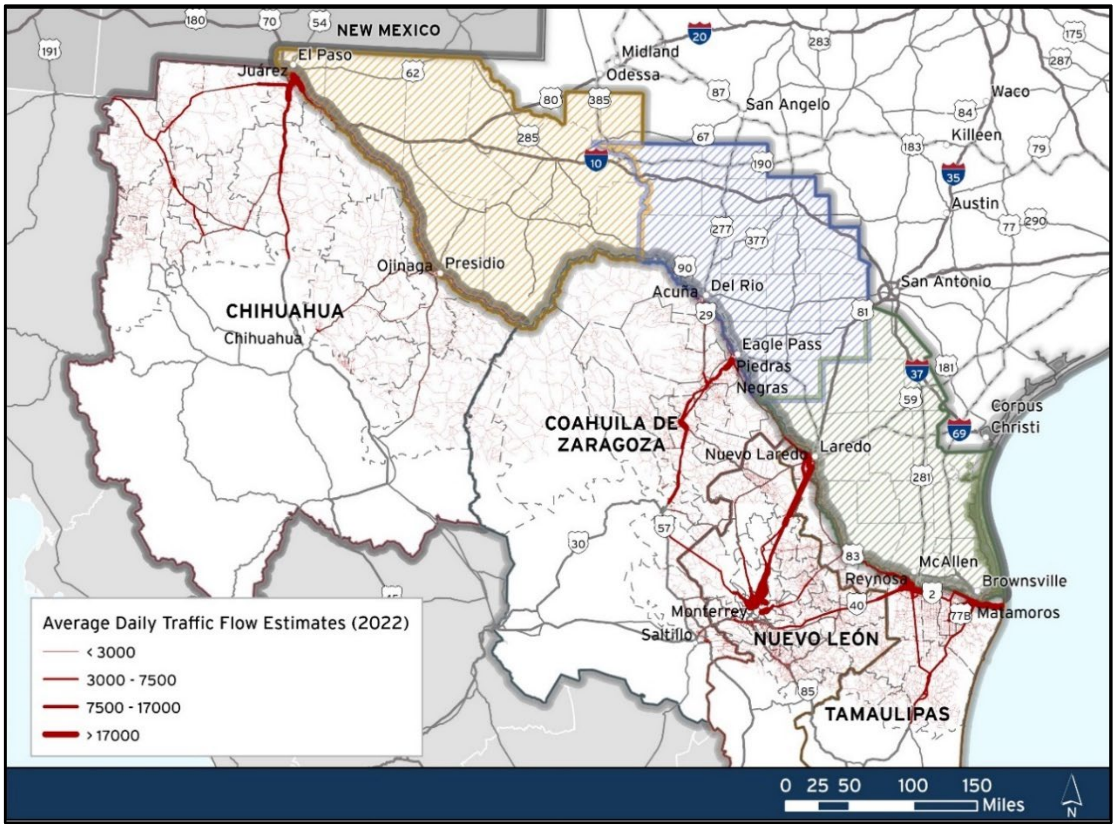
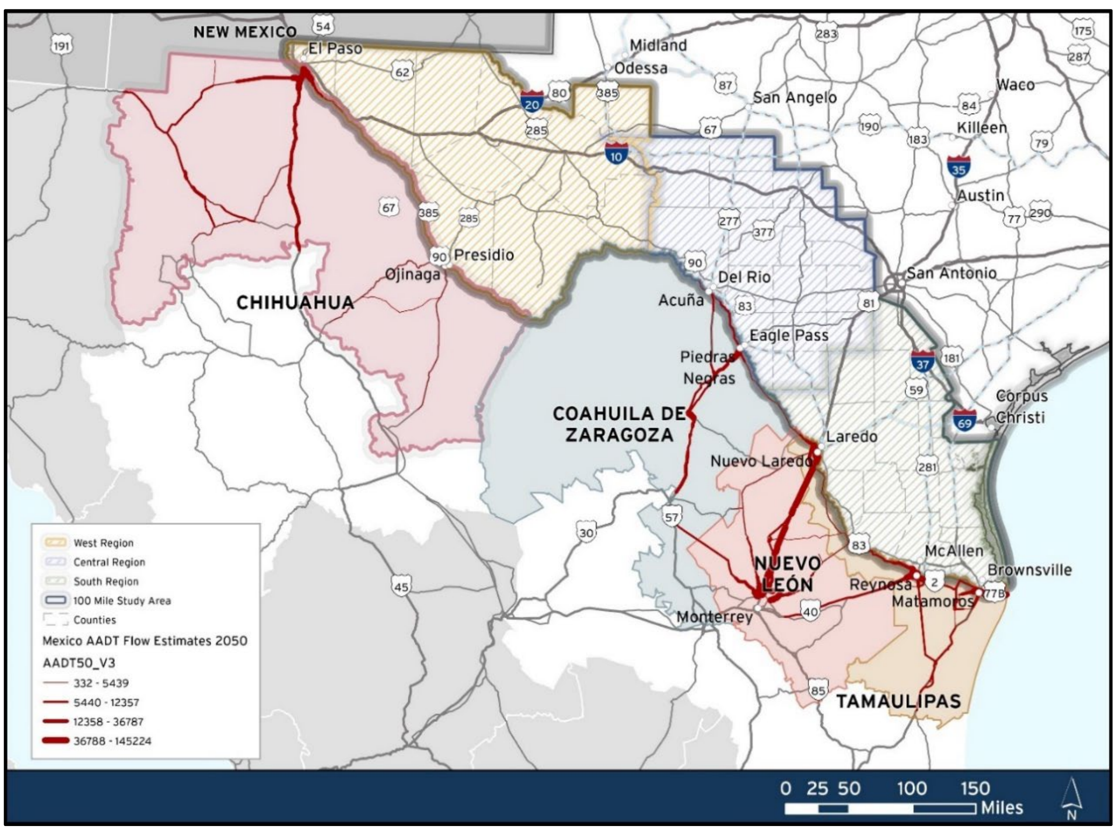


Figure 19: 2050 Total Vehicles AADT – Mexico Border Region



Vehicle Miles Traveled (VMT)

VMT measures the total distance driven by vehicles over a set period, typically one year. It is crucial for transportation planning, policymaking, and revenue forecasting, as it reflects travel demand and behavior. Statewide, VMT is expected to grow at a CAGR of 1.3% for passenger vehicles and 1.5% for trucks during the period 2022–2050. That represents an additional 277.2 million VMT for passenger vehicles and 40.0 million VMT for trucks. In the Border Region, VMT is expected to grow at a CAGR of 0.7% for passenger vehicles and 1.9% for trucks during the period 2022–2050.

Table 11 shows the passenger vehicle and truck miles traveled by functional class. Interstate Freeways will exhibit 2022–2050 CAGRs of 0.7% for passenger vehicles and 1.9% for trucks. Furthermore, Other Freeways will have the highest CAGR for passenger vehicles (1.5%), and Principal Arterials will have the highest CAGR for trucks (2.7%).

Table 11: Vehicle Miles Traveled by Function Class and Vehicle Type in Border Region, 2022 and 2050 (in thousands)

Function Class	2022		2050	
	Passenger Vehicle Miles	Truck Miles	Passenger Vehicle Miles	Truck Miles
Interstate Freeways	12,744	7,122	15,354	12,079
Other Freeways	3,313	96	5,069	193
Expressway	56	28	57	44
Principal Arterial	17,224	1,079	19,966	2,282
Minor Arterial	3,543	495	4,271	668
Collector	2,688	573	3,355	638
Frontage	2,628	69	3,530	109
Ramps	1,146	53	1,481	80
Other[3]	644	7	790	3
Local Street	51	16	36	14
Total	**44,038**	**9,539**	**53,910**	**16,109**

Compared to the State of Texas, the Border Region is expected to have a higher CAGR for truck VMT during the 2022–2050 (1.5% in the State vs. 1.9% in the Border Region). VMT in the Central Region is projected to grow at an annual rate of 0.7% over the same period. In comparison, the South Region is expected to see 0.7% annual growth, whereas the West Region is forecasted to grow by 1.3% per year. The majority of this regional VMT growth is driven by an increase in truck VMT, which is highest

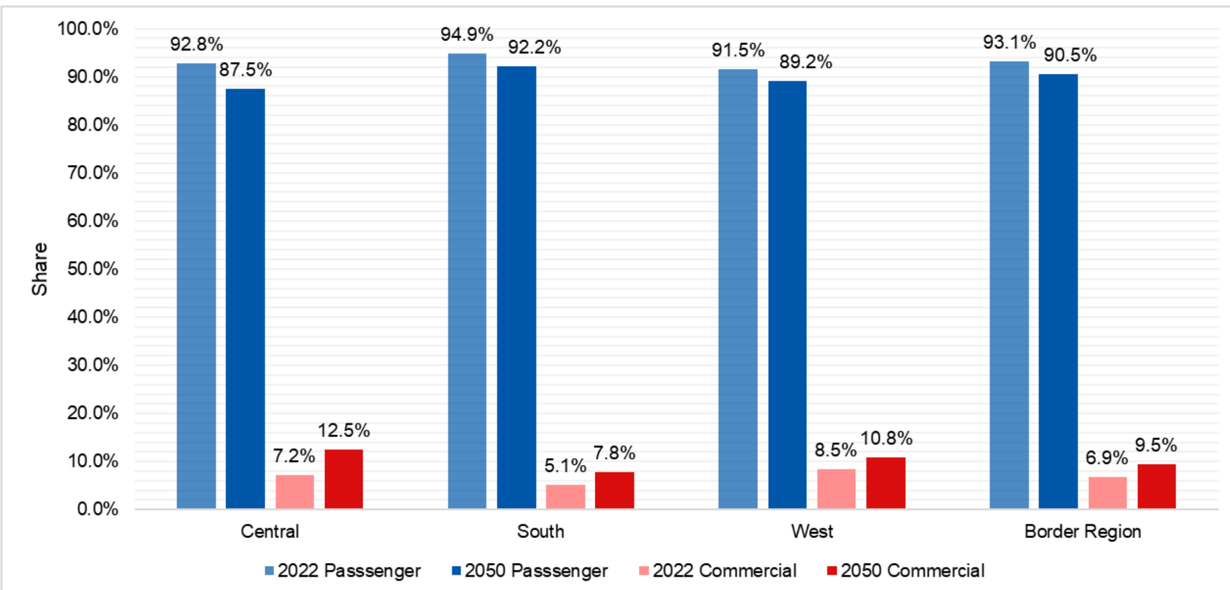
[3] Other function classes include radial toll roads, circumferential toll roads, radial truck-only roads, managed lanes (HOV & HOT), and managed lane connector to freeway mainlanes.

in the Central Region with a 2.5% CAGR from 2022 to 2050, followed by the South at 2.0%, and the West at 1.9%.

Mode Split

Figure 20 shows the distribution of trip volume by region and mode, highlighting a rise in truck share by 2050. The Central Region leads with a 12.5% share of trips by trucks. The South Region is projected to see a mode split increase in trucks from 5.1% in 2022 to 7.8% in 2050, while the West Region's share grows from 8.5% to 10.8%. The truck share in the Border Region also rises from 6.9% to 9.5%. Conversely, passenger vehicle trip volume share declines. The Border Region drops from 93.1% to 90.5%, with the Central Region projected to have the lowest passenger vehicle share at 87.5%. The South Region decreases from 94.9% to 92.2%, and the West Region declines from 93.1% in 2022 to 90.5% in 2050.

Figure 20: 2022 and 2050 Trips Share by Mode



Social and Cultural Regional Components

Economic Development and Growth Needs

Gross domestic product (GDP) and employment growth were used to discuss the economic growth and development needs in the Border Region. GDP highlights the region's overall economic performance, while employment trends reveal how job opportunities are distributed across communities. Together, these metrics provide valuable insights into where economic activity is concentrated and where disparities may exist, helping identify areas that require targeted investments. Assessing these indicators is essential for developing policies that promote balanced growth, economic resilience, and equitable access to opportunities, ensuring that all regions—especially those lagging behind—can benefit from infrastructure improvements, workforce development, and cross-border trade activities.

GDP Growth

Real GDP growth in the study area has outpaced the statewide growth rates between 2017-2022, growing by 57.7% in current dollars, while the state's GDP grew by 44.1% (**Table 12**). The West Region has been the driver of GDP growth within the study area. The West Region saw a 91.9% GDP increase in the five-year period, while both the South and Central Regions saw GDP growth below the overall Texas growth rate.

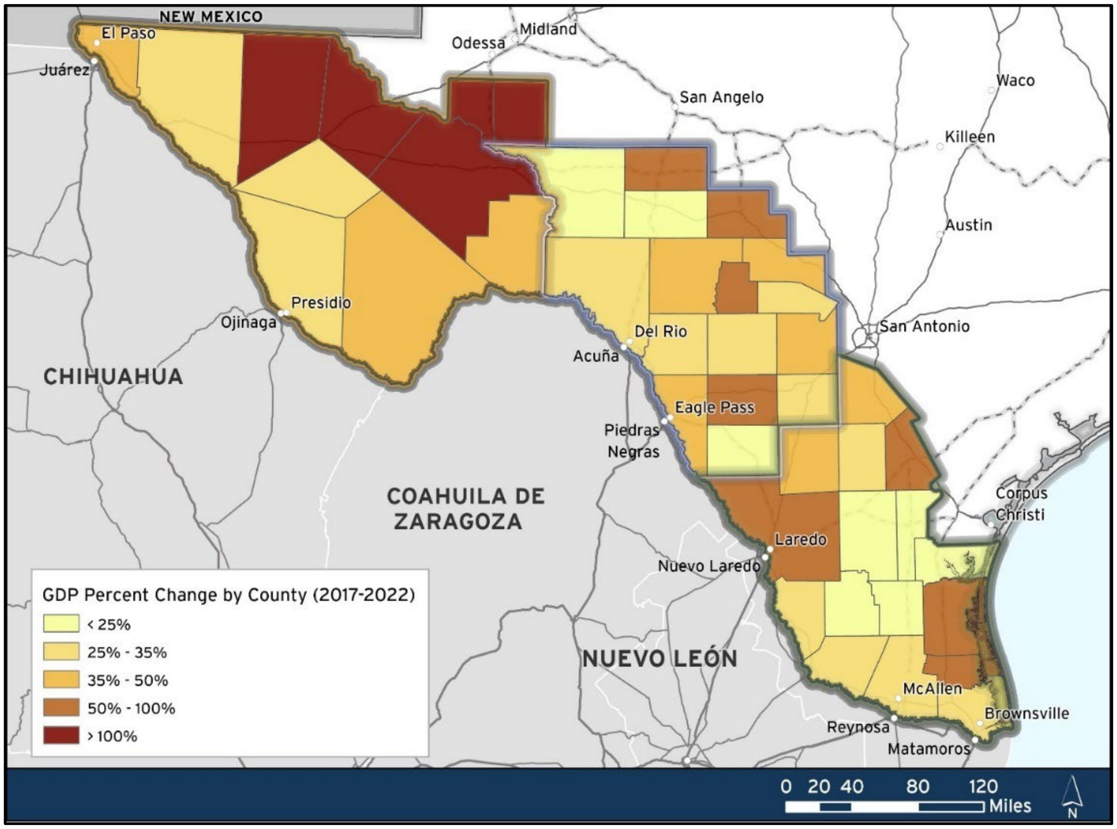
Table 12: Change in Total Gross Domestic Product, 2017-2022 (in billions USD)

Region	GDP 2017	GDP 2022	Change in GDP	Percent Change in GDP
South	57.6	79.8	22.2	38.5%
Central	14.1	18.6	4.5	32.0%
West	42.8	82.1	39.3	91.9%
Texas Border Region	**114.5**	**180.5**	**66.0**	**57.7%**
Texas	**1,667.3**	**2,402.1**	**734.8**	**44.1%**

Source: U.S. Bureau of Economic Analysis, "CAGDP9 Real GDP by county and metropolitan area" and INEGI, "Producto Interno Bruto Por Entidad Federativa 2017" and "Producto Interno Bruto Por Entidad Federativa 2022."

The Texas study area makes up over 7% of total Texas GDP, concentrated primarily in the West and South Regions. GDP growth is concentrated in just one area, with the five fastest growing counties all in the West Region (**Figure 21**).

Figure 21: GDP Percent Change by County, Texas Study Area 2017 – 2022



Source: U.S. Bureau of Economic Analysis, "CAGDP9 Real GDP by county and metropolitan area"

Employment

The Border Region represents roughly 8% of Texas's total employment (**Table 13**). The number of jobs in the Texas Border Region has been steadily increasing for over a decade, with an additional 81,500 jobs between 2010 and 2021 (**Table 14**). This growth has been concentrated in the South Region of the study area (**Figure 22**), which accounted for 74,000 of the new jobs in this period and makes up over half of total employment in the region. The employment projections in **Section 2.3**. indicate that this upward trend is expected to continue through 2050.

Table 13: Study Area Employment for All Industries by Region, Texas Study Area 2022 (in thousands)

Region	Employment	% of Border Region	% of Texas/Mexico
West	480	32.0%	3.0%
Central	160	11.0%	1.0%
South	840	57.0%	5.0%
Texas Border Region	**1,480**	**32.0%**	**8.0%**

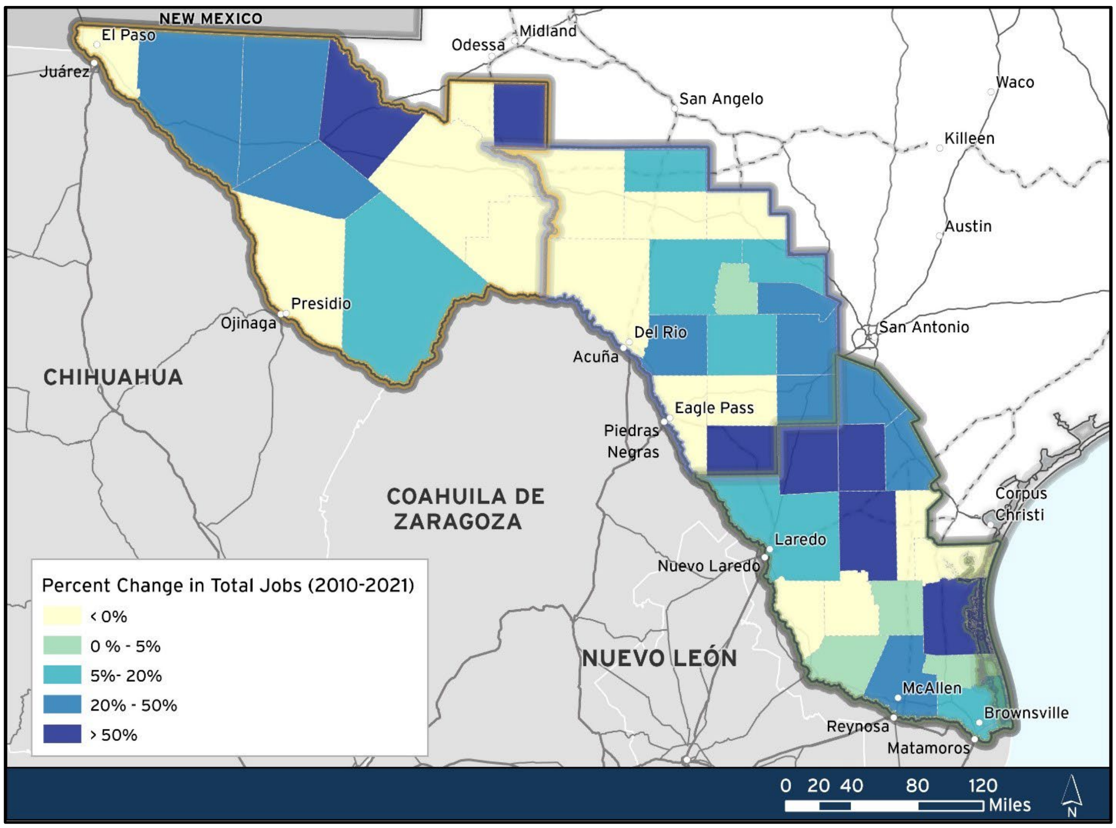
Source: U.S. Census Bureau. LEHD Origin-Destination Employment Statistics (2022)
NOTE: *Discrepancies in the total are due to rounding errors.*

Table 14: Change in Total Jobs, Texas Study Area 2010 – 2021 (in thousands)

Region	Total Jobs 2010	Total Jobs 2019	Total Jobs 2021	Change in Jobs (2010-2021)	% Change (2010-2021)
South	484.4	570.1	558.5	74.1	15.3%
Central	80.3	92.9	85.2	4.8	6.0%
West	335.9	345.5	338.4	2.5	0.7%
Study Area	**900.6**	**1,008.5**	**982.1**	**81.5**	**9.0%**
Texas	**10,152.4**	**12,433.1**	**12,222.0**	**2,069.6**	**20.4%**

Source: U.S. Census Bureau. LEHD Origin-Destination Employment Statistics (2002-2021)
NOTE: *Discrepancies in the total are due to rounding errors.*

Figure 22: Change in Employment, Texas Study Area 2010 – 2021



Source: U.S. Census Bureau. LEHD Origin-Destination Employment Statistics (2002-2021)

While the West Region leads in GDP growth, the South Region accounts for most of the job creation, adding 74,000 new jobs since 2010, emphasizing the need to sustain workforce development and infrastructure support. With the Texas Border Region contributing over 7% of Texas's GDP and 8% of statewide employment, enhancing trade infrastructure, transportation networks, and access to education and job opportunities across all regions—particularly in the South and Central areas—will be critical for balanced, sustainable growth and long-term economic resilience.

Challenges and Concerns

Unique challenges within the Texas-Mexico Border Region are particularly pronounced in the West and South regions, necessitating strategic transportation investments to mitigate disparities in access, mobility, and economic opportunity. Key corridors in these areas serve as vital lifelines for communities facing significant social vulnerability, where improvements in transportation infrastructure can enhance quality of life and promote inclusive economic growth.

In the West Region, El Paso stands out with corridors such as US 62 and SH 17, which facilitate essential goods movement while also providing access to employment and services. The demographics of this region include a substantial percentage of low-income families and individuals experiencing barriers to transportation. Targeted investments in these corridors are essential for addressing these disparities, ensuring that marginalized communities can fully participate in the local economy and benefit from increased trade opportunities. The concentration of high needs in this area underscores the importance of prioritizing infrastructure improvements that support both mobility and economic inclusion.

The South Region also presents critical socio-economic concerns, with corridors like US 83 through Zapata and Starr Counties playing a crucial role in facilitating access to economic opportunities and cross-border trade. These areas are strategically located near vital trade routes and border crossings, making investments in transportation infrastructure particularly impactful for enhancing connectivity and accessibility for undeserved communities. The presence of vulnerable populations in these areas necessitates that decision-makers focus on creating equitable transportation solutions that ensure all residents can benefit from the economic opportunities associated with increased trade and improved access to services.

The Central Region, while less affected by high socio-economic needs compared to the West and South, still contains corridors that require attention. For example, SH 85 through Frio and Dimmit Counties and US 190 through Pecos and Crockett Counties show critical indicators that reveal challenges such as poverty and limited access to services. Improvements in these corridors will support both mobility and connections to employment, further contributing to social and economic development.

By concentrating efforts on corridors with high and medium needs—especially in the West and South Regions—the BTMP can effectively address critical mobility challenges and enhance access to opportunities for historically underserved communities. Strategic investments in these areas will promote equitable transportation outcomes and foster broader economic competitiveness, ensuring that all residents can participate in and benefit from the region's growth. A deeper dive into the concerns across the regions is provided in subsequent sections, however, there is the need for further analysis of the cultural, socio-economic, and historical contexts of the region to fully grasp the needs and challenges.

Identification of the Regional Border Connectivity Network (RBCN)

Development Process of the RBCN

As part of the Region-to-Region Connectivity Study, the study designated the Regional Border Connectivity Network (RBCN) to be used for performance measurement and needs assessments. This section describes how the network was designated in the Texas-Mexico Border Regions. For a complete understanding of the network designation process, see Network Designation Process memo and Network Needs Methodology memo.

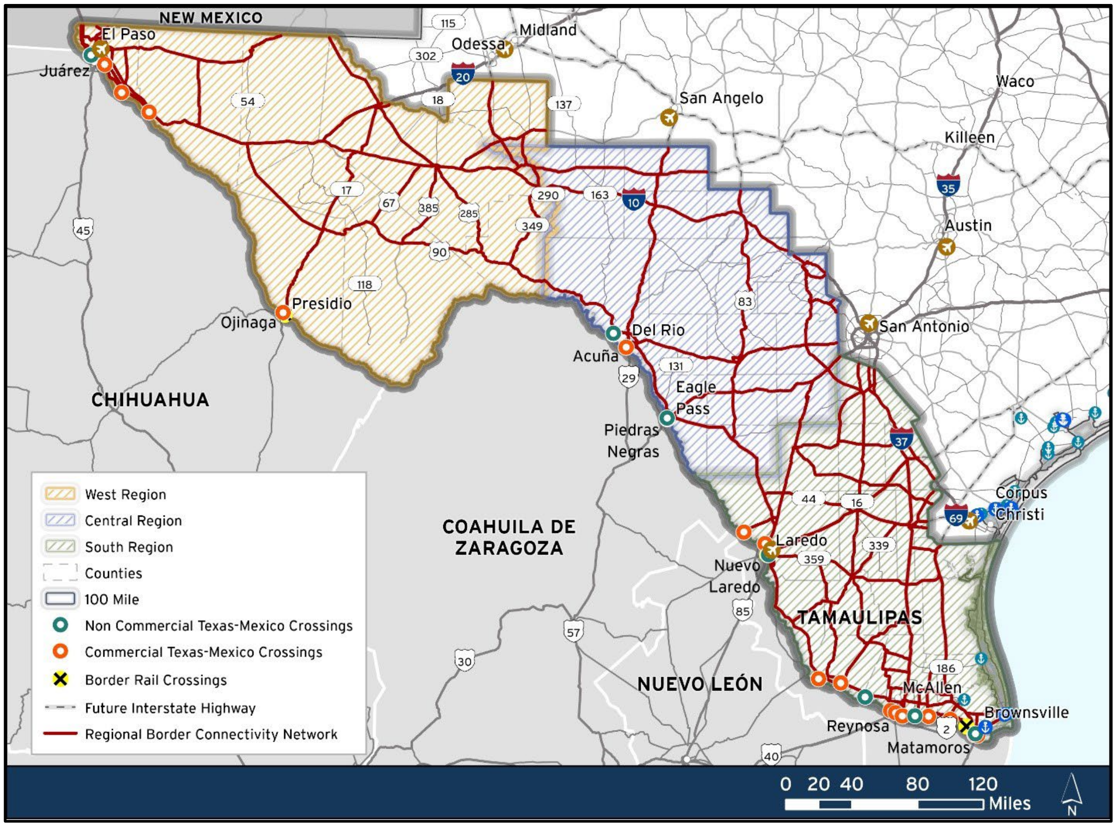
The process of designating the RBCN consisted of two separate phases: one that was data-driven and another that was informed by stakeholders. This collaboration helped to refine and adjust the network to better reflect real-world conditions, ensuring that the final delineation is both accurate and relevant to the needs in the Border Region.

The network was developed and scored based on two high-level themes: the movement of people and goods, and market access and connectivity.

The second phase involved collaborative engagement with TxDOT Districts, specifically the El Paso, Laredo, and Pharr Districts. Stakeholder feedback was instrumental in refining the initial network draft. Discussions incorporated input on future plans and projects, such as US 67, Port-to-Plains Segment 3 Corridor Study, and the I-10 Corridor Study, considering alignment with regional development priorities and infrastructure goals.

The process resulted in a RBCN (**Figure 23**) spanning 4,958 miles. This extensive coverage ensures comprehensive transportation accessibility and efficiency, connecting all 43 counties within the study area, where 1,639 miles of the network are in the West Region, 1,232 miles in the Central Region, and 2,088 miles in the South Region. The following section is a needs assessment of the RBCN.

Figure 23: Regional Border Connectivity Network



Needs Assessment

This section builds on the performance and conditions metrics and existing conditions developed in the Network Needs Methodology Memorandum and the Existing Conditions Memorandum and presents the following:

- Definition for each of the criteria for each of the goals (see **Table 15**)
- Performance measures for each of the criterion
- The thresholds that were used to calculate a high, medium, and low performance category for each criterion to determine the level of need. There are criteria with no performance categories since qualitative assessments were conducted. The qualitative assessments will be used to inform the unmet border connectivity needs.
- The RBCN corridors with a high level of needs for each criterion

Table 15: Criteria and Thresholds Used for Assessing Needs

Goal	Criteria
Mobility, Reliability, and Connectivity	Existing and forecasted volume-to-capacity (V/C) ratios and level of service (LOS)
	Travel Time Reliability Index (TTRI)
	Travel time delays
	Route directness and redundancy
	Multimodal connectivity
Safety and Security	Total crashes, severe crashes, and truck-related crashes
	Crash contributing factors
	Bridge strikes
	At grade rail crossing incidents
Asset Preservation and Technology Deployment	Current design standards (lane width and shoulders)
	Pavement conditions
	Bridge height restrictions
	Bridge conditions
	Existence of Intelligent Transportation Systems (ITS) infrastructure
Economic Competitiveness, Cross-Border Resiliency, and Sustainable Funding	Exposure to risk
Customer Service, Stewardship and Sustainability	Access to historic, cultural, and tourist activities
	Electric vehicle (EV) charging inventory and proximity
	Access to rest areas and truck parking facilities

Mobility, Reliability and Connectivity

The criteria that were used to assess mobility, reliability and connectivity include existing and forecasted V/C ratios and LOS, Travel Time Reliability Index (TTRI) for passenger and trucks, travel time delays for passenger and trucks, route directness and redundancy (connectivity – shortest and fastest routes), and multimodal connectivity.

Existing and Forecasted V/C and Level of Service (LOS)

The metrics for this criterion include V/C ratios and LOS described below.

V/C Ratios

The V/C ratio on links within the SAM network for the years 2022 and 2050 were studied. V/C ratio data by segment from the study were aggregated to calculate average V/C ratios for RBCN corridors. A lower V/C ratio suggests that a corridor operates with less congestion and smoother traffic flow. Generally, a V/C ratio below 0.5 signifies that traffic is in free-flow condition, far below the roadway's capacity. **Table 16** categorizes corridors into low, medium, and high V/C ratios based on established thresholds.

Table 16: V/C Ratios Performance Measure Thresholds

V/C Ratio	Threshold for 2022	Threshold for 2050
Low	0 - 0.01	0 - 0.02
Medium	0.02 – 0.04	0.02 – 0.05
High	0.04 - 0.12	0.05 - 0.13

Figure 24 shows the V/C ratio distribution in 2022. The Central Region has the highest number of corridors with high V/C ratios, which means traffic congestion and delays will be highest in those corridors. These corridors in the Central Region include SH 16, US 83, US 90, SH 173, US 277, and FM 1021. There are 10 corridors in South Region that are classified with high V/C ratios. Those include US 83, SH 44, FM 681, FM 755, SH 107, SH 285, FM 490, SH 186, US 59, and SH 97. There is only one corridor with a high V/C ratio in West Region and that corridor is US 385.

Figure 24: V/C Ratios Performance Categories, 2022

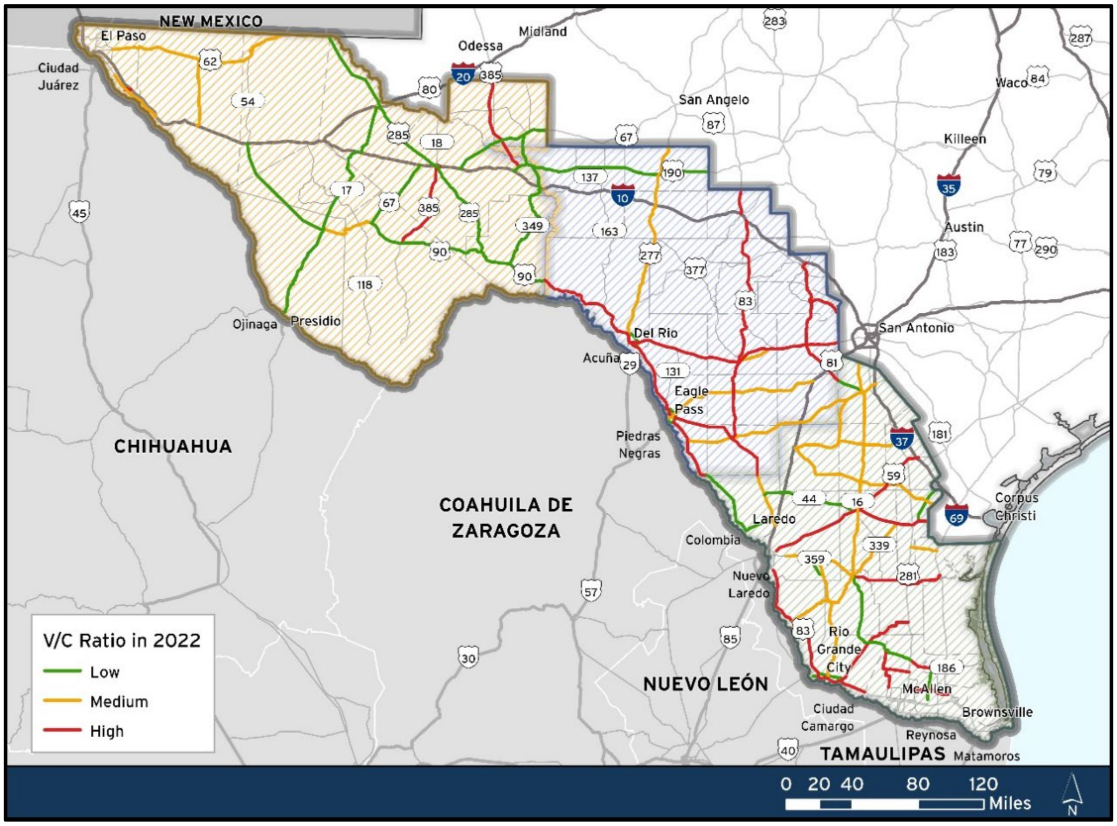


Figure 25 shows the forecasted V/C ratio distribution in 2050. Central Region has the highest number of corridors with high V/C ratios in 2050. These Central Region corridors include SH 173, FM 1021, US 83, SH 16, and US 90. US 277 Central Segment falls in medium V/C ratio category, which was in high V/C ratio category in 2022. In the South Region, SH 186 and SH 285 are predicted to be in medium V/C ratio category but were in high V/C ratio category in 2022. In the West Region, US 62 goes to high V/C ratio from medium V/C ratio in 2022.

Figure 25: Forecasted V/C Ratios Performance Categories, 2050

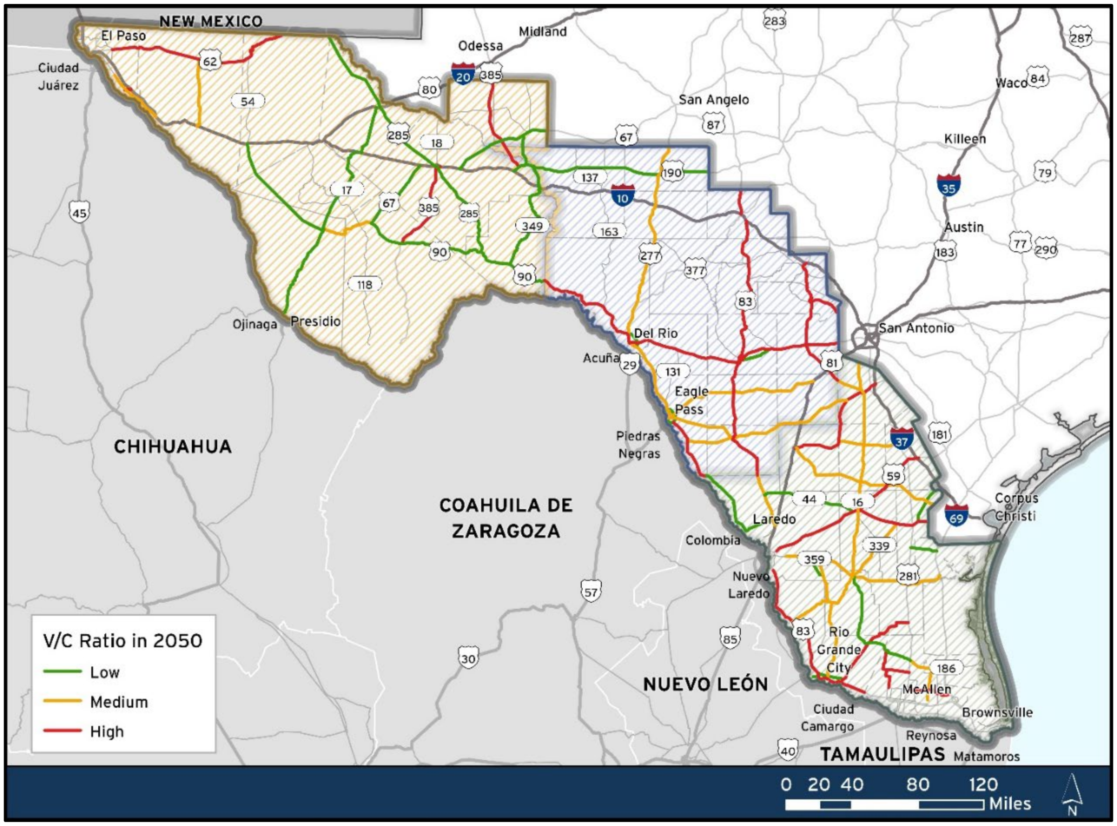


Table 17 shows how V/C ratio for corridors changes over 2022 to 2050 in the three regions. In 2022, the Central Region had the highest percentage of corridor length with a high V/C ratio at 55%, but this is predicted to drop to 47% by 2050. In the South Region, the percentage is also expected to decrease from 40% in 2022 to 34% in 2050. However, the West Region is set to see a rise in V/C ratio from 11% to 22%, indicating that traffic congestion might get worse or that there might not be enough road improvements to handle future traffic demands. Overall, for the Border Region, the percentage of corridors with a high V/C ratio across all regions is expected to decrease slightly from 36% in 2022 to 35% in 2050.

Table 17: Percentage of Corridor Miles within V/C Ratio Classification by Region, 2022 and 2050

Region	High		Medium		Low	
	2022	2050	2022	2050	2022	2050
Central	55%	47%	30%	36%	15%	17%
South	40%	34%	40%	47%	20%	19%
West	11%	22%	22%	11%	67%	67%
Border Region	**36%**	**35%**	**31%**	**33%**	**33%**	**33%**

Level of Service (LOS)

A congestion metric that uses both base year and future year congestion as defined by the TxDOT Statewide Planning Map was used for the LOS analysis. The segments for both years are identified as "moderately congested" or "congested" based on the distance measured between vehicles. The segments were then categorized into three level of congestion as listed in **Table 18**.

Table 18: Definition of Congestion LOS

Segment Congestion Level	Detail
Level 1	If the segment is not congested or "moderately congested" in the current year, and "moderately congested" in the future year
Level 2	If the segment is "moderately congested" in the current year, but "congested" in the future year
Level 3	If the segment is "congested" in the current year

A corridor score for congestion was generated by calculating the weighted average of the congestion level score by segment length. The corridors were then ranked from low to high according to their position in the lowest to highest third of the final weighted average score. The specific classifications and thresholds are detailed in **Table 19**.

Table 19: Congestion Level Performance Measure Thresholds

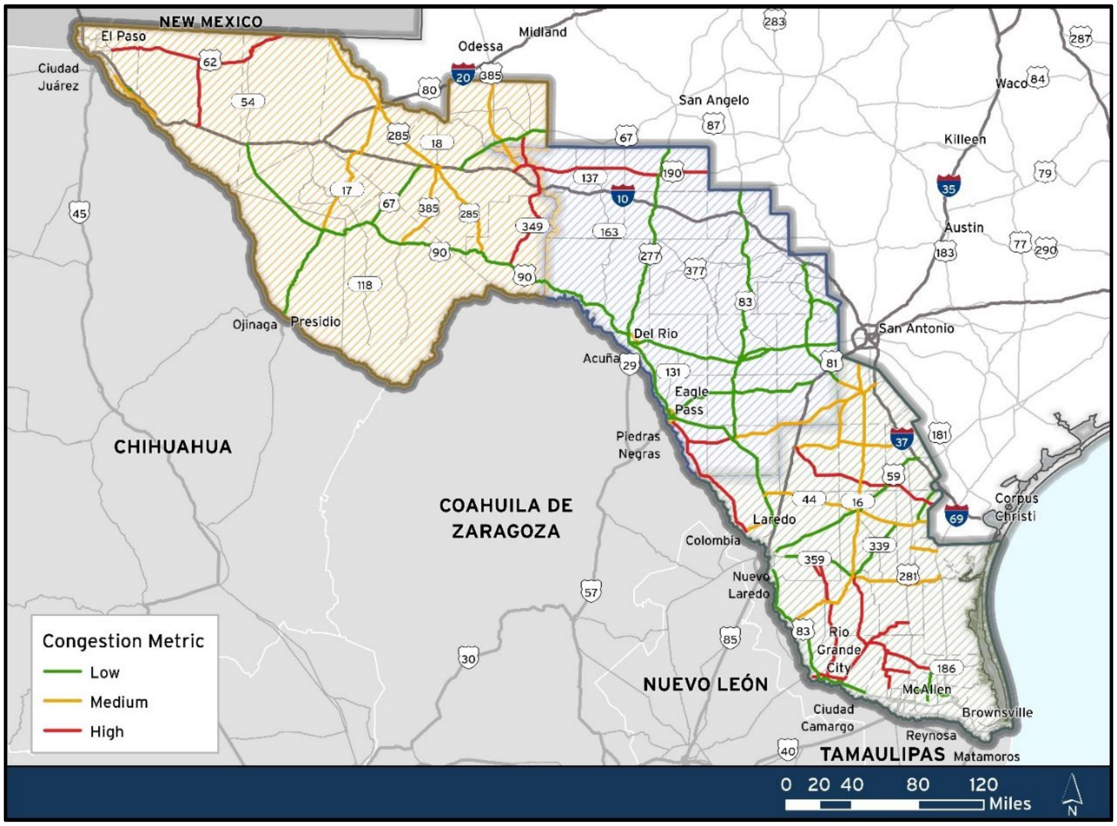
Corridor Congestion Level	Score Threshold
Low	0.22 - 0.48
Medium	0.48 - 0.75
High	0.75 - 8.94

Figure 26 illustrates congestion category for the corridors and **Table 19** provides a summary of the percentage of congestion levels across all three regions. In the overall Border Region, 25% of the corridor length is classified as having high congestion, 43% as medium congestion, and 32% as low congestion. In the West Region specifically, 31% of the corridor length is expected to experience high congestion, including US 62, SH 349, and RM 1111. The Central Region has the smallest proportion of corridor length with high congestion compared to the other two regions. In this region, US 190, FM 1021, and FM 2644 are classified under the high congestion category. The South Region has 12 corridors within the high congestion class. The South Region has 12 corridors classified within the high congestion category, mainly concentrated near Rio Grande City and McAllen. Notable corridors include FM 624, FM 649, FM 681, FM 755, and FM 1017.

Table 20: Congestion Metric Categories by Border Region

Region	High	Medium	Low
Central	7%	11%	82%
South	33%	46%	21%
West	31%	35%	34%
Border Region	**25%**	**43%**	**32%**

Figure 26: Congestion Metric Performance Categories



Travel Time Reliability Index

The Travel Time Reliability Index (TTR) is a measure used to evaluate the consistency of travel times on a given road segment over a specified period. To assess travel time reliability, travel times are classified into distinct time periods to capture variations throughout the day, including peak hours mid-day, and nighttime. A higher TTR value indicates greater variability in travel times, suggesting less reliable travel conditions.

This index helps identify routes with significant travel time fluctuations, informing strategies for improving reliability. By improving TTR through measures like enhancing road conditions or traffic management, transportation authorities can make segments more appealing to drivers, and improve overall transportation efficiency. Strategies like traffic management, infrastructure improvements, and intelligent transportation systems can help mitigate travel time fluctuations, leading to more efficient and reliable transportation networks.

In **Figure 27**, the travel time reliability is shown for passenger vehicle trips. There is great reliability in the South Region with decreased reliability moving west through the Central and West Regions. The South Region is more highly populated and is home to major trade routes that encourage investment in the roads, therefore increasing reliability among other factors.

Figure 27: Passenger Vehicle Travel Time Reliability Performance Categories

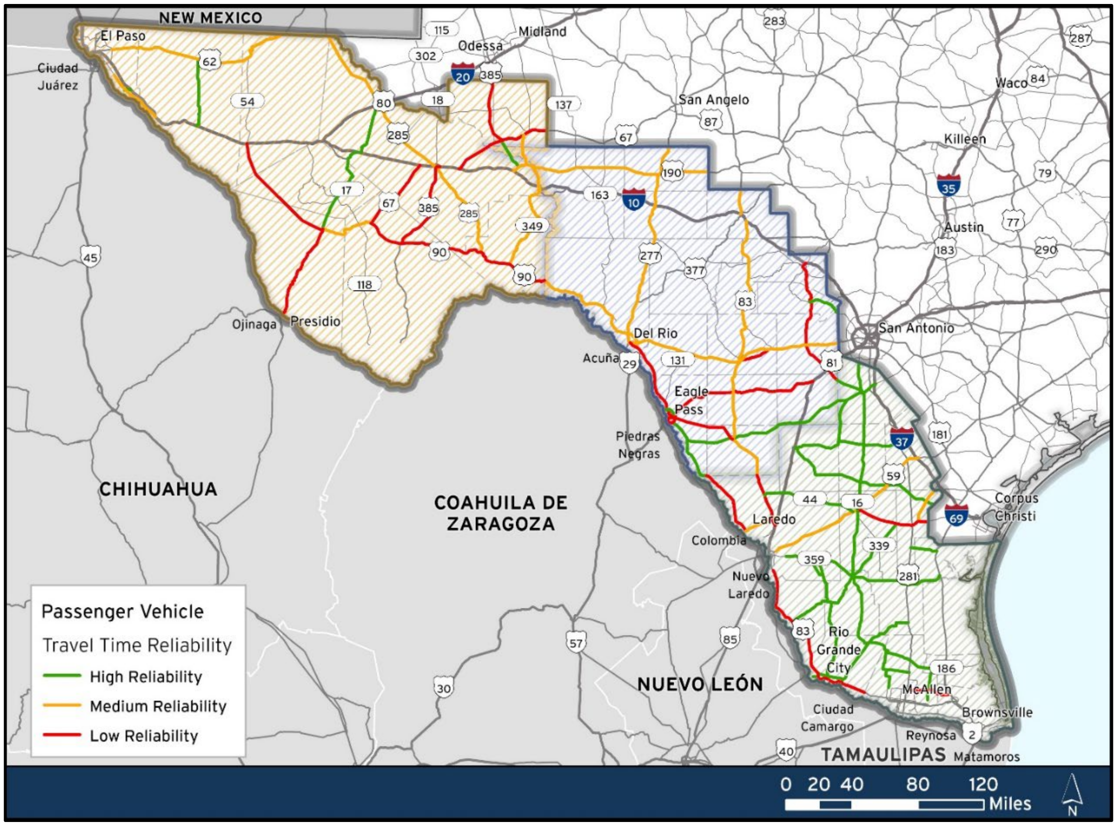
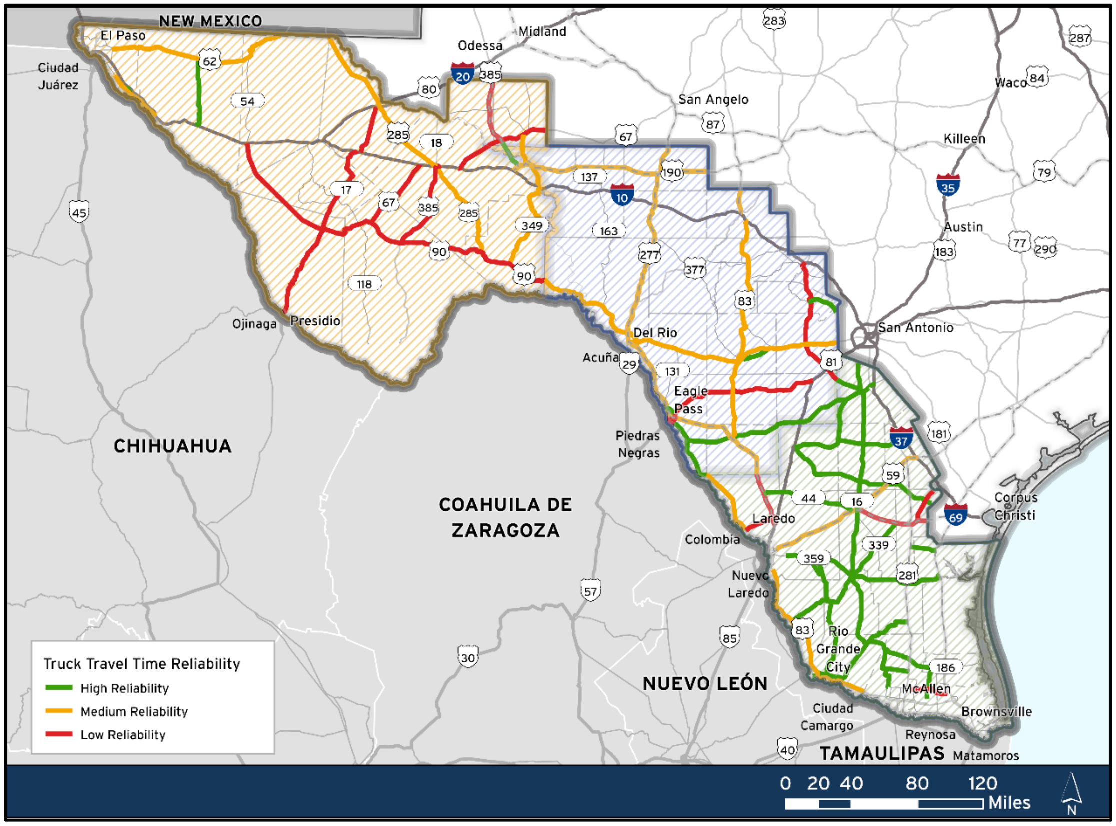


Figure 28 shows the reliability of trucks which is similar to the passenger routes. One key difference is that in the West Region, trucks have less reliability than passenger vehicles, which may be due to it being more difficult to move freight on more rural roads.

Figure 28: Truck Travel Time Reliability Performance Categories



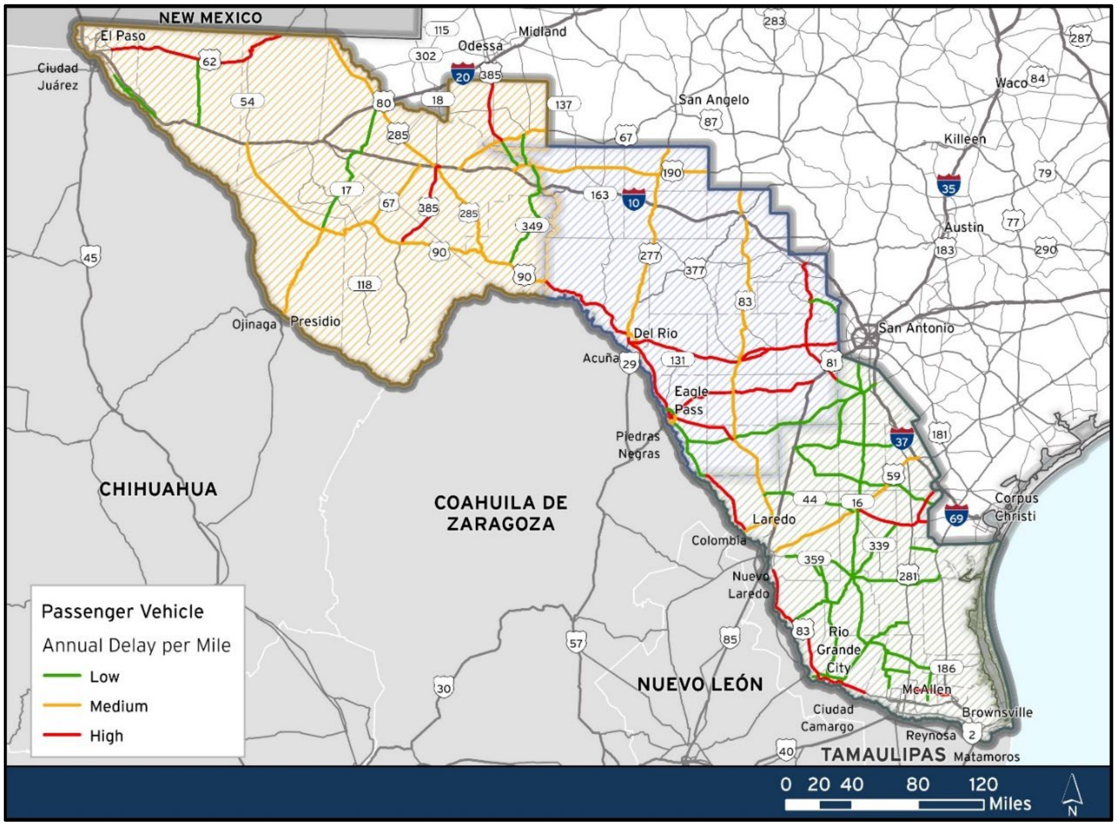
Travel Time Delays

Time travel delay is a measure of recurring congestion on a roadway segment. Using GPS-based travel time data from the National Performance Management Resource Data Set (NPMRDS), temporal variations in travel times for both trucks and passenger vehicles were studied. Additionally, traffic volume data from the NPMRDS Network data and truck distribution factors were used to determine the actual number of vehicles impacted by delays.

To calculate the hourly traffic volume delays, the traffic volumes were calculated at 15-minute intervals and adjusted for various factors. Directional splits were assumed to be even (50/50) unless specific adjustment factors were available. Two types of delays were calculated, total delay and peak hour excessive delay. The NPMRDS GPS Data provided the delay values, while the traffic volume distribution helped estimate the actual number of vehicles or trucks affected by the delay.

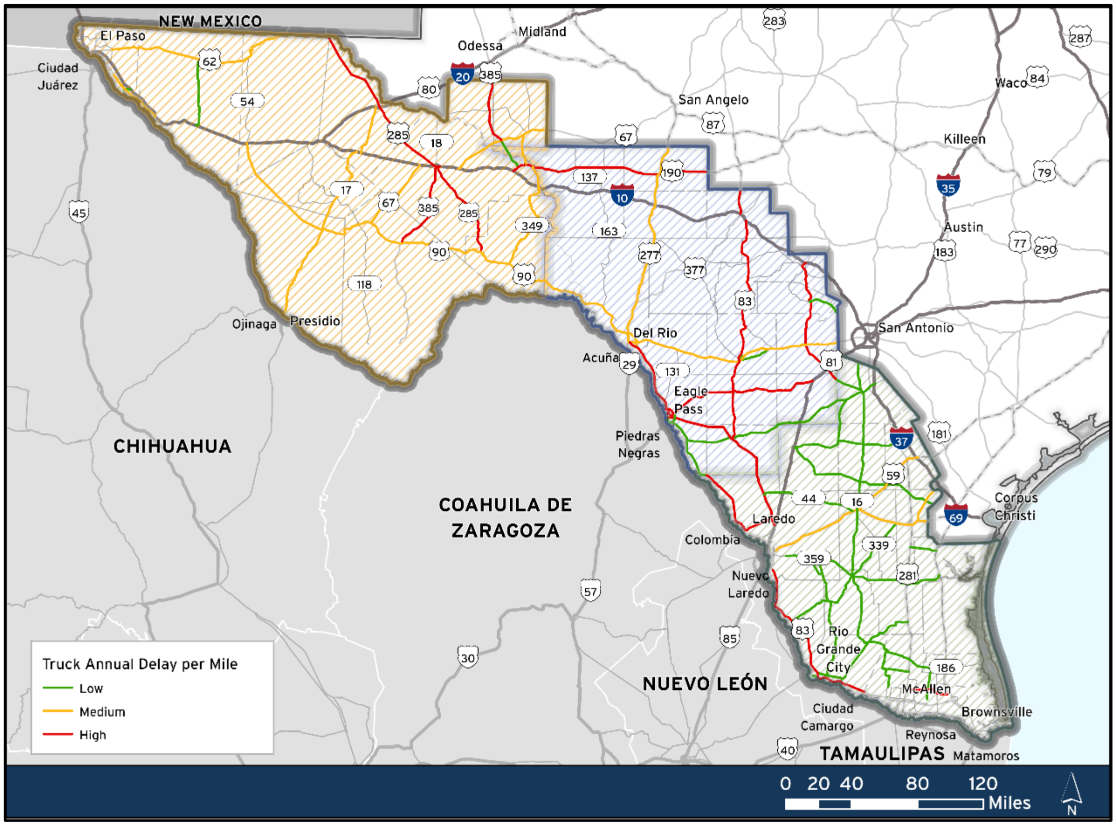
In **Figure 29**, the results of the analysis indicate lower delays for passenger vehicles in the South Region and some routes traveling north and south. There are greater delays in east and west bound routes especially in the West Region.

Figure 29: Passenger Vehicle Annual Delay per Mile Performance Categories



In **Figure 30**, trucks in general face fewer delays in the South Region, and greater delays in Central and West Regions.

Figure 30: Truck Annual Delay per Mile Performance Categories



The total delay results found that the total delay quantifies the cumulative amount of time lost due to slower-than-expected travel speeds. High total delay values indicate significant congestion and inefficiencies within the corridor or segment. This implied that high total delay suggests areas where infrastructure improvements or traffic management strategies may be necessary to reduce congestion and improve traffic flow. The peak hour excessive delay results identified critical bottlenecks and peak hour congestion points that require targeted interventions to alleviate traffic during the most congested times.

Overall, high levels of delay often lead to low travel time reliability due to increased congestion and unpredictable travel conditions. Segments with frequent delays are likely to also experience inconsistent travel times. Therefore, improving one aspect (delay or reliability) can indirectly benefit the other.

Route Directness and Redundancy

The efficient movement of goods and people to, from, and within a region relies on strong connectivity with surrounding areas. A lack of connectivity can increase travel times and transportation-related emissions, as well as direct traffic onto roads that are not intended to handle high traffic volumes or heavy vehicles. To understand the Region-to-Region connectivity in the Texas-Mexico Border Region, the study prepared an Origin-Destination (OD) matrix that reflected actual truck and passenger vehicle movements across the Border Region using INRIX GPS data provided by TxDOT.

A multi-step processes was followed to analyze the movement of passenger vehicles and trucks across the Border Region and to conduct the connectivity analysis. The data preparation process resulted in an OD matrix highlighting the movement of vehicles and economic activity throughout the region. The connectivity analysis included analyzing vehicle movements, identifying discrepancies between ideal and actual paths, and evaluating road network connectivity performance.

The results of this connectivity analysis included categorizing roadways by high, medium, or low in three categories: Avoidance Score, High Avoidance Score for Fastest Path, and High Avoidance Score for Shortest Path.

The Avoidance Score indicates how much a road link is avoided despite being the shortest or fastest path available between a given OD pair. Therefore, a high Avoidance Score indicates that a roadway segment has significantly less trips on it than would be expected, which can happen due to a myriad of factors such as congestion, reliability issues, and access to amenities like truck parking and rest areas.

The High Avoidance Score for Fastest Path indicates that the road is underutilized relative to its potential as the fastest route between a given OD. Therefore, a high score in this category indicates that drivers are choosing slower, and perhaps longer, routes over this road. The segment-level fastest route avoidance scores for trucks in the Texas-Mexico Border Region can be viewed in **Figure 31**.

To better visualize the fastest path in the study area for trucks, the results from 2022 (**Figure 31**) and predictive analysis of 2050 (**Figure 32**) showing the expected fastest paths can be compared. By understanding the future fastest path a truck may take, planners can proactively address future traffic patterns . This map also helps identify current areas of need and which paths might be avoided the most due to various reasons, such as road conditions, amenities, or connectivity. This may also alleviate congestion as some of the higher avoided areas are around larger metropolitan areas connected by larger highways.

Figure 31: 2022 Fastest Path (Trucks) Performance Categories

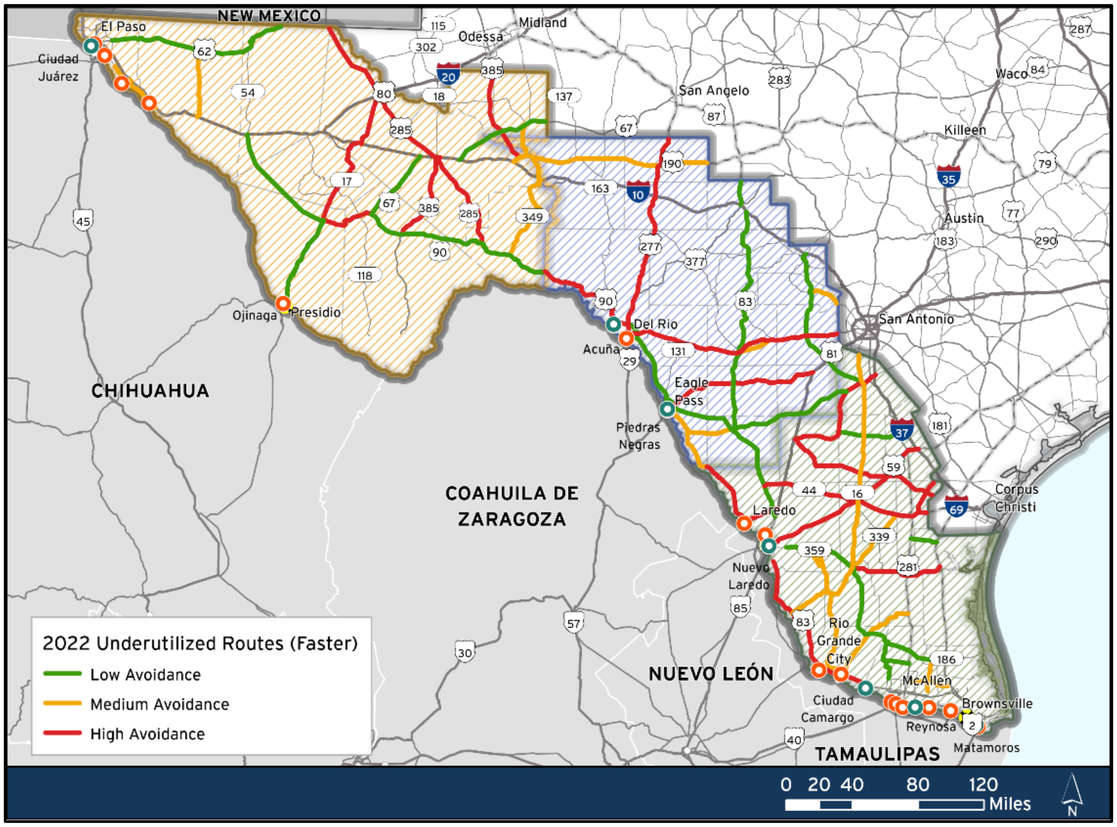
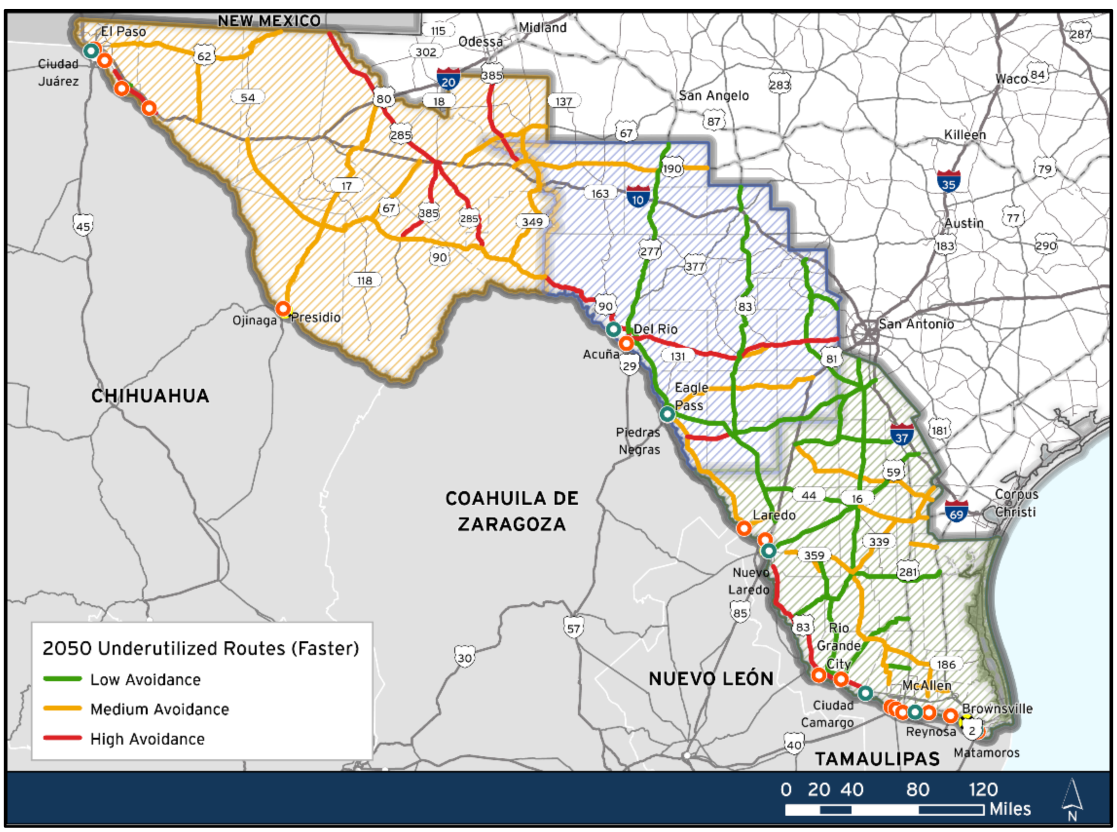


Figure 32: 2050 Fastest Path (Trucks) Performance Categories



Finally, the High Avoidance Score for Shortest Path indicates that a significant number of drivers are avoiding the roadway, despite it being the shortest route available. This means that drivers are choosing longer routes, which may be due to a variety of reasons such as heavy congestion, safety issues, poor roadway conditions, or other factors. The segment-level shortest route avoidance scores for trucks within the Border Region can be viewed in **Figure 32**.

As shown in **Figure 33** and **Figure 34** below, the analysis covers the results from 2022 and predictive analysis of 2050 shortest paths taken by trucks. Understanding truck traffic patterns can guide decisions about where to locate distribution centers, manufacturing facilities, and other businesses that rely on efficient transportation. Comparing the recent past to the future will help in the planning process for the future of freight operations in the Border Region. This may also help in understanding the paths that are preferred by truck drivers and companies to improve those roads, the connectivity between them, and the facilities along the paths. Taking shorter paths may result in more sustainable and greener operations for trucking companies.

Figure 33: 2022 Shortest Path (Trucks) Performance Categories

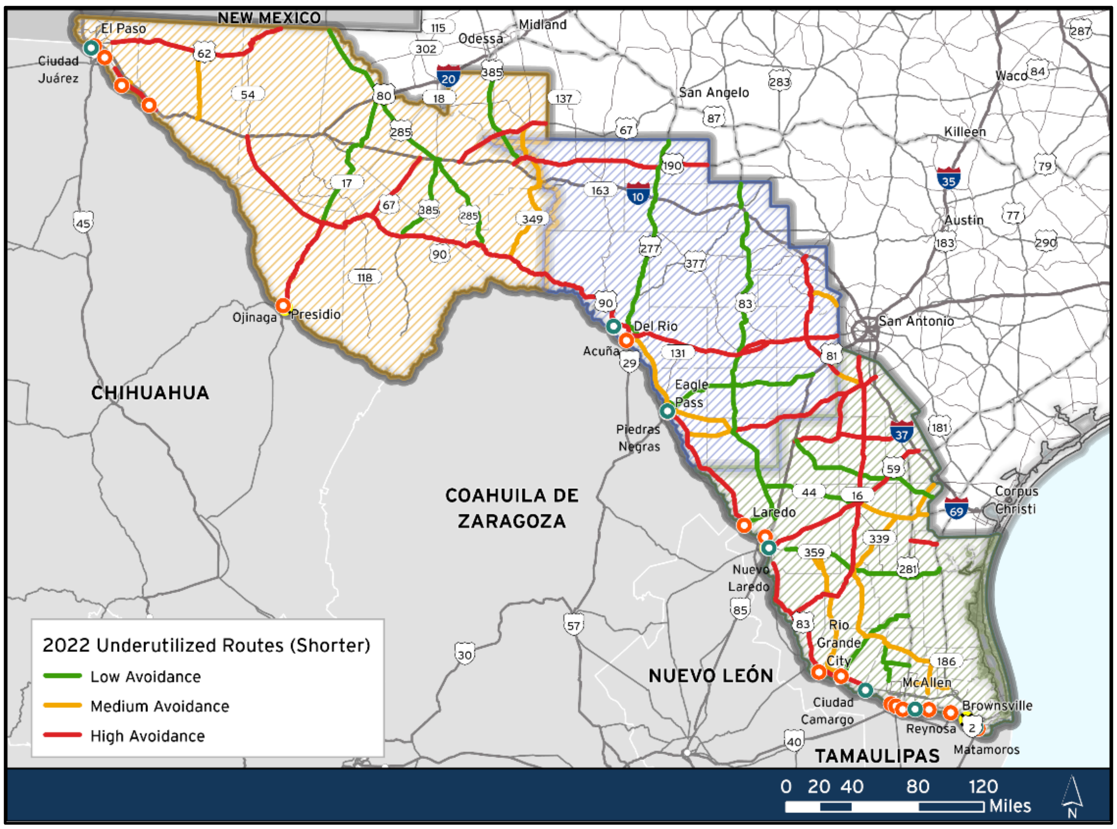
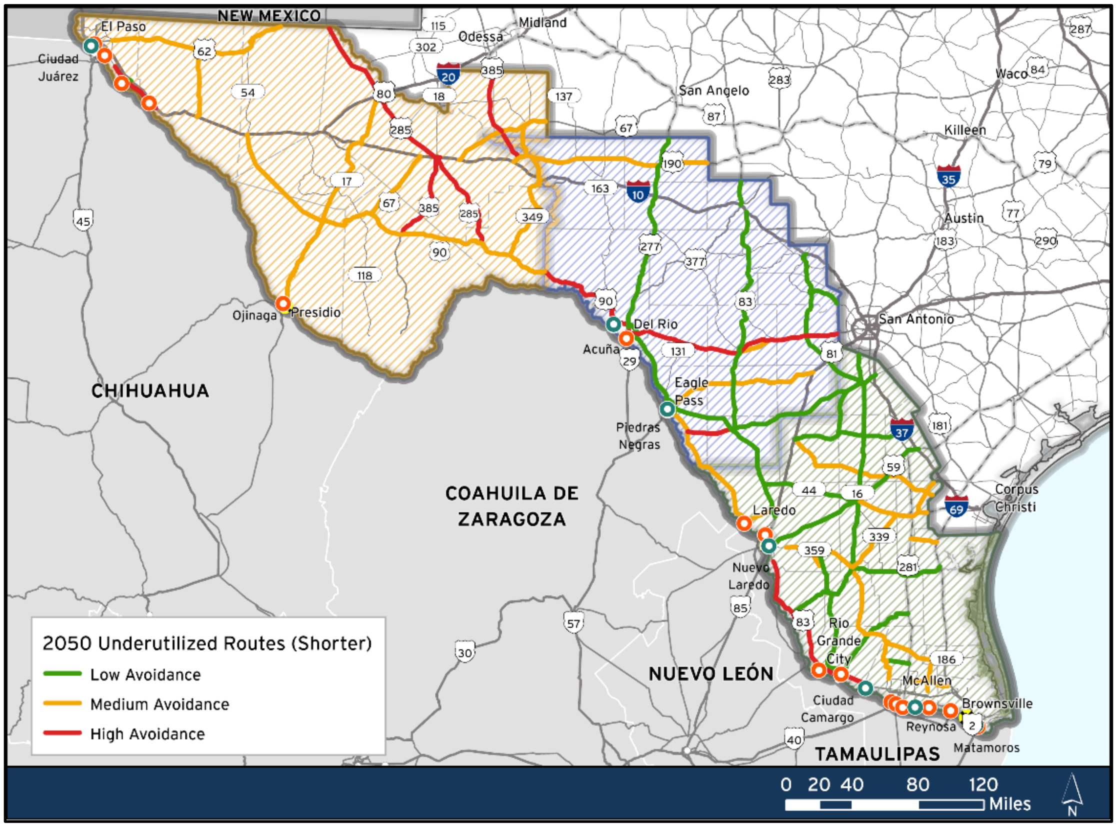


Figure 34: 2050 Shortest Path (Trucks) Performance Categories



Multimodal Connectivity

Passenger bus routes, passenger train routes, and bicycle tourism routes were analyzed to identify gaps within the multimodal network. Intercity passenger bus service is provided by Greyhound. Amtrak provides passenger rail service on the Sunset Limited route from California to Louisiana. In the Border Region, the passenger rail route roughly follows US 90 from El Paso to San Antonio.

The Bicycle Tourism Trail Study (BTTS) Network was reviewed to identify long distance bicycle routes. The network is a statewide network of long-distance bicycle routes for tourism and local use, indicating future demand for both long-distance and local cycling. The network identifies bike lanes, buffered bike lanes, shared use paths, wide outside shoulders, and routes that do not meet bikeway design guidance. Wide outside shoulders were the only bicycle facility located along the RBCN, and is the only facility scored in the RBCN. Bike routes that do not meet the bikeway design guidance were also included in the scoring as they identify future long-distance cycling demand.

The raw segment score was calculated by adding the values per each of the ranked conditions identified in **Table 21** below. The score ranges from zero to six. A six signifies that the segment is located along a passenger bus route, the Bicycle Tourism Trail Network with a wide outside shoulder, and passenger train route.

Table 21: Multimodal Level Scoring

Passenger Bus	Bicycle Tourism Trail Study Network	Passenger Train
Passenger Bus Route = **2** No Passenger Bus Route = **0**	Bike Route Wide Outside Shoulder = **2** Bike Route Does Not Meet BTTS Bikeway Design Guidance = **1** No Bike Route = **0**	Passenger Train Route = **2** No Passenger Train Route = **0**

A multimodal corridor score was calculated by calculating the weighted average multimodal score by segment length. The corridors were then ranked from low to high according to their position in the lowest to highest third of the final weighted average score. The specific classifications and thresholds are detailed in **Table 22**.

Table 22: Multimodal Connectivity Performance Measure Thresholds

Multimodal Connectivity	Score Threshold
Low	0
Medium	0.01 - 0.13
High	0.14 - 13.12

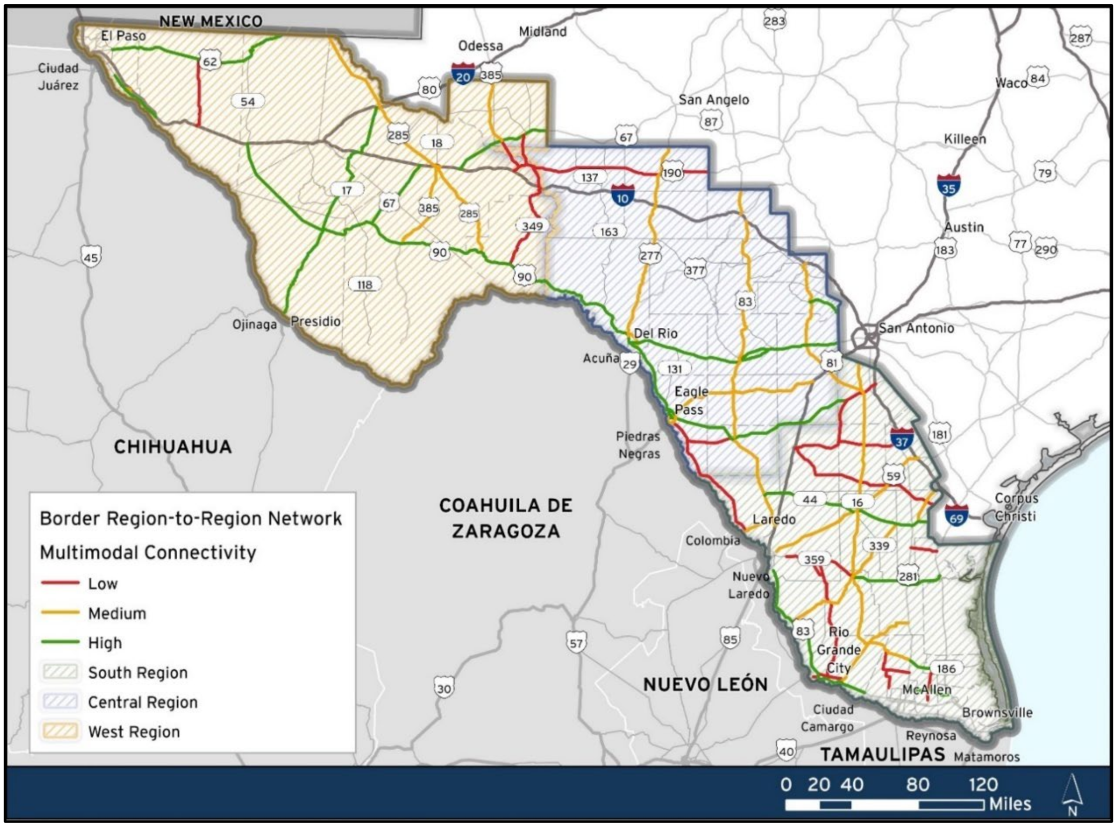
As shown in **Figure 35**, the South Region has the greatest number of corridors and miles of corridors within the low classification. These represent many of the multimodal connectivity gaps that have no passenger bus, passenger train, or bicycle routes identified. While the West Region has three corridors and the Central Region has four corridors in the low classification, the South Region has thirteen. These roads include: Vaquillas Road, FM 490, FM 624, FM 649, FM 650, FM 681, FM 1015, FM 1472, SH 72, SH 97, SH 141, SH 359, and SL 195. It should also be noted that in both the South and Central Regions there are no north-south corridors ranked in the high classification.

As shown in **Table 23**, the South Region has the highest percentage low scoring multimodal connectivity compared to the other two regions. The West Region has the greatest percentage of high scoring corridors.

Table 23: Multimodal Connectivity Categories by Border Region

Multimodal Connectivity	Low	Medium	High
Central	17%	46%	37%
South	36%	41%	23%
West	15%	25%	60%
Border Region	**24%**	**38%**	**38%**

Figure 35: Multimodal Connectivity Performance Categories



Safety and Security

The criteria that were used to assess safety and security include total crashes, severe crashes, truck-related crashes, crash contributing/causing factors, bridge strikes, and at grade rail crossing incidents.

Total Crashes, Severe Crashes, and Truck Related Crashes

This section provides a comprehensive evaluation of safety conditions along the RBCN, focusing on crash risk and severity. The analysis identifies safety risk scores for each corridor, derived through a systematic and data-driven approach, applied to one-mile segments and full corridor analyses. These scores help to pinpoint areas with the highest potential for safety improvements.

The safety risk scoring process involved several key steps. First, observed, predicted, and expected crash values were calculated for different crash types, including multi-vehicle property damage only (PDO) crashes, multi-vehicle fatal and injury crashes, single-vehicle PDO crashes, and single-vehicle fatal and injury crashes. This assessment was conducted for total crashes, fatal and injury crashes, and truck crashes. The calculations incorporated a variety of factors such as roadway geometry, historical crash data, and future predictions, using Texas-specific functions.

The analysis was conducted at two levels:

- **Segment Analysis**: Safety risks are defined as excess crashes, representing the additional crashes observed at a specific location compared to the expected crash frequency for similar sites in Texas, accounting for traffic volumes and roadway geometric characteristics.
- **Corridor Analysis:** The corridor analysis offers an overarching view of crash risk along entire corridors. Safety risk scores for each corridor level are derived by aggregating the segment analysis results, providing critical insights into the relative safety performance of each corridor.

For both levels of analysis, the results were visualized using a color-coded risk scale: red indicates significantly higher-than-expected crash frequencies, signaling a critical need for safety improvements; orange reflects medium safety risks, while yellow and green denote progressively lower levels of risk.

Total Crash Safety Assessment

This section provides total crash analysis within the study network, encompassing all severity types of crashes across the evaluated segments and corridors. The findings are crucial for understanding the overall safety performance of the transportation network and for guiding targeted interventions to enhance safety conditions. **Figure 36** presents the safety risk assessment at the segment level for total crashes, while **Figure 37** illustrates the safety risk scores for the corridor-level.

Figure 36: Total Crash Safety Risk Assessment by Segment

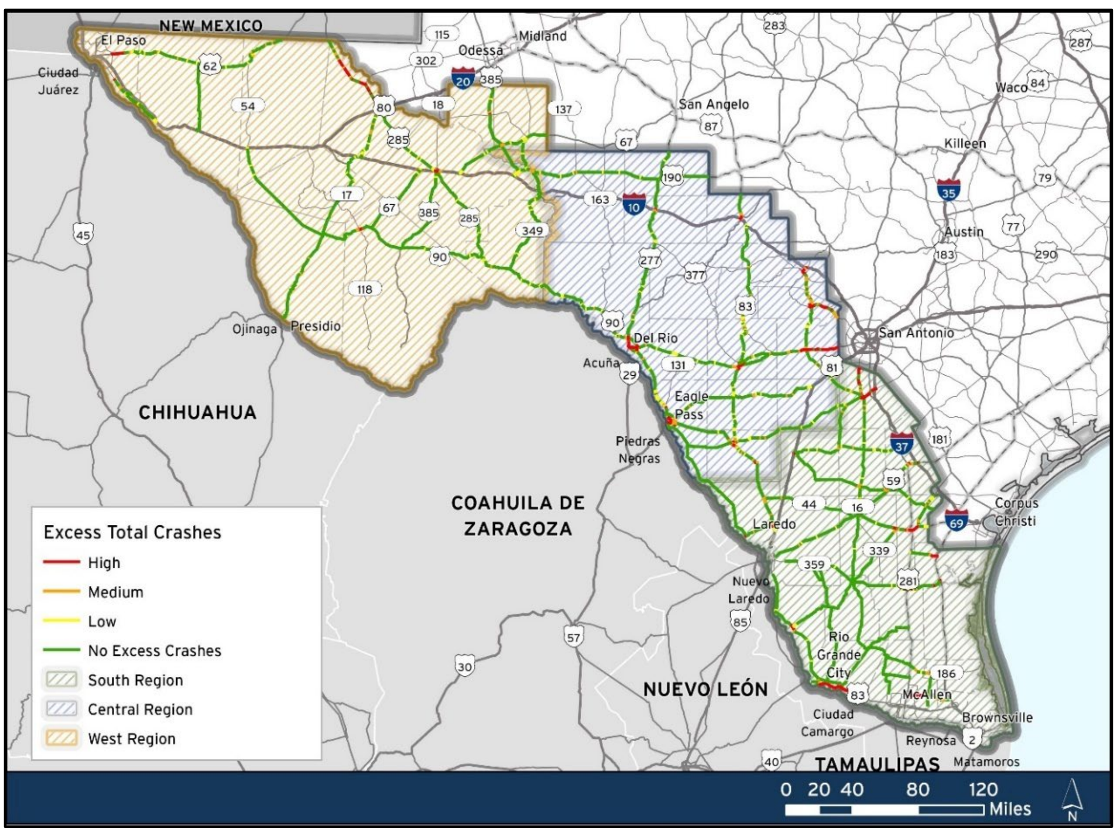
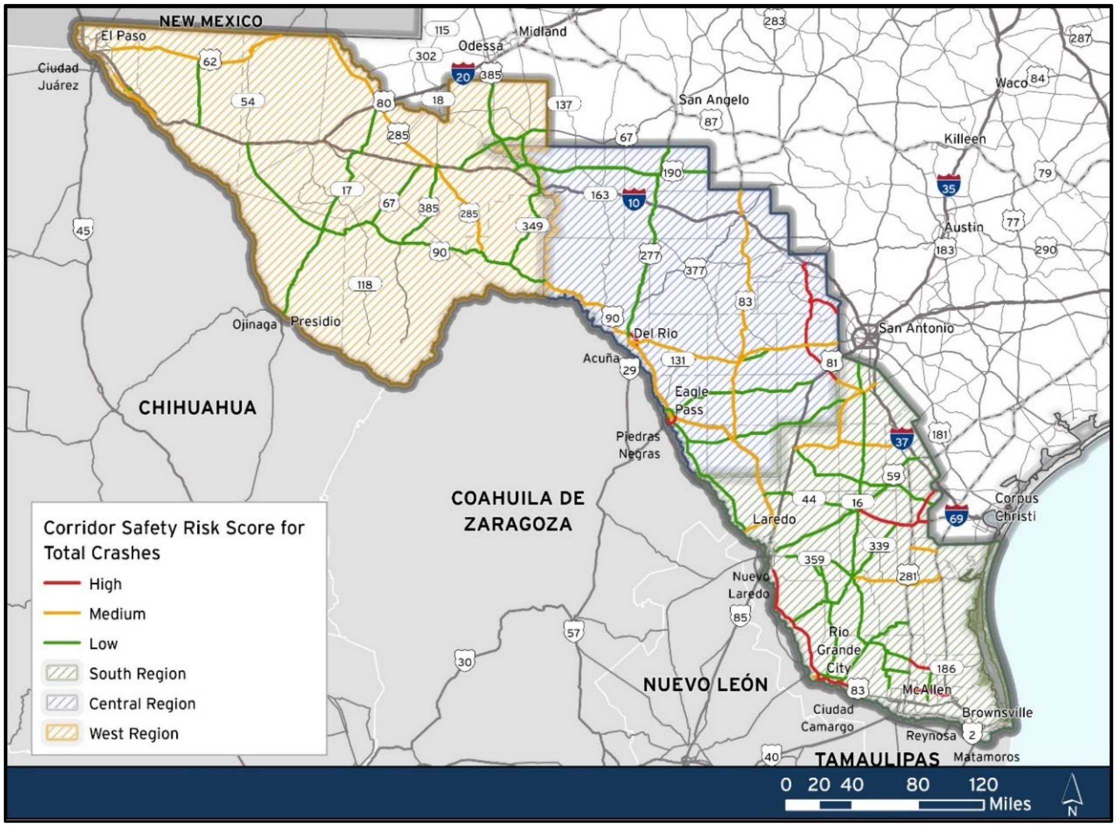


Figure 37: Total Crash Safety Risk Scores by Corridor



The following key findings summarize the results of this segment-level evaluation for total crashes.

- The highways where segments with high excess crashes are clustered include US 90, US 83, US 285, SH 16, SH 44, and SH 173.
- 1-mile segments with a high number of excess crashes are:
  - US 62 (far West Region near El Paso): 26 excess crashes
  - US 207 (far west Central Region, Eagle Pass): 18 excess crashes
  - US 285 (West Region north of I-20 interchange): High excess crashes identified
  - US 277, US 90, and SH 349 (near Del Rio in the far west Central Region): 13.4 excess crashes in average
  - US 83 (far South Region near McAllen): 17.8 excess crashes

Table 24 summarizes the corridors identified with elevated safety risk scores, as represented in red in **Figure 37**. The corridors are ranked in **Table 24** in descending order of their safety risk scores, with the highest scores positioned at the top.

Table 24: RBCN Corridors Identified as High Safety Risk Based on Total Crashes

RBCN Corridor	Location
SH 16	Central Region, between State Highway 173 and San Antonio
SH 107	South Region, in McAllen between I-69C and I-69E
SL Loop 79	Central Region, far west near Del Rio, between US 377 and US 277
SH 186	South Region, near McAllen between I-69C and I-69E
SH 44	South Region, far east near Alice
SL 195	Central Region, far west near Eagle Pass, between US 57 and the border
SH 173	Central Region, far east near San Antonio, between I-10 and I-35
US 83	South Region, along the US/ Mexico border, between McAllen and Laredo
SH 359	South Region, near I-37 and Corpus Christi

Key findings from the total crash safety assessment at the corridor-level include:

- **High Safety Risk Corridors:** Nine of the 56 corridors (16%) were identified as having a high safety risk score, indicating a significant need for targeted safety interventions in these areas.
- **Medium Safety Risk Corridors:** 14 corridors (25%) fell into the medium safety risk category, suggesting that while these areas are relatively safer, they still require monitoring and potential improvements to enhance safety.
- **Low Safety Risk Corridors:** A substantial majority, 33 corridors (58%), were classified as having a low safety risk score, reflecting effective safety measures in place and lower incidences of excess crashes.

Overall, the corridor-level analysis reveals insights into regional safety concerns, particularly highlighting the status of SH 16, situated in the Central Region near San Antonio. This corridor recorded the highest safety risk score of 1.8, which significantly exceeds the average score of 0.39 for all assessed corridors. This finding underscores the need for safety enhancements in this area to mitigate potential risks.

In examining regional patterns, it is noteworthy that no corridors in the West Region, comprising a total of 12 corridors, were identified with high safety risk scores. This suggests relatively stable safety conditions, indicating that existing safety measures in this region may be effectively addressing potential hazards.

Conversely, the Central and South Regions display a greater level of concern. For the Central Region, with four out of 16 corridors—equating to 25%—classified as having high safety risk scores. This situation signals a need for comprehensive safety assessments and targeted improvements to enhance safety conditions in these areas. Similarly, the South Region reflects a safety concern, as five out of 28 corridors, or 17%, were categorized with high safety risk scores. This emphasizes the necessity for focused safety measures to address the identified risks and improve the overall safety of the transportation network in this region.

Commercial-Vehicle Related Crash Safety Assessment

This section concentrates on the analysis of truck-related crashes within the study network. The findings are crucial for understanding the distinct safety challenges posed by trucks and for guiding targeted interventions to enhance safety conditions. **Figure 38** displays the safety risk assessment at the segment level for truck-related crashes, while **Figure 39** presents the safety risk scores at the corridor level.

Figure 38: Truck-Related Crash Safety Risk Assessment by Segment

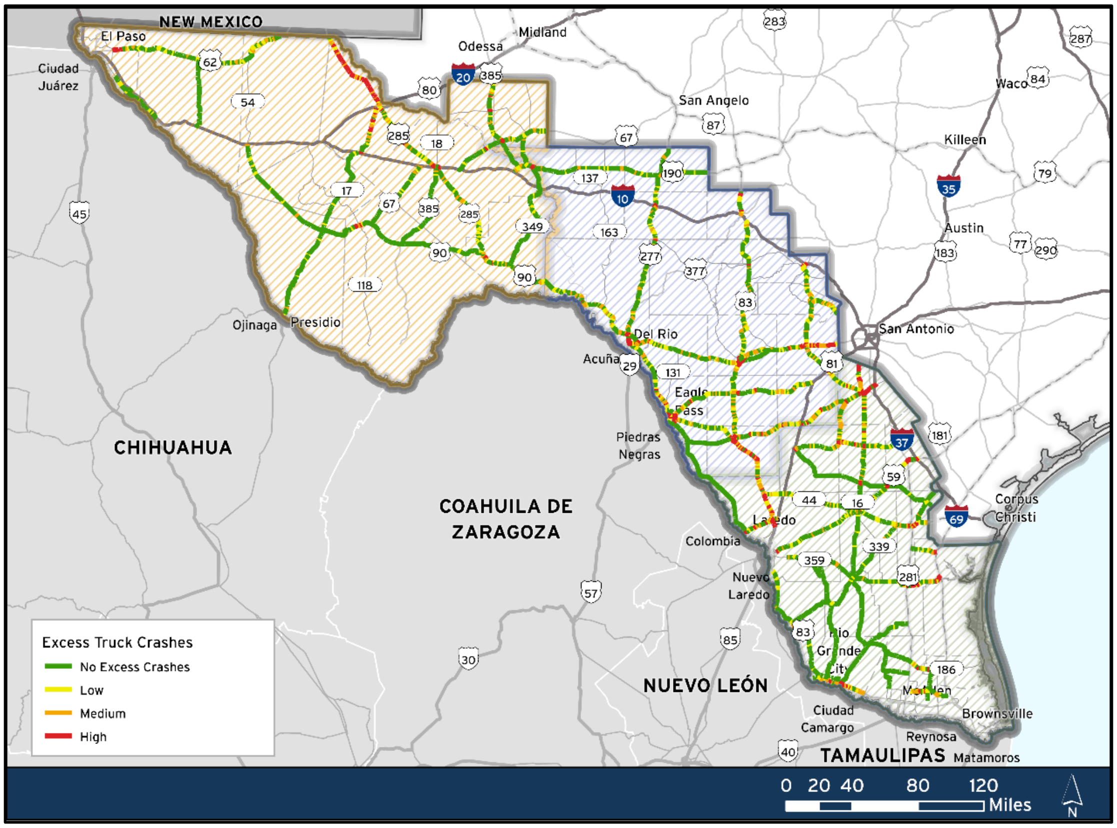
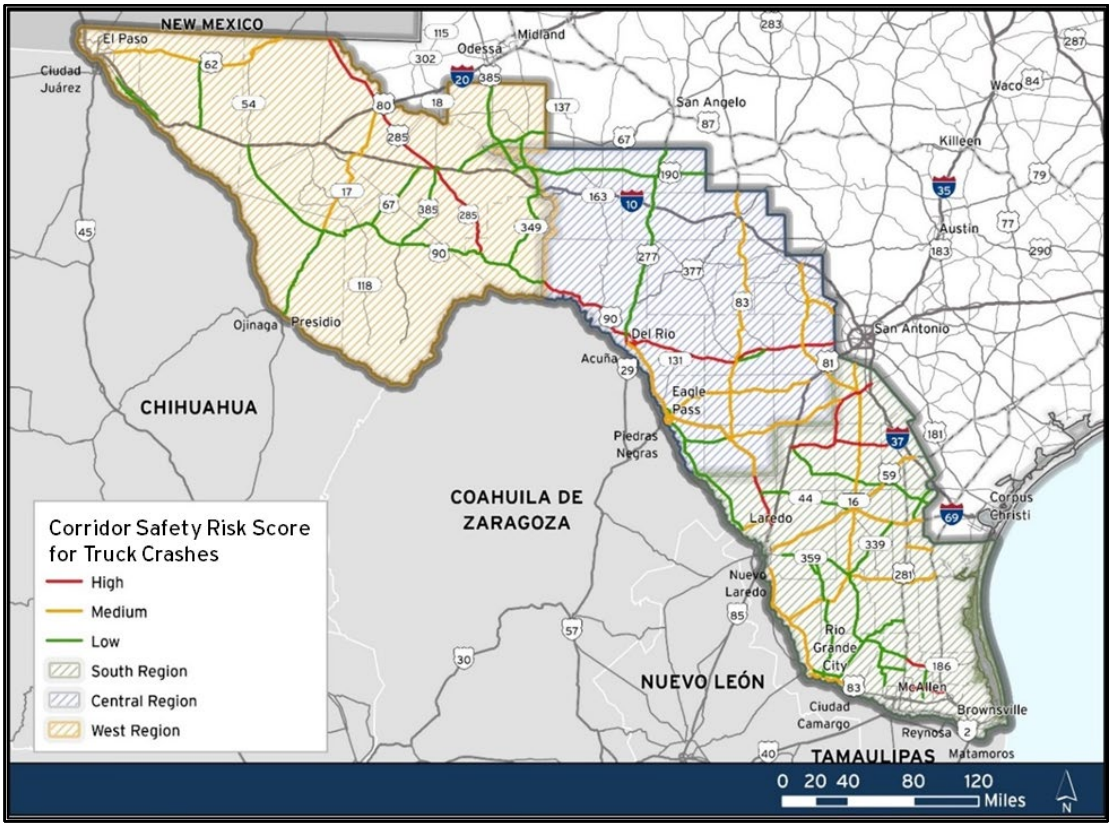


Figure 39: Truck-Related Crash Safety Risk Scores by Corridor



The following key findings summarize the results of this segment-level evaluation for commercial-vehicle related crashes:

- Among the segments evaluated, 30% were identified as experiencing excess truck crashes. This indicates that these segments have a higher crash frequency compared to similar facilities with equivalent traffic volumes and roadway characteristics. Conversely, 70% of the segments exhibited no excess crashes, suggesting lower crash rates than those observed at similar locations across Texas.
- The highways where segments with high excess crashes are clustered include the following:
  - US 62, the section in the far West Region near El Paso: 225.5 excess crashes
  - US 277, the section in the Central Region near Eagle Pass: 148.6 excess crashes
  - US 57, the section in the Central Region near Eagle Pass: 135.4 excess crashes

Table 25 summarizes the corridors identified with elevated safety risk scores, as represented in red in **Figure 39**. The corridors are ranked in **Table 24** in descending order of their safety risk scores, with the highest scores positioned at the top.

Table 25: RBCN Corridors Identified as High Safety Risk Based on Commercial-Vehicle Related Crashes

Corridor	Location
SL 79	Central Region, far west near Del Rio, between US 377 and US 277
US 83	South Region, along the US/ Mexico border, between McAllen and Laredo
US 285	West Region, near Pecos between I-10 and US 90
SH 107	South Region, in McAllen between I-69C and I-69E
FM 2369	Central Region, near Uvalde between US 83 and US 90
SH 97	South Region, between I-37 and I-35
SH 186	South Region, north of McAllen, between US 281 and I-69E
SH 72	South Region, between I-37 State Highway 72
US 90	Central Region, from the end of the region near San Antonio to Langtry on the TX/MX border

Key findings from the commercial-vehicle related crash safety assessment at the corridor-level include:

- **High Safety Risk Corridors:** Nine of the 56 corridors (16%) were identified as having a high safety risk score, underscoring the urgent need for targeted safety interventions in these areas. Notably, three of these corridors—SH 107, SH 186, and SL 79—were also recognized in the total crash analysis.
- **Medium Safety Risk Corridors:** 17 corridors (30%) were classified as having a medium safety risk score. While these areas are relatively safer, they still necessitate ongoing monitoring and potential improvements to enhance safety.
- **Low Safety Risk Corridors:** A significant majority, thirty corridors (54%), were identified as having a low safety risk score, indicating that effective safety measures are in place and that there are fewer incidents of excess crashes.

Overall, while the analysis of truck-related crashes demonstrates patterns that are largely consistent with those observed in total crashes, showing both types of crashes tends to cluster in similar high-risk areas, the specific corridors and segments exhibiting the highest rates of truck-related crashes were different. Distinctive patterns include the prevalence of certain highways, such as SL 79 near Del Rio, which indicated the highest safety risk score of 1.88. This score is significantly above the study area average of 0.52, indicating a critical need for safety enhancements. Additionally, US 83, situated in the South Region near Laredo between the I-35 interchange and SH 44, also displayed a high safety risk score of 1.8. These findings underscore the necessity for targeted safety interventions in these corridors to address the unique risks associated with trucks and enhance overall traffic safety.

In examining regional patterns, only one corridor out of 12 in the West Region, specifically US 285, was identified with a high safety risk score. This finding suggests relatively stable safety conditions in this region. However, the Central and South Regions exhibit more significant safety concerns regarding commercial-vehicle related crashes. In the Central Region, four out of 16 corridors, representing 25%, were classified as having high safety risk scores. Similarly, the South Region demonstrates that five out of 28 corridors, or 17%, categorized with high safety risk scores. This underscores the necessity for focused safety measures to address the identified risks and improve the overall safety of the transportation network in this region.

Fatal and Injury Crash Safety Assessment

This section focuses on the analysis of fatal and injury crashes within the RBCN. The findings are vital for identifying the most critical safety issues and understanding the factors contributing to the most severe outcomes on the transportation network. By analyzing these high-impact crashes, targeted interventions can be developed to address the specific challenges associated with fatal and injury incidents. **Figure 40** illustrates the safety risk assessment at the segment level for fatal and injury crashes, while **Figure 41** presents the safety risk scores at the corridor level.

Figure 40: Fatal and Injury Crash Safety Assessment by Segment

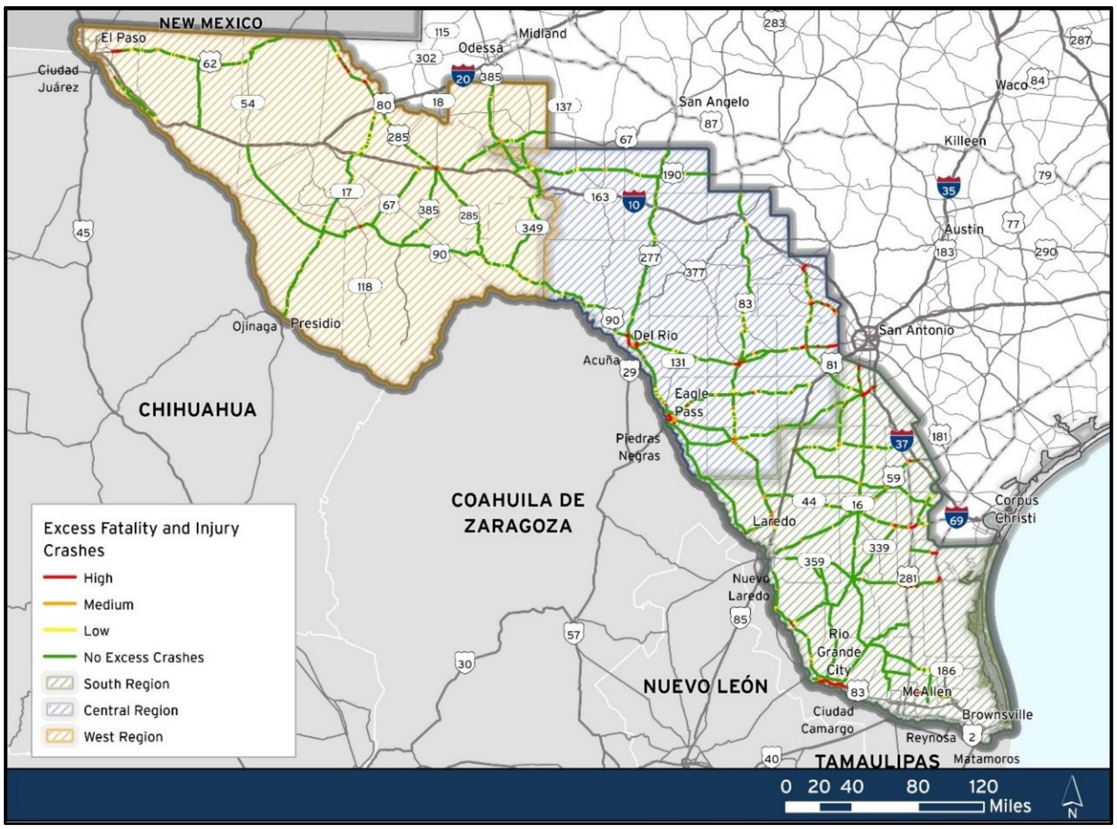
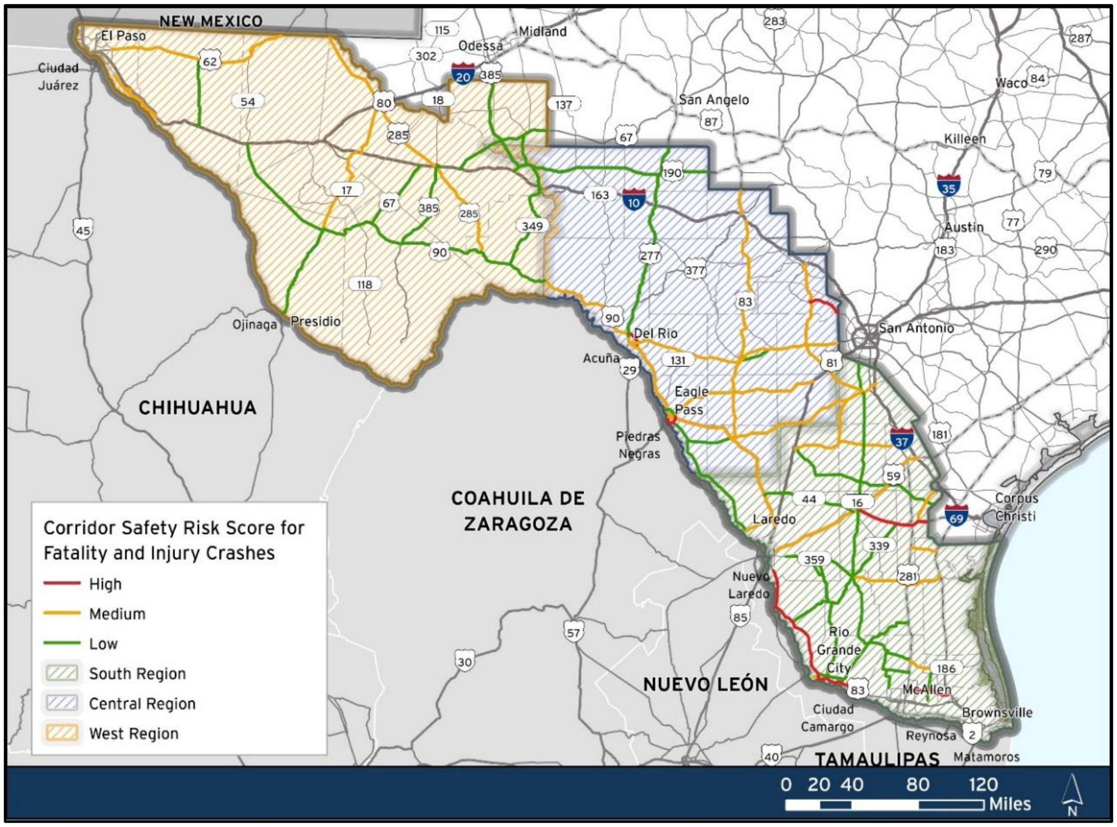


Figure 41: Fatal and Injury Crash Safety Risk Scores by Corridor



The following key findings summarize the results of this segment-level evaluation for fatal and injury crashes:

- Among the segments evaluated, 17% were identified as experiencing excess fatal and injury crashes. This indicates that these segments have a higher crash frequency compared to similar facilities with equivalent traffic volumes and roadway characteristics. Conversely, 83% of the segments exhibited no excess crashes, suggesting lower crash rates than those observed at similar locations across Texas.
- The highways where segments with high excess crashes are clustered include the following:
  - US 83, located in the South Region along the US-Mexico border, contains the highest number of one-mile segments identified with a significant number of excess fatal and injury crashes.
  - US 90, situated in the Central Region, ranks second in terms of the number of segments experiencing elevated fatality or severe injury crash rates.
- Segments containing the highest volume weighted excess fatality and injury crashes include:
  - US 62, in the far West Region near El Paso: 94.1 excess fatal and injury crashes
  - US 83, in the South Region near McAllen: 38.1 excess fatal and injury crashes
  - US 277, in the far west of the Central Region in Eagle Pass: 31.9 excess fatal and injury crashes

Table 26 summarizes the corridors identified with elevated safety risk scores, as represented in red in **Figure 37**. The corridors are ranked in **Table 26** in descending order of their safety risk scores, with the highest scores positioned at the top.

Table 26: RBCN Corridors Identified as High Safety Risk Based on Fatal and Injury Crashes

Corridor	Location
SH 107	South Region, in McAllen between I-69C and I-69E
SH 16	Central Region, from State Highway 173 to the end of the study area, near San Antonio
SL 195	Central Region, far west near Eagle Pass, between US 57 and the border
SH 44	South Region, between State Highway 16 and the end of the study region, near Corpus Christi
SL 79	Central Region, far west near Del Rio, between US 377 and US 277
US 83	South Region, along the US/ Mexico border, between McAllen and Laredo

Key findings from the fatal and injury crash safety assessment at the corridor-level include:

- **High Safety Risk Corridors:** Six of the 56 corridors (10%) were identified as having a high safety risk score, highlighting the critical need for targeted safety interventions in these areas. Notably, three of these corridors—SH 107, US 83, and SL 79—were also recognized in both the total and truck crash analyses.
- **Medium Safety Risk Corridors:** 26 corridors (39%) were classified as having a medium safety risk score. While these areas are relatively safer, they still necessitate ongoing monitoring and potential improvements to enhance safety.
- **Low Safety Risk Corridors:** A significant majority, twenty-eight corridors (50%), were identified as having a low safety risk score, indicating that effective safety measures are in place and that there are fewer incidents of excess crashes.

The corridor-level safety assessment for fatal and injury crash analysis reveals that SH 107, located near McAllen on the South Region, has the highest safety risk score of 1.5, which is significantly greater than the study area average of 0.35. These results underscore the necessity for prioritized safety interventions specifically aimed at addressing the elevated risks associated with fatal and injury crashes in these corridors.

An examination of regional patterns reveals that none of the 12 corridors in the West Region of the study area were identified with a high safety risk score for fatal and injury crashes. However, the Central Region shows that three out of 16 corridors—representing 18%—classified as having a high safety risk score. Similarly, in the South Region, three out of 28 corridors, or approximately 11%, were identified with a high safety risk score.

Summary of Safety Assessment

This section presents a comprehensive assessment of safety conditions throughout the study network, with a particular focus on crash risk and severity. The analysis employs a systematic, data-driven methodology to derive safety risk scores for one-mile segments and entire corridors. By calculating observed, predicted, and expected crash values for various types of incidents—including property damage only, as well as fatal and injury crashes—this study identifies segments and corridors with the highest potential for safety enhancements.

The following is a summary of the key findings derived from the three safety evaluations: total crashes, severe crashes, and truck-related crashes.

- The total crash safety assessment indicates that nine out of 56 corridors were identified as having high safety risk scores, particularly highlighting US 90, US 83, and US 285.
- The analysis of truck-related crashes shows similar trends, with specific corridors such as SL 79 and US 83 necessitating targeted interventions.
- The evaluation of fatal and injury crashes emphasizes corridors like SH 107, which recorded the highest safety risk score among all assessed corridors.
- The analysis conducted across the three studies consistently identified three corridors as high-priority areas:
    - US 83 (Segment 1): A total of 26 segments were identified with high excess crashes in the overall analysis, 15 in the truck analysis, and 25 in the fatality and injury analysis.
    - SH Loop 79: This corridor showed 9 segments with high excess crashes in the total analysis, all 9 segments were also noted in the truck analysis, and 3 in the fatality and injury analysis.
    - SH 107: This corridor revealed 9 segments with high excess crashes in the total analysis, 6 in the truck analysis, and 10 in the fatality and injury analysis.
- Overall, these findings emphasize the critical need for prioritized safety enhancements in essential areas, particularly within the Central and South Regions, to mitigate risks and improve the overall safety of the transportation network.

Crash Contributing Factors

Understanding the factors that contribute to traffic crashes is essential for improving road safety and implementing effective prevention strategies. This section highlights the primary factors contributing to crashes across the Border Region. This analysis uses crash data from 2019 through 2023 from the TxDOT Crash Records Information System (CRIS) database. **Table 27** lists the top five contributing factors for the study area and shows the percentage of crashes attributed to these factors across the regions. The analysis revealed that the top five factors were mostly consistent across the study area and across the regions, with only slight variations in their rankings.

Table 27: Top Five Crash Contributing Factors for Study Area

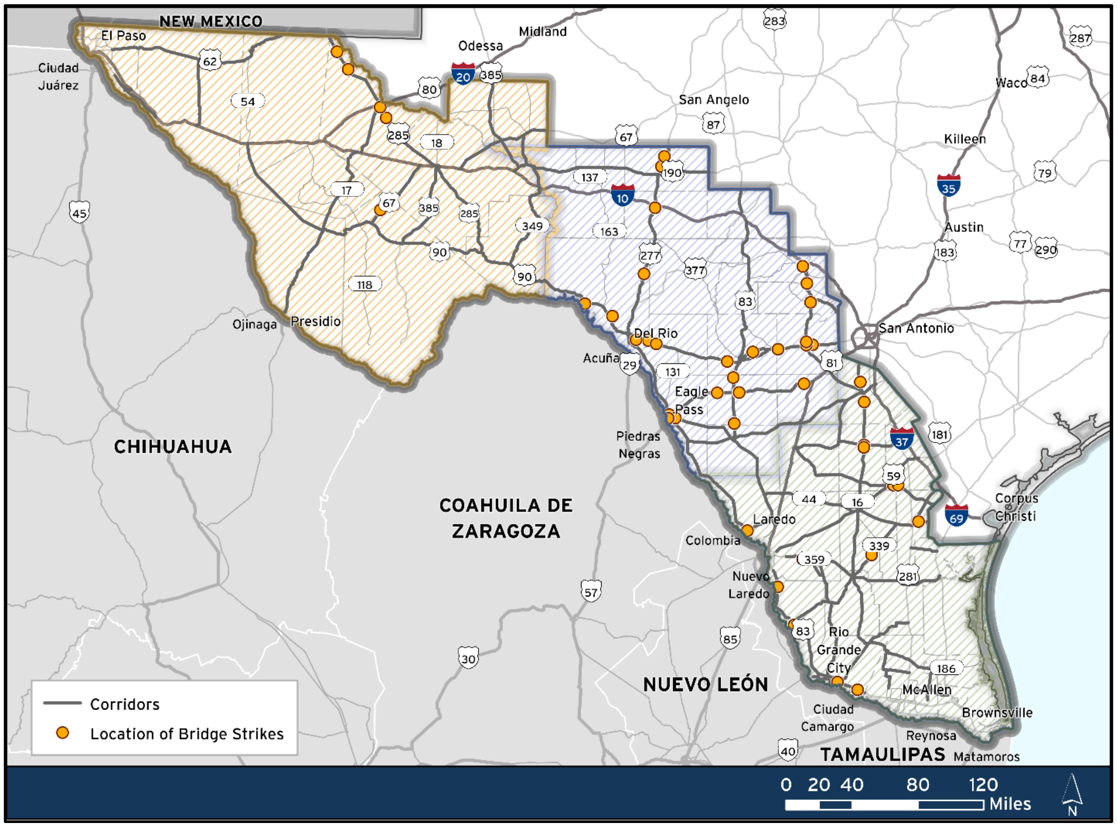
Top five crash contributing factors	Overall	% Overall	Central	% in Central	South	% in South	West	% in West
Failed to Control Speed	4,670	13%	1,389	9%	2,281	15%	998	7%
Driver Inattention	3,385	10%	1,799	12%	1,134	7%	444	3%
Wild animal on road	2,232	6%	1,082	7%	826	5%	319	2%
Failed to yield ROW- stop sign	1,868	5%	916	6%	673	4%	279	2%
Cell/ mobile device use- talking	1,696	5%	697	5%	544	4%	450	3%

Failure to control speed accounted for the highest percentage of crashes, contributing to 13% of incidents across the Border Region. It was also the leading cause of crashes in the South and West Regions, responsible for 15% and 7% of crashes, respectively. Driver inattention ranked as the second most common factor, causing 10% of crashes overall, and was the top primary cause in the Central Region, contributing to 12% of crashes in the region. Wild animal on the road listed as primary factor for 6% of the crashes. Failure to yield on stop sign ranked the fourth top primary contributors for the study area causing 5% of the overall crashes. This ranked 4^{th}, $4^{th,}$ and 6^{th} most frequent factors in Central, South and West Regions, respectively. The fifth leading factor contributing to crashes in the study area was talking on cell/mobile devices while driving, responsible for 5% of total crashes. This factor was most prevalent in the West Region, where it ranked as the second highest contributor to crashes.

Bridge Strikes

A bridge strike occurs when a vehicle collides with a bridge while trying to pass underneath it. These incidents pose serious safety risks, leading to injuries and fatalities, infrastructure damage, disruptions to commerce, and increased travel delays. According to 2019 to 2023 crash data from TxDOT CRIS database, there were 54 bridge strikes on the corridors. **Figure 42** shows the locations of bridge strikes.

Figure 42: Location of Bridge Strikes by Region



Half of the total bridge strikes occurred in the Central Region, with US 90 recording the highest number at 9 incidents. SH 173 had 5 strikes, and US 57 had 5 strikes. The South Region experienced 16 bridge strikes, with 5 occurring on US 83 and 4 on SH 16. The West Region saw 12 strikes during this period. Of these, 4 of each took place on US 285 and US 277, and the rest were on US 67 and US 277.

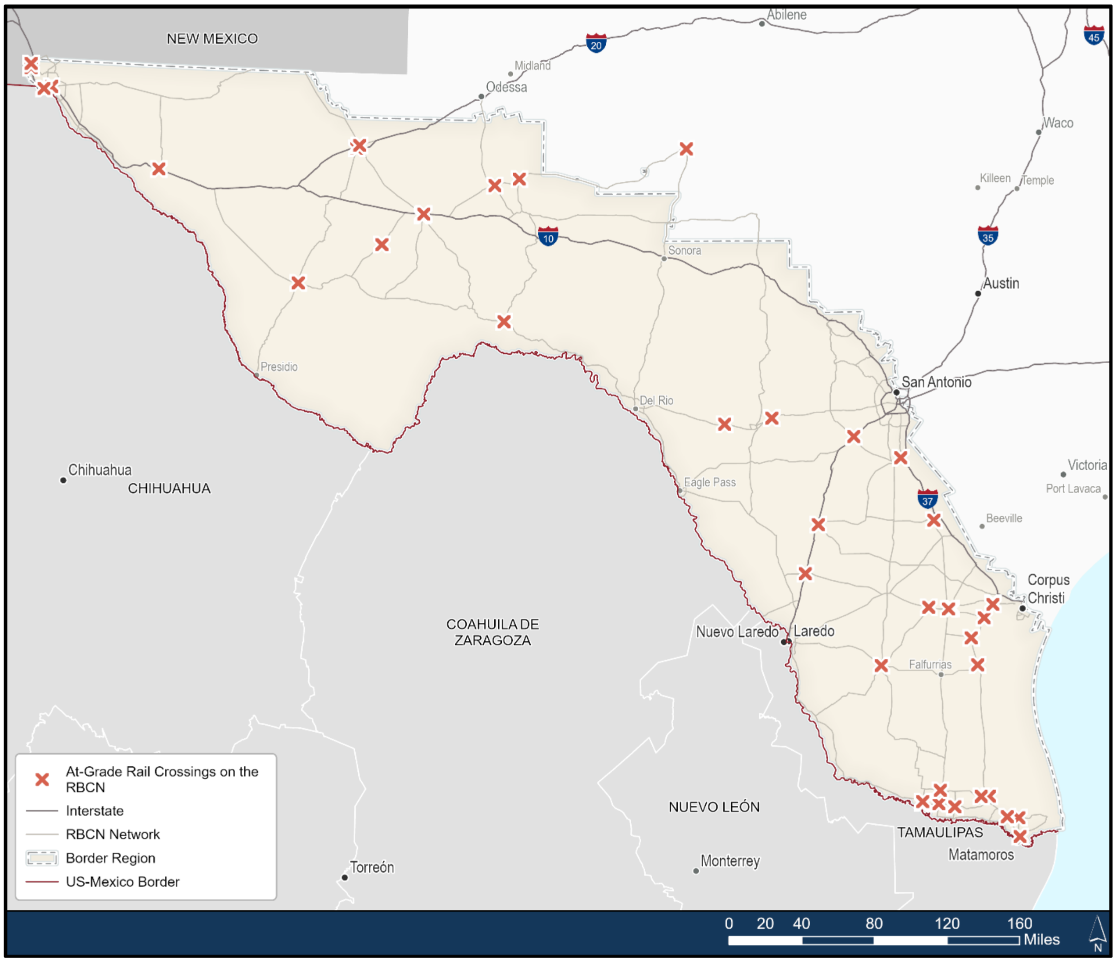
At Grade Rail Crossings Incidents

At-grade rail crossings are where a highway or road intersects with a railroad, and vehicles or pedestrians have access to cross the railroad tracks. This type of crossing can cause significant delays to the flow of goods, vehicles, and pedestrians within a region, primarily due to the passing or stoppage of trains at the crossing. Safety issues and roadway delays can also occur due to at-grade rail crossing incidents, which are when there is a conflict between a train and a vehicle or pedestrian crossing its tracks.

At-grade rail crossing incidents in the Border Region and their impact on the safety of roadway users and the flow of goods were studied by assessing the number of incidents occurring between trains and other vehicles or pedestrians at highway-rail grade crossing points, and the resulting impact on surrounding traffic. The metrics used to analyze at-grade rail crossing incidents include Rail Crossing Inventory Data, Highway/Rail Grade Crossing Incidents data, the time and dates of crossing incidents, and surrounding traffic conditions following an incident. The final research produced two points of analysis. First, buffer zones around the identified at-grade rail crossings were created, within which to analyze the impact an incident has on surrounding traffic. Secondly, an analysis of the safety implications of at-grade rail crossings in the Border Region via the identification of safety "hotspots" was performed.

To identify at-grade rail crossing locations in the Border Region, the Federal Railroad Administration's (FRA) Rail Crossing Inventory Data for Texas was filtered to include only at-grade crossings that are directly on the RBCN. This resulted in a Rail Crossing Inventory dataset of 43 at-grade rail crossings (**Figure 43**).

Figure 43: At-grade Rail Crossings on the RBCN



Source: CPCS Analysis of FRA Data, 2024.

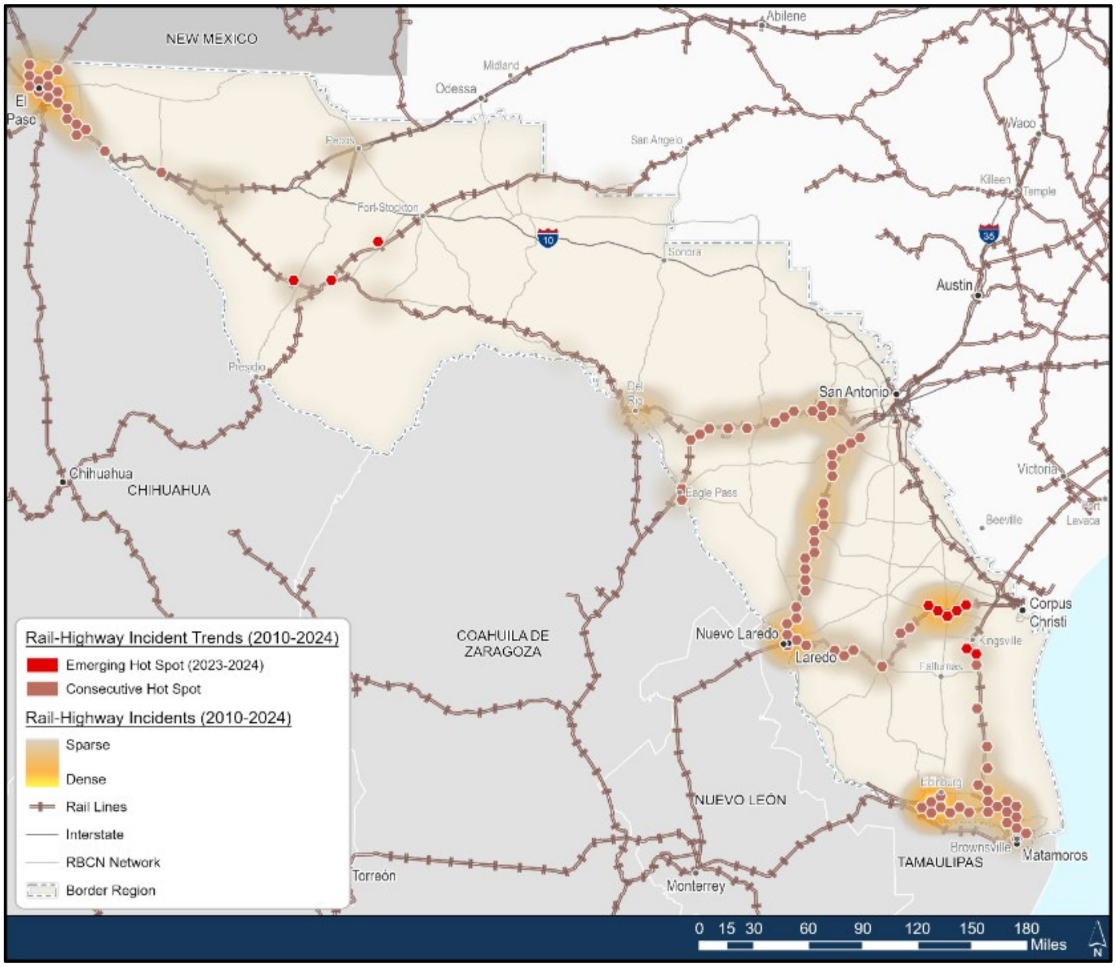
Buffer zones around each at-grade rail crossing in the Border Region were analyzed. These buffer zones were then used to make a preliminary assessment of how at-grade crossings affect regional connectivity on the RBCN. For each of the 43 at-grade rail crossings, Regional Integrated Transportation Information System (RITIS) travel time data for road segments intersecting and adjacent to the at-grade crossing for April through October 2022 was analyzed. The buffer zones were then provided a score categorizing the connectivity impact of an incident within the buffer zone as either high, medium, or low. A high score indicates that the movement of people and goods in the area is greatly affected by incidents occurring at the at-grade rail crossing. This is characterized by elevated levels of traffic or significant slowdowns on surrounding roads following an at-grade rail crossing incident.

The Rail Crossing Inventory data was merged with the FRA Highway/Rail Grade Crossing Incidents data for Texas for 2010 through 2023. This data was then filtered to incidents within 100 miles of the border, creating a dataset of 313 highway-rail crossing incidents in the Border Region.

A second point of analysis was to understand the at-grade rail crossings which pose higher safety risks. FRA Highway/Rail Grade Crossing Incidents data for Texas for 2010 through 2024 was merged with the Rail Crossing Inventory data, creating a dataset of the number of incidents reported at each rail crossing in Texas Border Region during the study timeframe. The resulting dataset of 313 highway-rail crossing incidents was then analyzed to understand where clusters of incidents are occurring in the Border Region. These "hotspots" include at-grade rail crossings that have experienced high incident rates over the past 14 years or have seen an increase in the number of incidents in the last year, 2023 to 2024.

As seen in **Figure 44**, from 2010 to 2024 at-grade rail crossing incidents primarily occurred in urban areas along the border, particularly in the El Paso, McAllen, and Brownsville areas. Additional areas of concentration include along the I-35 and the US 90 corridors. An emerging hotspot, which is an area where multiple incidents have occurred recently, can be seen on SH 44. Therefore, prioritizing corridors with hotspots for improvements to highway-rail safety inspections could yield major improvements in both safety and regional connectivity.

Figure 44: Highway-rail Incident Hotspots in Texas Border Region (2010-2024)



Source: CPCS Analysis of FRA Data, 2024.

Asset Preservation and Technology Deployment

The criteria that were used to assess asset preservation and technology deployment include current design standards, pavement conditions, bridge height restrictions, bridge conditions, and the existence of ITS.

Current Design Standards

In this section, current design standards including lane width and shoulders, are examined to determine driving conditions for travelers along the RBCN.

Number of Lanes

Stretches of road with two lanes or less limit the ability to pass slow moving or stopped vehicles and can lead to less reliable travel times when there is congestion, construction, or an incident that closes a travel lane. Data on the number of lanes is collected from the TxDOT Roadway Inventory and displayed in **Figure 45** as the percentage of lane mileage with two lanes or less within a corridor. **Table 28** shows the score threshold of the three categories and **Figure 45** shows the number of lanes performance categories. The lowest third, indicated in green, are corridors where 80% or less of centerline miles are two lanes or less. The middle third, shown in yellow, are corridors where about

80%-95% of the mileage is two lanes or less. The highest third, shown in red, are corridors that are completely or almost completely two lanes or less. Corridors with a high percentage of two lanes or less are concentrated in the South Region, where SH 359, FM 624, FM 1472, FM 681, FM 650, FM 490, SH 173, US 83, SH 359, FM 1017, and FM 649 are completely or almost completely two lanes or less. In the West and Central Regions, FM 3380 is completely or almost completely two lanes or less. **Table 29** shows percentage of lane mileage in the study area with two or less number of lanes.

Table 28: Number of Lanes Performance Measure Thresholds

Number of lanes	Score Threshold
Low	0% - 78.61%
Medium	78.62% - 96.56%
High	96.57% - 100%

Figure 45: Number of Lanes Performance Categories

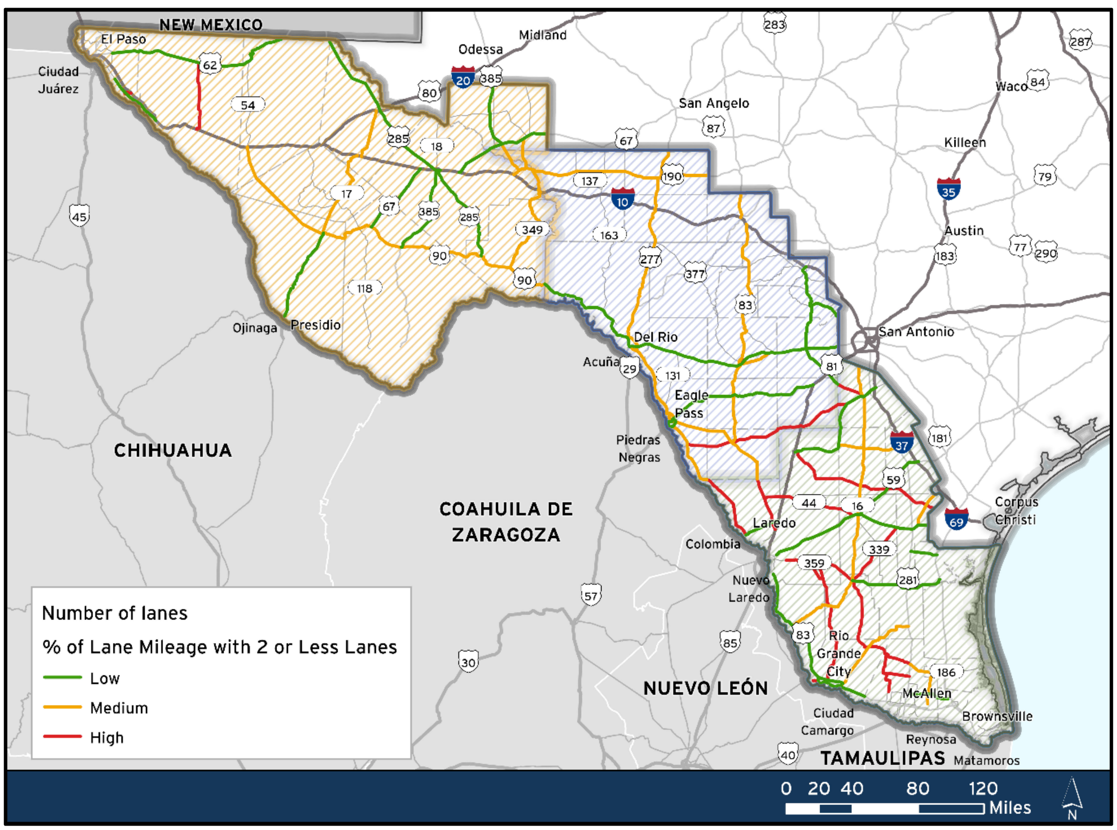


Table 29: Lane mileage with two or less number of lanes

Region	Percentage of lane mileage with two or less number of lanes
Central	69%
South	76%
West	79%
Border Region	**74%**

Shoulder Width

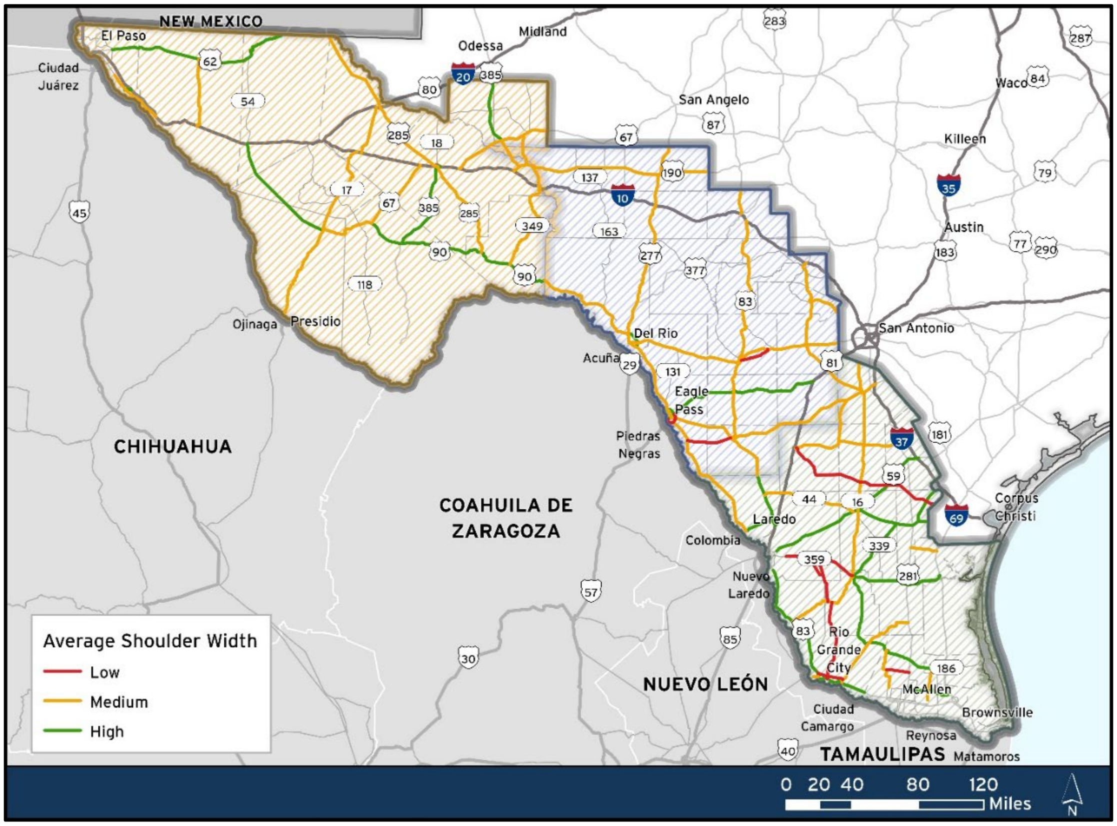
Outside shoulder width is essential for highway routes as it provides space for emergency stops, breakdowns, and vehicle recovery, ensuring the safety of both stranded vehicles and passing traffic. Additionally, wider shoulders enhance road capacity and drainage, improving overall highway performance and safety by preventing water from pooling and reducing hydroplaning risks. Outside shoulder width is collected from TxDOT roadway inventory 2022 data, where the values are recorded for segments. Average values of segments were aggregated as values for corridors.

Table 30: Shoulder Width Performance Measure Thresholds

Shoulder Width Condition	Average Shoulder Width Range
Low	Less than 4 feet
Medium	4-8 feet
High	More than 8 feet

As shown in **Figure 46**, All corridors with a low shoulder width are in the Central and South Region, with the majority in the South Region. SH 359, FM 649, FM 624, and FM 490 in the South Region and FM 1023 and FM 2644 in the Central Region all have a low average shoulder width. Additionally, the future roads Vaquillas Road, SL 480, and SL 195 were all measured to have no shoulder because they are not yet constructed.

Figure 46: Shoulder Width Performance Categories



Pavement Conditions

Roadways that experience high use and/or insufficient maintenance may exhibit poor pavement condition, which can impede the flow of goods and passengers and may result in serious safety concerns. The presence or lack of sufficient drainage can also have a major impact on the integrity of road infrastructure, especially during extreme weather events. TxDOT collects pavement conditions data as part of the Pavement Management Information System (PMIS) reporting requirement. A Distress Score was assigned to each road segment and has been used to classify the RBCN, where a low distress score means poor or low pavement condition. The pavement conditions thresholds for segments are listed in **Table 31** below.

Table 31: Pavement Conditions Performance Measure Thresholds

Pavement condition	Distress Score ranges
Level 1	Below 70
Level 2	Between 70 to 79
Level 3	Higher than 80

The Distress Scores by segment were aggregated to determine the total mileage of each corridor that falls under the low, medium, or high category. **Table 32** summarizes the output across three regions and overall condition of the Border Region corridors. The South Region exhibits the worst pavement conditions with 10% scored low, while the Central and West Regions have 2% and 7% of mileage with low condition ratings, respectively. Overall, the corridors show most pavements across all regions are well-maintained, with 84% in high condition, 10% medium, and 6% low, indicating effective pavement maintenance practices.

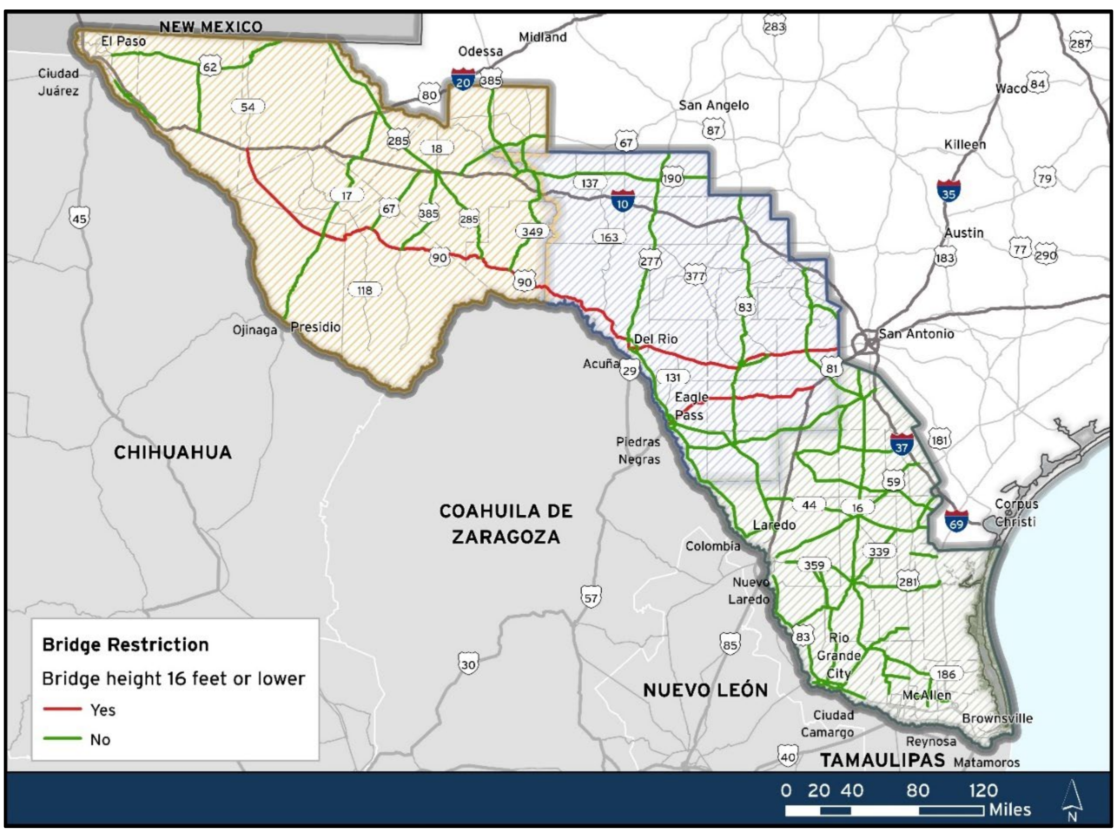
Table 32: Pavement Conditions by Border Region

Region	High	Medium	Low
Central	89%	8%	2%
South	78%	13%	10%
West	85%	8%	7%
Border Region	**84%**	**10%**	**6%**

Bridge Height Restrictions

Large trucks must avoid routes with bridge height restrictions, leading to longer travel times and increased congestion on the few viable routes. The presence of a low bridge clearance makes that corridor impassable for travelers with over height trucks. A corridor that has height restriction should be prioritized for further improvement through the scoring. TxDOT's Bridge Division maintains data on the height of bridges in its network, which was used for scoring. As shown in **Figure 47**, if any corridor has a bridge with vertical clearance with 16 feet or less, those corridors were marked as height restricted bridge.

Figure 47: Bridge Height Restrictions Performance Categories



In the South Region, there were no bridges along the RBCN with a height less than 16 feet clearance. Both the West and Central Regions each had two corridors with height restrictions. In the West Region, the US 67/90 corridor includes two bridges with a vertical clearance below 16 feet. Additionally, the US 90 in the West Region has one bridge in Culberson County that also falls under this height restriction. In the Central Region, the US 57 corridor features a height-restricted bridge in Eagle Pass, while the US 90 includes a bridge in Uvalde County that is similarly constrained by height restrictions.

Bridge Conditions

TxDOT has a Superstructure Conditions Index database for bridges which was used to assess the condition of bridges. This database has "Superstructure Condition Rating" scaled from 0-9 for each bridge, where "9" is in good condition and "0" is in bad condition. Bridge crash data from TxDOT's CRIS was incorporated to generate the final bridge condition metrics by segment. The bridge metric scoring is shown in **Table 33**.

Table 33: Bridge Condition Scoring

Bridge condition	Bridge Condition Score ranges
Level 1	Superstructure Condition Rating" of <5 irrespective of number of crashes. Also, any bridge with "Superstructure Condition Rating" of 5 to 6 along with the number of crashes falling in the "Highest Tercile" and "Middle Tercile" range.
Level 2	"Superstructure Condition Rating" of five to six along with number of crashes falling in the "Lowest Tercile" range. Also, any bridge with "Superstructure Condition Rating" of seven or less than seven along with the number of crashes falling in the "Highest Tercile" range
Level 3	"Superstructure Condition Rating" of seven or less than seven along with number of crashes falling in the "Middle Tercile" and "Lowest Tercile" ranges

Scores were assigned at the segment level, and for the specific segment where the bridge is located. Then corridor level scores were aggregated from the weighted average of the segment scores, where segment length was used as weight. That created a new range of scores for the corridors. Then corridors with low, medium, or high bridge condition were determined by tercile range. Overall, 41% of corridor length were in low bridge condition. **Table 34** shows the threshold for corridor level bridge condition.

Table 34: Bridge Condition Performance Measure Thresholds

Bridge Condition	Score Threshold
Low	0.22 - 0.50
Medium	0.51 - 0.75
High	0.76 - 8.94

Table 35 shows that the Central Region has the highest percentage of corridor length with low bridge condition at 56%. West has the second highest percentage for corridor length with low bridge condition with 38% and South has the lowest percentage of corridor length with low bridge condition at 30%.

Table 35: Bridge Condition Categories by Border Region

Bridge condition	High	Medium	Low
Central	19%	25%	56%
South	32%	38%	30%
West	23%	39%	38%
Border Region	**25%**	**34%**	**41%**

Existence of ITS Infrastructure

ITS plays a critical role in meeting the dynamic needs of modern travel and traffic management, greatly enhancing the safety, efficiency, and sustainability of our transportation infrastructures. ITS Readiness metric for infrastructures was calculated. Key factors for generating their segment level score include the presence of digital messaging signs (DMS) and closed-circuit television (CCTV) cameras, which indicate existing electrical circuitry crucial for wiring additional devices that enhance emergency response and information flow. Another factor is the readiness for electric vehicles (EV), which serves as an indicator of futureproofing the infrastructure.

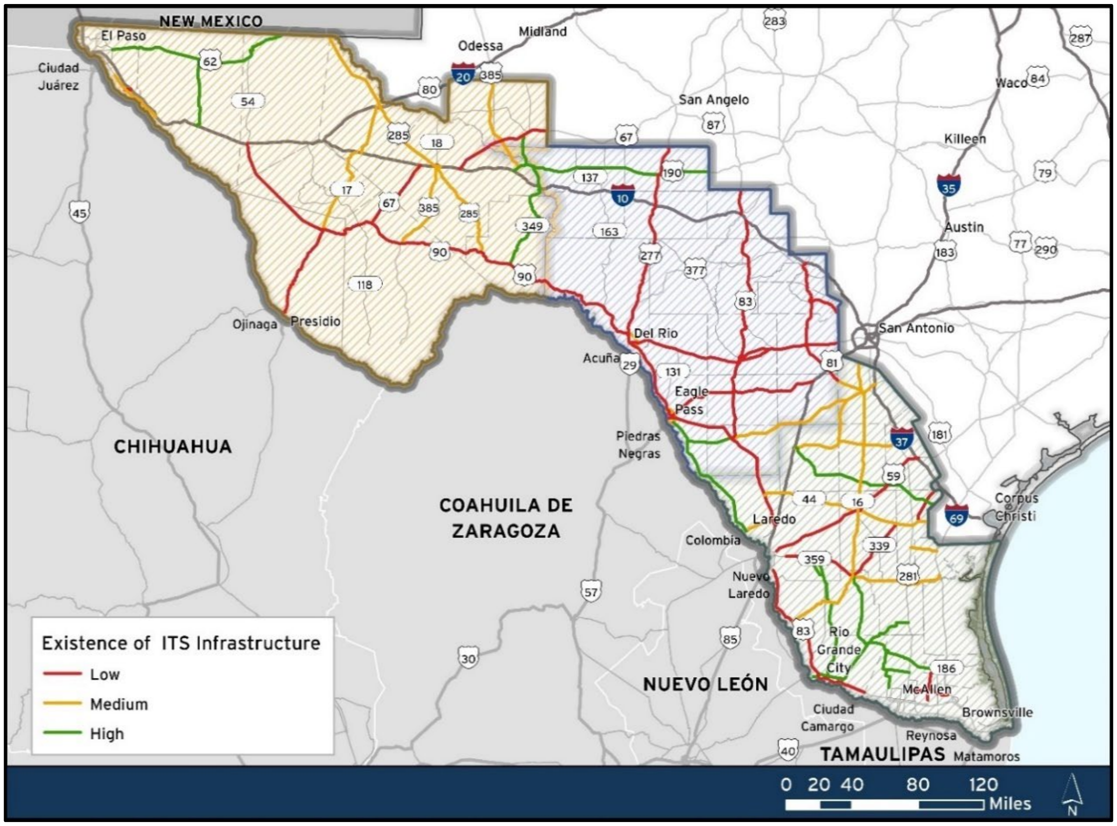
To consolidate the segment level ITS readiness metric into corridor-level values, a weighted average of the segment scores, using the mileage of each road segment as the weight was calculated. The final ITS scores classify roads into high, medium, and low levels of ITS infrastructure presence. The corridors were then ranked from low to high according to their position in the lowest to highest third of the final weighted average score. The specific classifications and thresholds are detailed in **Table 36**.

Table 36: ITS Infrastructure Performance Measure Thresholds

ITS Infrastructure Existence	Score Threshold
Low	0.21 - 0.49
Medium	0.50 - 0.75
High	0.76 - 8.94

A high ITS score generally signifies that a corridor is well-equipped with a substantial number of CCTV cameras and DMS. These corridors also include high length of roadways that align with the U.S. Environmental Protection Agency's (EPA) designated freight EV-ready network. **Figure 48** displays the distribution of ITS infrastructure existence along the corridors within the final RBCN.

Figure 48: Existence of ITS Infrastructure Performance Categories



The Central Region holds the highest percentage of mileage marked by low ITS scores, highlighting significant potential for system upgrades. Key corridors include: US 90, which cuts through the Central Region, affecting Val Verde, Kinney, Uvalde, and Medina Counties; US 277 stretching from Del Rio to Schleicher County; US 83 from Laredo to Kimble County; and US 57, which connects Eagle Pass through to Frio County and intersects with I-10. The West Region has two main corridors that scored high. These includes US 67/90 that spans across Crane, Upton, Pecos, and Presidio Counties and US 90 from I-10 in Culberson County extending to Terrell County. The South Region showed four major roadways with low ITS score. US 83 near the Laredo-Rio Grande borders, covering mainly Zapata and Starr Counties; SH 359 covering Duval, Webb, and Jim Wells Counties; FM 1015 in the vicinity of McAllen; and US 59 passing through Webb, Duval, and Live Oaks Counties, beginning its stretch near Laredo.

Economic Competitiveness, Cross-Border Resiliency, and Sustainable Funding

The criteria that were used to assess economic competitiveness, cross-border resiliency, and sustainable funding includes exposure to risk.

Exposure to Risk

The disabling or destruction of the RBCN could have a debilitating impact on national economic security. Such disruptions would hinder trade flows, which are essential for the livelihoods and quality of life of millions of people, would follow as was seen during the COVID-19 pandemic with disruptions that had locally and international widespread negative effects.

Overview

The effects of the COVID-19 pandemic on cross-border commodity flow at Texas-Mexico border crossings were most felt from March 2020 to November 2021, as all land border crossings between Mexico and Texas were closed to non-essential travelers which resulted in major impacts or shocks to the supply chain. Northbound traffic by truck dropped to almost zero in spring 2020 at the El Paso, Hidalgo, and Laredo ports of entry before beginning to rebound in the summer.[4] All Border Regions experienced a drop in trade value in 2020, due to the COVID-19 pandemic, with the South Region leading the drop at $46 billion, followed by the West Region at $8 billion and the Central Region contracting from $5 billion in 2019 to $4 billion in 2020. Industries most impacted included automotive goods, defense/aerospace, electronics, personal care products and semiconductor industries.

Resiliency Analysis

The Bureau of Transportation Statistics reports that before the pandemic, in 2019, the U.S. had 594 billion in trade with Mexico (both directions).[5] The COVID-19 pandemic exposed the weaknesses that exist in current supply chain networks and the vulnerabilities to external shocks that key supply chain networks have. In 2020, U.S.-Mexico freight activity dropped by 10.1%, compared with 2019.[6] The drop in trade flows had a negative impact on the local and the national US and Mexican economy.

Monthly cross border trade volume data revelated that all identified supply-chain categories suffered notable declines in April and May 2020 due to the pandemic (**Figure 49**). Durable Goods saw the most prolonged recovery period, taking six months to rebound to pre-pandemic levels. Conversely, Industrial Products bounced back quickly within two months, with Agricultural and Non-Durable Goods

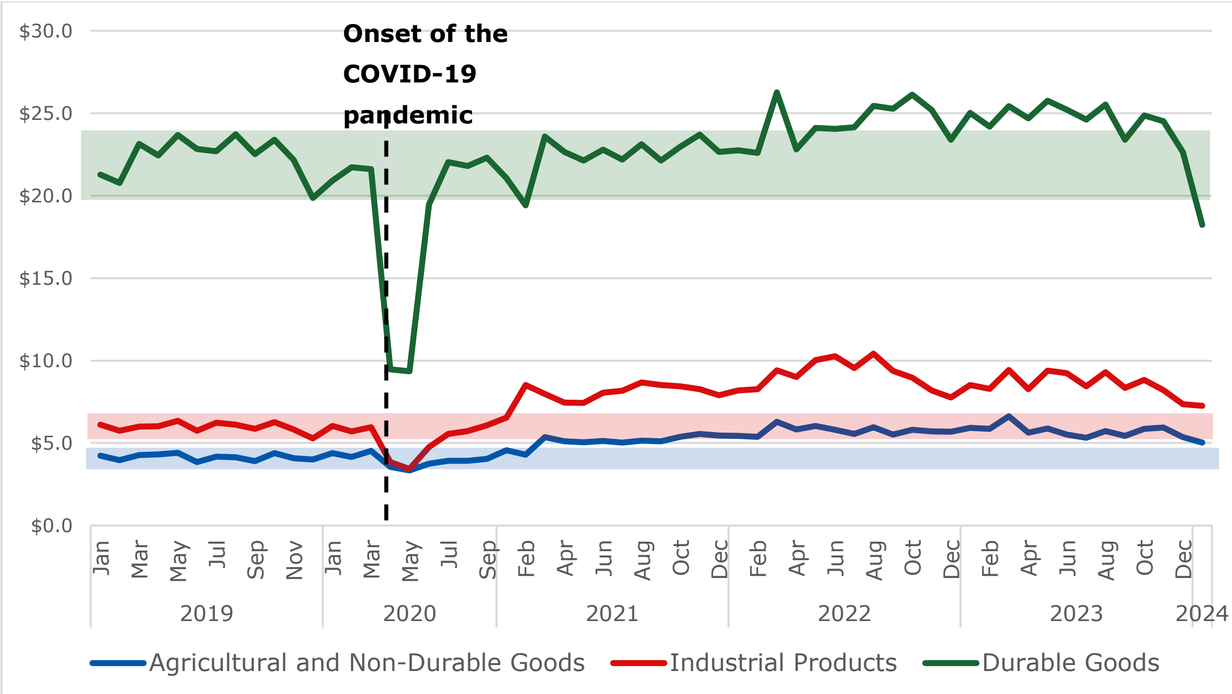
[4] Texas A&M Transportation Institute, Shipping Stranglehold: Pandemic Hampered Business Operations and Supply Chains in Texas, retrieved from https://tti.tamu.edu/researcher/shipping-stranglehold-pandemic-hampered-business-operations-and-supply-chains-in-texas/

[5] Bureau of Transportation Statistics, March 6, 2020, 2019 North American Transborder Freight Numbers, retrieved from https://www.bts.gov/newsroom/2019-north-american-transborder-freight-numbers

[6] Bureau of Transportation Statistics, March 8, 2021, Annual North American Transborder Freight down 13% in 2020 from 2019, https://www.bts.gov/newsroom/annual-north-american-transborder-freight-down-13-2020-2019

trailing slightly at three months. The varying recovery rates reflect each supply chain's degree of resilience and the extent to which production was affected by quarantine restrictions.

Figure 49: Impact of COVID-19 on Cross-Border Supply Chains (in Billion Dollars), 2023



Source: CPCS analysis of BTS TransBorder Freight Data.

After recovery, trade values for these supply-chain groups have risen. Industrial Products led the growth at 45%, amounting to an increase of $32.1 billion from 2019 to 2023. Agricultural and Non-Durable Goods also showed strong expansion at 39%, with a $19.3 billion increase. Durable Goods experienced a more gradual ascent, registering a 10% increase by 2023, equivalent to $27.4 billion. **Table 37** summarizes the impact of the COVID-19 pandemic on the three key high-value industry supply chains.

Table 37: COVID-19 Impact on Prioritized Supply Chains

High-Value Industry Supply Chains	Description of Impact
High-Tech Products	The northbound trade of high-tech products saw a more pronounced drop during April and May 2020 compared to the southbound flows from Texas to Mexico. However, these northbound flows rebounded more quickly, returning to pre-pandemic levels by August 2020. In contrast, the southbound flows took until March 2021 to fully recover.
Motor Vehicle	Similar to the high-tech sector, the motor vehicle industry saw a more pronounced decline in northbound trade flows at the onset of the COVID-19 pandemic, with a sharper decrease during April and May 2020 compared to southbound flows from Texas to Mexico. Since that initial drop, northbound flows have not fully recovered to pre-pandemic levels, experiencing a 15% decrease in total flows in 2023 compared to 2019. In contrast, southbound flows have shown a robust increase, growing approximately 39% in value during the same period.
Industrial Machinery Supply Chains	At the onset of the COVID-19 pandemic, trade in industrial machinery, both northbound and southbound, experienced significant declines during April and May 2020. Following a period of recovery and subsequent growth, the northbound flows by 2023 had returned to levels nearly equivalent to those of 2019. Meanwhile, the southbound flow of industrial machinery from Texas to Mexico recorded a modest increase of 14% between 2019 and 2023.

Source: CPCS analysis of BTS TransBorder Freight Data.

As shown in **Table 37** above, the southbound flow of goods from Texas to Mexico demonstrated better resilience to the external shock brought about by COVID-19. The northbound flow of goods from Mexico to Texas often struggled to regain post-pandemic levels, with the exception of high-tech products where northbound recovery was better than southbound recovery.

These differences can be attributed to various factors, most notably the economic disparities between Mexico and Texas, which influence each region's ability to recover from disruptions like the pandemic. The economic impact of the pandemic was uneven across the border, with Mexico experiencing a slower economic recovery. Moreover, businesses adjusted their supply chains in response to the pandemic which resulted in an increase in the southbound flow of goods and materials as industries ramped up production in the US.

Using the automotive industry as an example, in 2021 it was hard hit with delays because of a shortage in semi-conductor chips as a result of the pandemic. This led to lead times of more than five months. As a result of widespread lockdowns, the demand for cars and other vehicles plummeted. Once consumers were ready to get back on the road and looking to buy, the low chip supply meant that manufacturers couldn't meet the explosive demand. According to The Washington Post, automotive manufacturers worldwide were expected to produce 1.5 million to 5 million fewer cars than planned in 2021 because of these delays and shortages.[7] COVID-19 played a big part in the delays, especially when cases spiked in Malaysia, where many chips are processed and packaged. In Texas, February's devastating winter storm exacerbated the semiconductor deficit, as did a fire at a vital plant in Japan.[8]

In response to the low supply of semiconductor chips for car manufacturing in 2021, Texas has taken several measures to address the situation. This included the approval of the Texas Semiconductor Innovation Fund which required the approval of the Texas CHIPS Act. This fund provides subsidies to companies that manufacture chips within the state and provides matching funds to universities and other state entities investing in chip design or manufacturing projects. Following the recognition of the national security significance of microchips, the state intensified efforts to boost production which contributed to the recovery of southbound trade flows within the automotive supply chain.[9]

With the impact of COVID-19 waning, it would be prudent to plan for the occurrence of disruptive events with a similar scale of impact. This should be done on two levels, one being on the level of the producer or the manufacturer and the other being the level of the government, in this case the State of Texas.

With respect to manufacturers, key priorities to improve resilience against impacts like COVID-19 include improving network agility. Network agility refers to the producer's ability to respond to disruptions quickly by employing a flexible ecosystem of suppliers and partners that can handle sudden shortfalls or even produce new products. This could include the development of alternative sites and assembly nodes to optimize costs and improve reaction times. For instance, those dependent on offshore production would move some manufacturing onshore or closer to their core markets, bringing rise to the practice of near shoring.

The State of Texas can support nearshoring practices by enacting economic policies in support of businesses either moving or setting up alternative sites. This consideration is applicable to the High-Tech Products, Motor Vehicle and Industrial Machinery Supply Chains.

Nearshoring refers to the practice of relocating business operations to a nearby country. In this case businesses could either move to Texas from Mexico or vice-versa. It has been identified as an economic opportunity for Texas, as many businesses within Mexico consider the U.S. as their final market which is the largest consumer market globally. With the enactment of policies that support the practice of nearshoring, an increase in trade within the Border Region would be realized. The Texas Association of Business (TAB) is actively fostering collaboration between Texas and Mexico, with a goal

[7]The Washington Post, General Motors and Ford halt production at more factories as global semiconductor shortage worsens, April 8, 2021, retrieved from https://www.washingtonpost.com/technology/2021/04/08/gm-manufacturing-chip-shortage/

[8] Hegar, G. 2021. Texas Comptroller: Getting to Point B: Texas Businesses Strengthen and Protect Supply Chain in Response to the Pandemic, retrieved from https://comptroller.texas.gov/about/media-center/op-eds/2021/21-12-31.php

[9] Uranga, F. 2023. Texas Legislature 2023: With $1.4 billion investment, Texas hopes to sprint to the front of the microchip manufacturing race, retrieved from https://www.texastribune.org/2023/06/12/texas-microchips-semiconductors/

of enhancing regional competitiveness, and stimulating trade. It is a promising avenue for economic development, job creation, and stronger bilateral relations between Texas and Mexico.[10]

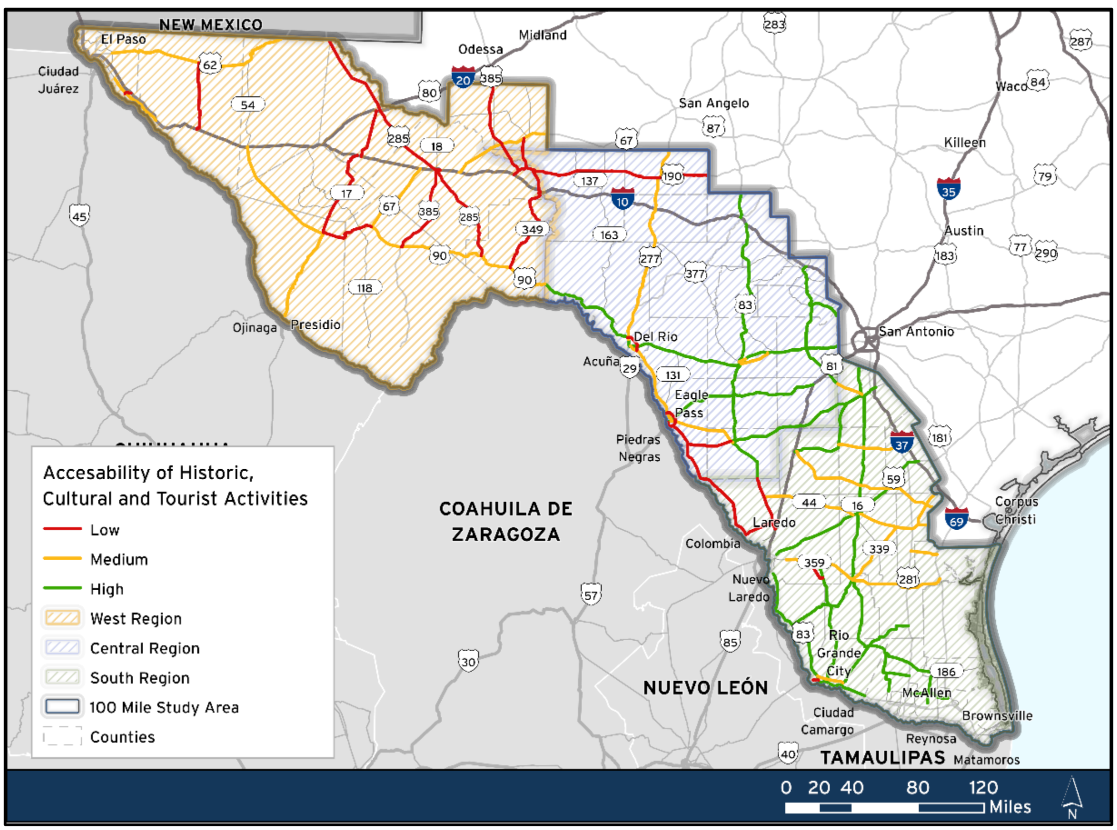
Customer Service, Stewardship and Sustainability

The criteria that were used to assess customer service, stewardship and sustainability include access to historic, cultural and tourist activities, EV charging inventory and proximity, access to rest areas and truck parking facilities, and benefits based on socio-economic factors.

Access to Historic, Cultural and Tourist Activities

Access to historic, cultural, and tourist activities is evaluated using data from the US National Park Service and the Texas Historical Commission. This assessment focuses on datasets related to nationally recognized historic highways, historical markers, museums, cemeteries, nature trails, and public parks. These elements capture the indirect impacts on various sectors of the tourism industry. The evaluation, as depicted in **Figure 50**, represents the measures of how efficiently and safely RBCN corridors connect travelers to historical sites, popular trails, and other publicly accessible attractions.

Figure 50: Accessibility of Public Historic, Cultural, and Tourist Activities Performance Categories



10 Texas Association of Businesses, The State Chamber, retrieved from https://www.txbiz.org/

A weighted score was calculated by analyzing the proximity of various historical and tourist attractions, categorizing distances into three ranges: under 25 miles, 50 miles, and 100 miles. In **Table 38**, the final scores are the result of an evaluation of distances and density of various datasets, including polylines, polygons, and points, and assigned high, medium, or low accessibility levels based on a weighted score.

Table 38: Access to Historic, Cultural, and Tourist Attractions Performance Measure Thresholds

Historic, Cultural, and Tourist Attractions Accessibility and Concentration	Score Threshold
Low	81 – 226
Medium	226 – 393
High	393 – 740

The threshold was established using quantile classification of the final scores, identifying RBCN corridors with significant gaps in accessibility to key points of interest. To consolidate the scores at the corridor level, weighted values were applied based on the proximity of historical, cultural, and tourist attractions within the study area. Corridors with public attractions located within 25 miles received the highest weights, while those beyond 50 miles were assigned much lower weights in the aggregated total. **Table 39** highlights the corridors that scored the lowest in the analysis, representing gaps within the RBCN.

Table 39: RBCN Corridors Identified as Low-Accessibility to Historical, Cultural, and Tourist Activities

Corridor Gaps	Limits
RM 1111	West Region, I-10 (Sierra Blanca) to US-62 (Cornudas)
SH 17	West Region, US 90 (Marfa) to I-20 (Pecos)
US 285	West Region, US 90 (Sanderson) to State line (Orla)
US 385	West Region, US 90 (Marathon) to SH-329 (Crane)
US 190	Central Region, I-10 (Iraan) to County Road 2251 (El Dorado)
SH 349	West Region, US 90 (Dryden) to US 67 (Rankin)
FM 1472	Central Region, FM 1021 (Maverick Co line) to SH 255 (Laredo)
US 83	South Region, Dimmit County line to I-35 (Los Veteranos)
FM 2644	Central Region, FM 1021 (El Indio) to US 277 (Carrizo Springs)

Electric Vehicle (EV) Charging Inventory and Proximity

EV Charging Inventory and Proximity were assessed using data from the U.S. Department of Energy's Alternative Fuels Data Center, with a weighted score evaluating the distances from RBCN segments. The availability of charging stations for various electric vehicles continues to expand statewide, providing options for both truck and passenger vehicles, predominantly through private companies such as Tesla, ChargePoint, and Blink Network. Under the National Electric Vehicle Infrastructure (NEVI) Program, administered by the U.S. Department of Transportation, nationwide deployment of EV charging stations is guided by established standards and guidelines to ensure a consistent and user-friendly experience. According to these standards, charging stations should ideally be located no more than 50 miles away along major highways and arterial routes, ensuring seamless travel for EV users.

Figure 51 presents the results of the analysis, showing the categorized scores for RBCN segments based on the proximity of EV stations. Accessibility was evaluated across three distance categories: under 25 miles, 25 to 50 miles, and beyond 50 miles, considering the concentration of stations within these ranges adjacent to the RBCN. The final output was classified using the quantile method, ranking the availability of charging stations into high, medium, and low scoring thresholds.

Figure 51: Accessibility to Public Electric Vehicle Charging Stations Performance Categories

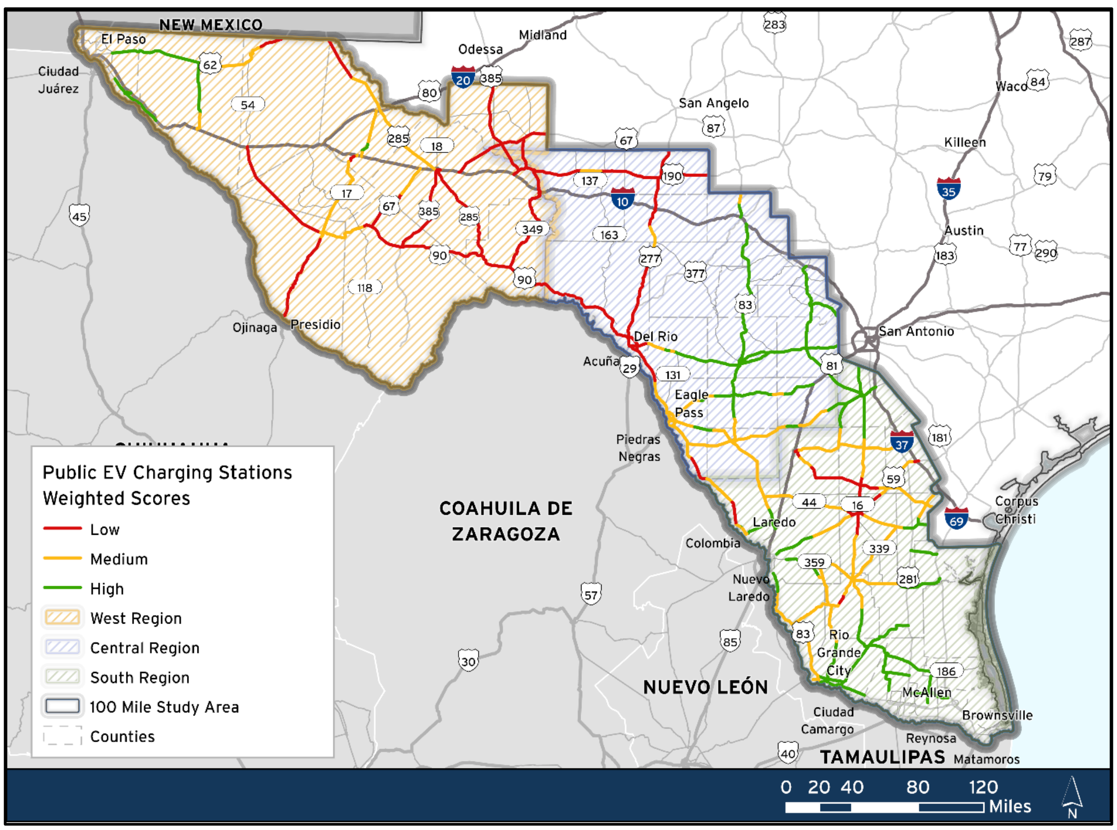


Table 40: EV Charging Station Inventory and Proximity Performance Measure Thresholds

EV Charing Station Proximity and Concentration	Score Threshold
Low	0.3 – 3.3
Medium	3.4 – 5.7
High	5.8 – 45.2

The thresholds were determined using quantile classification of the final aggregate scores, as shown in **Table 40**, to highlight RBCN segments with gaps in EV charging station availability. To consolidate the scores at the corridor level, weighted values were applied based on the proximity of EV stations to each segment. Segments with stations located within 25 miles received the highest weighting. A low score indicates segments with gaps in charging infrastructure, falling short of NEVI guidelines.

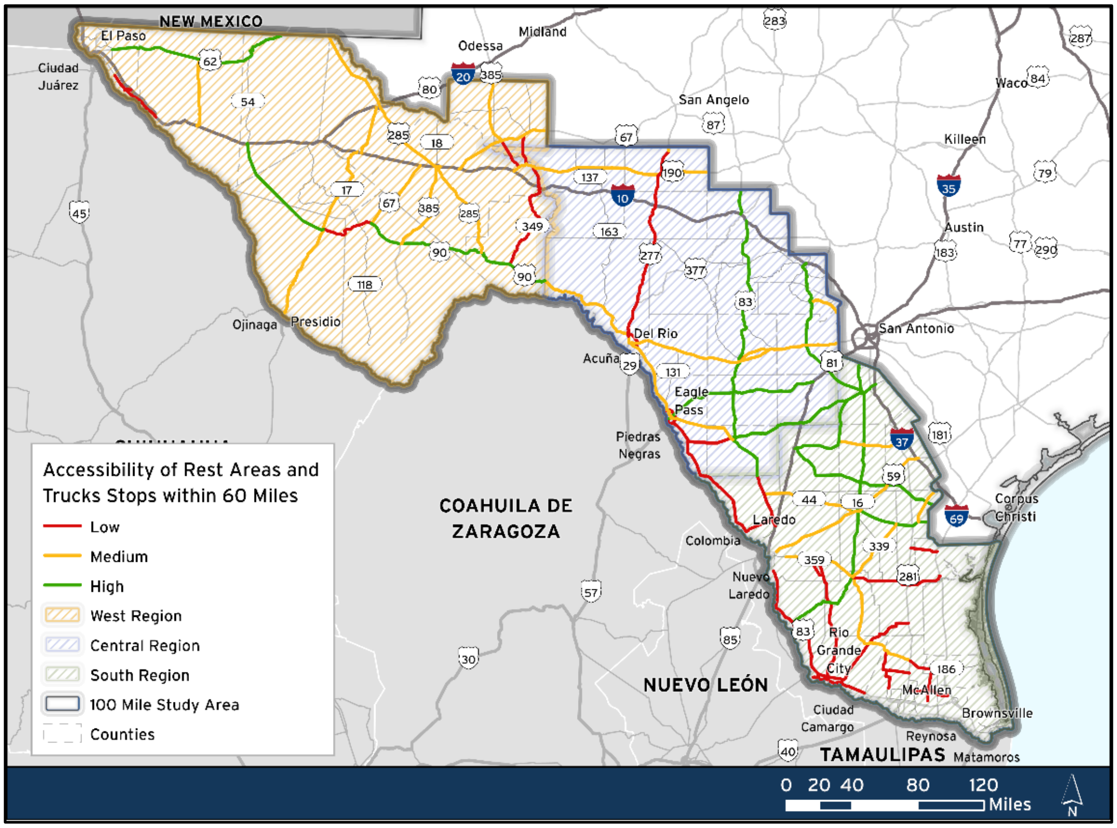
Table 41 summarizes the corridors where gaps in EV charging infrastructure are most pronounced in the final RBCN. Corridors near urban centers like El Paso, San Antonio, and the Rio Grande Valley scored highest due to the dense availability of charging stations within a 25- to 50-mile radius. In contrast, corridors in the West Region, particularly outside urban hubs such as Alpine, Marfa, and Pecos, scored lowest due to the scarcity or low density of EV charging infrastructure.

Table 41: RBCN Corridors Identified as Low-Accessibility to Public EV Charging Stations

Corridor Gaps	Limits
US 90	West/Central Region, I-10 (Van Horn) to US-277 (Del Rio)
US 385	West Region, Crane Co. line to US 67 (McCamey)
US 67	West Region, Presidio POE to SH 349 (Rankin)
SH 349	West Region, US 190 (Iraan) to US 90 (Dryden)
US 285	West Region, I-10 (Fort Stockton) to US 90 (Sanderson)
US 385	West Region, Crane County line to US 90 (Marathon)
US 190	Central Region, I-10 (Bakersfield) to Schleicher County line
US 277	Central Region, Schleicher County line (Hulldale) to SL 79 (Del Rio)
SH 16	South Region, FM 624 to 13 miles south of US 59 (Freer)
FM 624	South Region, SH 97 (Cotulla) to US 59 (Clegg)
US 59	South Region, FM 624 (Clegg) to SH 44 (Freer)

Access to Rest Areas and Truck Parking Facilities

Figure 52: Access to Rest Areas and Truck Parking Facilities Performance Categories



The availability of rest areas and truck parking is assessed by combining public rest areas and non-commercial truck stops (facilities) data from TxDOT and the US DOT; smaller-scale rest areas, categorized as "picnic areas" were filtered out due to the inadequate size for truck parking and lack of amenities. Considering the standard spacing between rest areas or truck stops, while TxDOT does not have a strict standard, the placement of facilities is generally influenced by terrain, traffic volumes, and land availability. The Federal Highway Administration (FHWA) recommends facilities to be spaced between 30 and 60 miles apart on major roadways. In rural or open areas, this spacing tends to be closer to 60 miles or more, while in urban or high-traffic corridors, rest areas may be more frequent, often around 30 miles apart. For this analysis, a 60-mile buffer was chosen as the minimum distance to evaluate the accessibility and abundance of public rest areas and truck stops.

The categorized scores of high, medium, and low reflect both the proximity and number of facilities within 60 miles of the RBCN corridors. While some corridors can access multiple facilities within their zones, others are more limited within this range. As shown in **Figure 52**, corridors near larger urban areas—such as El Paso, Laredo, and the Rio Grande Valley—consistently have the lowest scores for truck stops and rest areas availability. Additionally, many of the corridor gaps are concentrated in the south region, particularly near Rio Grande City, McAllen, and Laredo.

The scoring was determined by performing a spatial join to count the number of facilities within a 60-mile search radius. Corridors with higher facility counts were assigned the highest scores. Additionally, the scores were classified using a quantile distribution method.

Table 42: Access to Rest Areas and Truck Parking Facilities Performance Measure Thresholds

Accessibility of Rest Areas and Truck Stops within 60 miles	Score Threshold
Low	< 3
Medium	4-6
High	> 7

Thresholds were established using quantile classification of the final aggregate scores, as illustrated in **Table 42**, to identify RBCN segments lacking sufficient rest areas and truck stops. To calculate the corridors' scoring, weighted values were assigned based on the proximity of these facilities to each segment. Segments with facilities within 25 miles received the highest weights. **Table 43** summarizes the corridors within the RBCN that resulted in low scores, indicating segments with facility shortages.

Table 43: RBCN Corridors Identified as Low-Accessibility to Rest Areas and Truck Parking Facilities

Corridor Gaps	Limits
SH 20	West Region, Herring Rd (Clint) to I-10 (McNary)
US 67/90	West Region, SH-17 (Marfa) to US-67 (Alpine)
SH 349	West Region, US-67 (Rankin) to US-90 (Dryden)
US 277	Central Region, Co. Rd 316 (Hulldale) to US-90 (Del Rio)
FM 1021	Central Region, SL-480 (Eagle Pass) to FM-1472 (Webb Co line)
FM 1472	South Region, FM-1021 (Maverick Co line) to SH-255 (Laredo)
US 83	South Region, Dimmit Co line to I-35 (Botines)
US 83	South Region, Rio Bravo to Hildago Co line
FM 649	South Region, SH-359 (Oilton) to US-83 (Rio Grande City)
FM 755	South Region, US-281 (Rachal) to US-83 (Rio Grande City)
SH 285	South Region, SH-16 (Hebbronville) to SH-77 (Riviera)

Benefits Based on Socio-Economic Factors

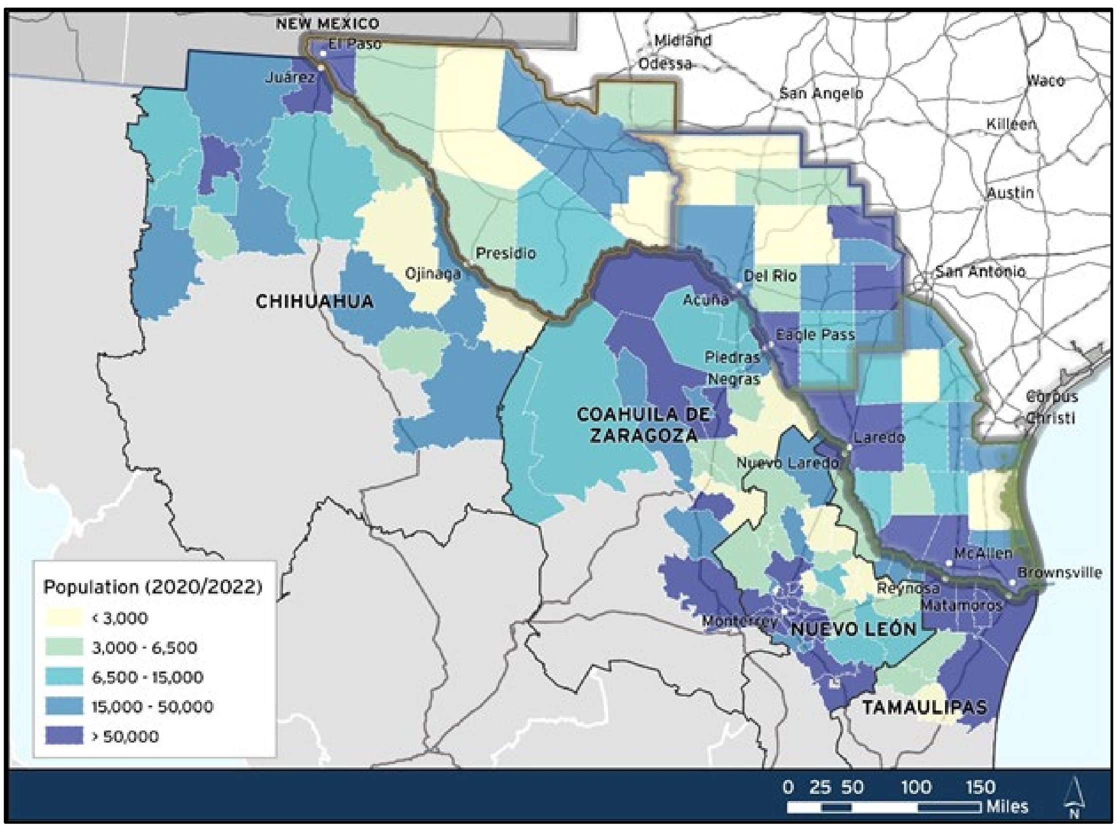
Equal protection in transportation ensures that all communities, regardless of socioeconomic status or transportation vulnerabilities, have fair access to transportation resources and opportunities.

needs were calculated based on metrics discussed in detail in the existing conditions report. The metrics used to analyze Community Resilience Estimates (CRE) Score, employment rate, population, and population growth from 2022 to 2050, the proportion of zero-car households, and the availability of public bus transportation.

Existing Population Metric

The population metric is derived from **Figure 53**: Study Area Population displayed below. The scale aligns with the map's legend, with 5 representing the smallest population (<3,000) to 1 for the densest populations (>50,000). Less populated regions were given a higher rank to address socio-economic conditions in rural areas. By giving higher scores to less populated regions, we aim to ensure that rural areas, which are often overlooked for infrastructure improvements, are given appropriate consideration. Focusing on these sparsely populated areas enhances fairness by addressing the historical underinvestment in rural communities, where transportation improvements can have a transformative impact on mobility, access to services, and economic growth. This approach helps bridge the gap between rural and urban regions, making the overall transportation network more inclusive and equitable. Corridor FM 624 through McMullen County in the South Region is a high-scoring corridor based on population rank, whereas FM 1472 through Webb County in the South Region is a low-scoring corridor based on population rank.

Figure 53: Study Area Population



Source: Texas Demographic Center, Texas Population Projections 2020 to 2060, 1.0 Migration Scenario; INEGI Principales resultados por localidad (ITER) del Censo de Población y Vivienda 2020

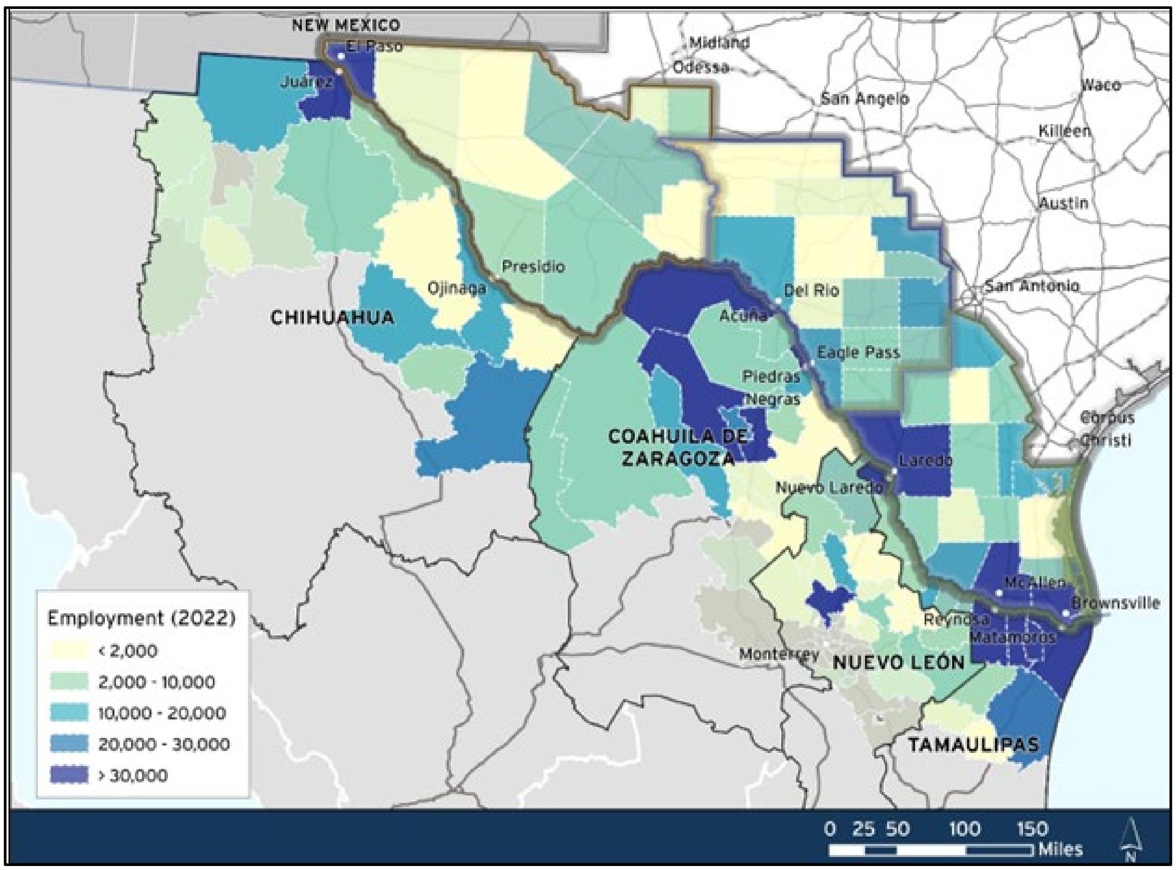
Forecasted Population Metric

This is the change in population from 2022 to 2050. A Binary scoring of 1 or 0 was used to represent population increase or decrease, respectively. From a fairness standpoint, this metric is crucial because areas with increasing populations may face greater demands on infrastructure and services, making it essential to ensure that these growing communities have equitable access to transportation resources. Corridor FM-305 through Pecos County in the West Region is a high-scoring corridor based on population growth, whereas SH 16 through Jim Hogg County in the South Region is a low-scoring corridor based on population growth.

Employment Metric

The employment metric was collected from a 5-point scale from the legend of **Figure 54**: Study Area Employment, 2020 Mexico and 2022 Texas in the latest Existing Conditions draft. A 5 indicates the smallest employment (<2,000) to 1 for the highest employment (>30,000). Thus, communities with low employment received higher scores. This ensures that areas with limited employment opportunities are recognized in the scoring process, emphasizing the need for transportation improvements that could support economic development and access to jobs in these underserved regions. A high scoring result for needs corridor based on employment would be FM 649. This corridor runs within Jim Hogg County located in the South Region.

Figure 54: Study Area Employment

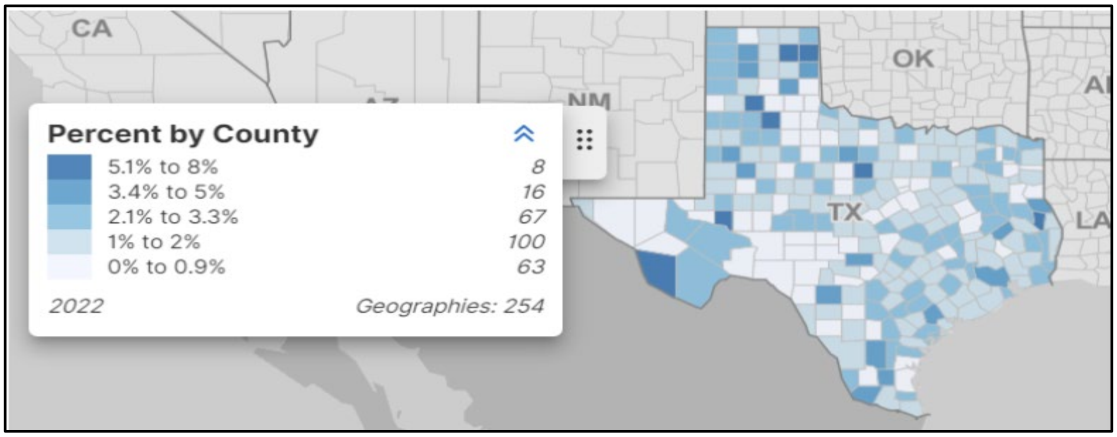


Source: Quarterly Census of Employment and Wages (QCEW) 2022 Q4; Labor Indicators for the Municipalities of Mexico (ILMM)

Zero Car Household Metric

This metric measures the percentage of households with vehicles within each county. The data is from ACS 2022. A 3-point scale is applied to reflect **Figure 55**: Percentage of Households with no Vehicles, Texas Study Area 2022 in the Existing Conditions draft. A county with a higher percentage of no vehicles in the household (>10%) received a 3, the median range of 5-10% received a score of 2, and the counties with a smaller percentage (<5%) of no vehicle households received a score of 1. This metric is crucial for the study because households without vehicles often face significant barriers to accessing transportation resources and services. By giving higher scores to areas with greater proportions of zero-car households, we ensure that the needs of these transportation-disadvantaged communities are more effectively addressed, promoting more equitable access to transportation and related services. For example, FM 755 passes through Starr County in which 11% of the households do not have vehicles.

Figure 55: Workers 16 Years and Over in Households with Zero Vehicles, Texas Study Area, 2022



Source: US Census Bureau Table S0801 Commuting Characteristics by Sex (2022 ACS 5 Year Estimates)

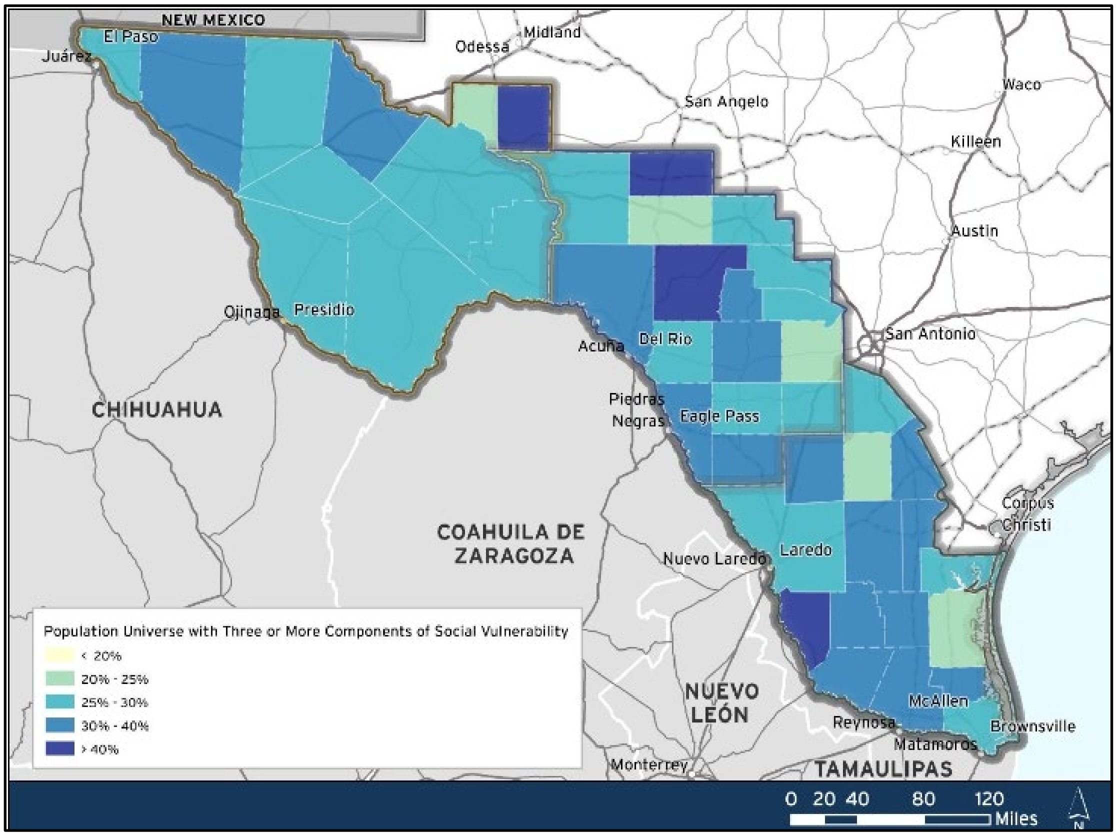
Bus Routes Metric

This binary metric of 1 or 0 shows if the Greyhound bus route runs along the corridor or not, respectively. This is an important metric because improving transportation access through intercity bus services like Greyhound is vital for communities with limited transportation options. By including this metric, we ensure that corridors with established bus routes receive appropriate consideration for improvements, addressing the mobility needs of individuals in areas where public transportation options are otherwise scarce. US 67 in Presidio County received a "1" since there was a commuter bus route running along the corridor. The route continues for 60 miles on the corridor, creating a strong need to retrofit the infrastructure.

CRE Community Resilience Estimates Metric

A 5-point scale from the legend of **Figure 56**: Rate of Population with Three or More Components of Social Vulnerability in the latest Existing Conditions draft was used as a metric. The scale aligns with the map's percentage scoring system, with 1 representing the least vulnerable and 5 indicating the highest-risk communities. The CRE (C) metric was doubled in the formula to give CRE a higher weight compared to other metrics. Incorporating CRE into the score ensures that corridors serving communities with higher social vulnerability are assigned a proportionally higher score, reflecting the need for more significant investment and improvements in areas where populations are less resilient to economic and social challenges. For instance, US 67 in the West Region passes through Upton County, where over 40% of the population experiences three or more social vulnerability factors. This places the county at the highest CRE ranking, which significantly contributes to US 67 receiving a high needs score.

Figure 56: Rate of Population Universe with Three or More Components of Social Vulnerability, Texas Study Area 2022



Source: US Census Bureau 2022 CRE Data

Length

This is the distance, measured in miles, for each corridor within a given county. Using length ensures that longer corridors receive higher scores, as they are likely to have the most significant impact.

Methods

Accessibility Index (I) is the cumulative sum of rankings across various access metrics. The CRE metric is weighted more heavily by multiplying its rank by 2, ensuring it has a more significant influence than the other metrics. The access index is used to calculate an access score for each corridor as it passes through a county. The index formula is as follows:

Access Index (I) = 2CRE Rank (C) + Population Rank (P)+ Population Growth Rank (PG)+ Employment Rank (E) + Zero Car Rank (Z)+ Bus Route Rank (B)

The Access Score of a corridor is calculated by weighting the access index by the length of the corridor within each county. This approach ensures that longer sections of the corridor, which serve more extensive areas or populations, have a proportionally larger impact on the overall access score. The weighted access score provides a more accurate representation of the corridor's accessibility performance across different regions. The Accessibility Score is the sum of the access index of each corridor section through each county weighted by the length of each corridor section divided by the sum of the total length of the corridor.

$$\text{Equity Score} = \frac{\sum(\text{Equity Index}_i \text{ X Length}_i)}{\sum(\text{Length}_i)}$$

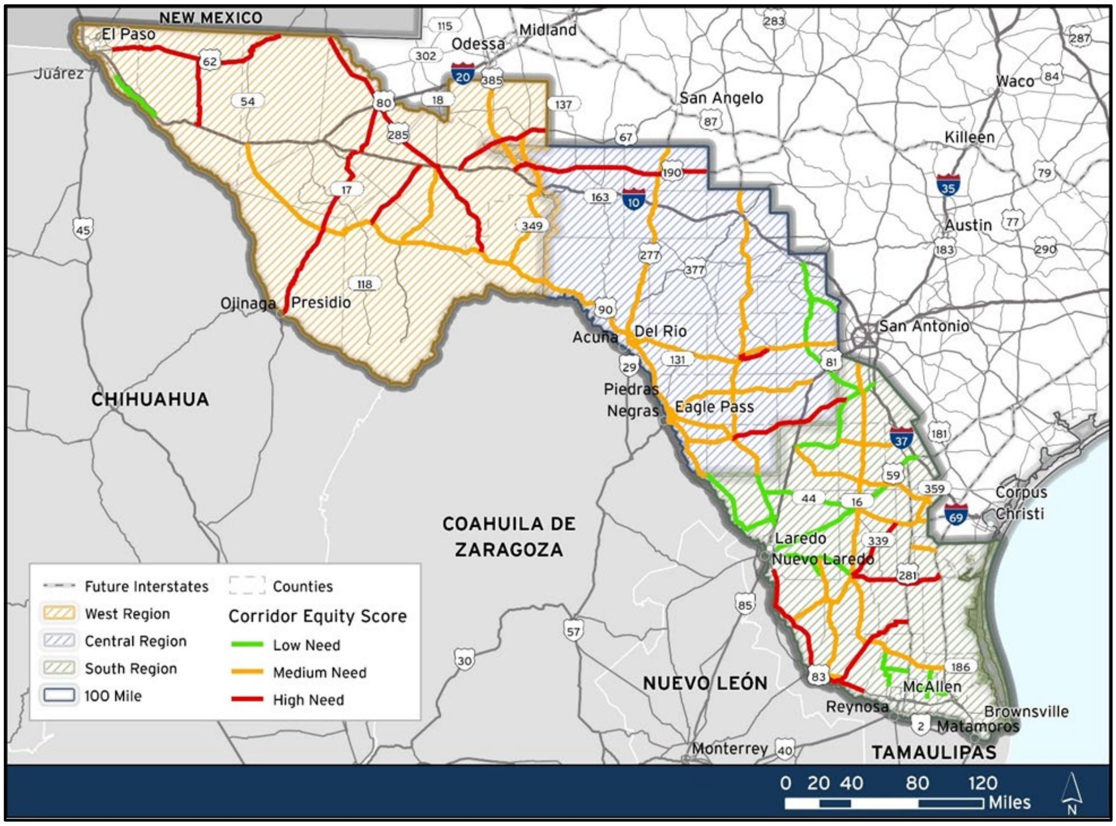
Scores are classified into three categories:

- Low: Accessibility score less than 15.
- Medium: Accessibility score between 15 and 17.
- High: Accessibility score greater than 17.

Accessibility Results

The final access scores categorize corridors into high, medium, and low accessibility needs based on a length weighted cumulative sum of the socio-economic metrics. A high accessibility score typically indicates that the corridor goes through regions facing heightened social vulnerability, characterized by factors such as a high CRE score, low employment rates, less dense populations, and a high proportion of households without access to a vehicle. Population growth and the availability of Greyhound public transportation contribute towards a high accessibility score as accessibility benefits from improvements on such corridors. **Figure 57** illustrates the needs corridors along the final RBCN.

Figure 57: Accessibility Performance Categories



The West Region had the most corridors with high scores compared to the other regions. Six corridors in the West Region with high scores include US 62 in El Paso, Hudspeth, and Culberson Counties, US 285 through Reeves, Pecos, and Terrell Counties, RM 1111 through Hudspeth County, SH 17 through Reeves, Presidio, and Jeff Davis Counties, US 190 through Pecos County, and US 67. In the Central Region, high-need corridors include SH 85 through Frio and Dimmit Counties, US 190 through Pecos and Crockett Counties, FM 1023, and FM 2369 through Uvalde County. The East region contained the highest number of low-need corridors. Prioritizing corridors with high and medium scores, particularly in the West Region, could significantly enhance transportation accessibility and support the needs of disadvantaged communities in these areas.

Unmet Border Connectivity Needs

This section presents the specific corridors within the Texas border region that have been identified as Priority or Second Priority based on a comprehensive analysis of unmet infrastructure needs. The identification of these corridors is a critical step in informing the consideration phase of the report.

West Region

Table 44 present the corridors, both priority and secondary priority classifications, and their respective limits within the RBCN that are included in the Considerations phase of this report.

Table 44: Priority Corridors Selected for Strategy Considerations in West Region

Priority Corridors – Unmet Needs	Limits
US 67	Presidio to Fort Stockton
US 90	US 285 to Del Rio to San Antonio

Table 45: Secondary Corridors Selected for Strategy Considerations in West Region

Second Priority Corridors – Unmet Needs	Limits
US 62	El Paso to State Line
RM 1111	US 62 to I-10
US 90	I-10 to US 67 to 258
SH 20	Herring ST to I-10
SH 17	I-20 to US 90
US 285	Stateline to US 90
US 385	I-10 to US 90
US 67	I-10 to Upton County Line
SH 349	US 67 to US 90

Figure 58 depicts the geographic locations of the aforementioned priority and secondary priority corridors within the West region of the RBCN.

Figure 58: Corridors Selected for Strategy Considerations in West Region

Central Region

Table 46 and **Table 47** present the corridors, both priority and secondary priority classifications, and their respective limits within the RBCN that will be included in the Considerations phase of this report.

Table 46: Priority Corridors Selected for Strategy Considerations in Central Region

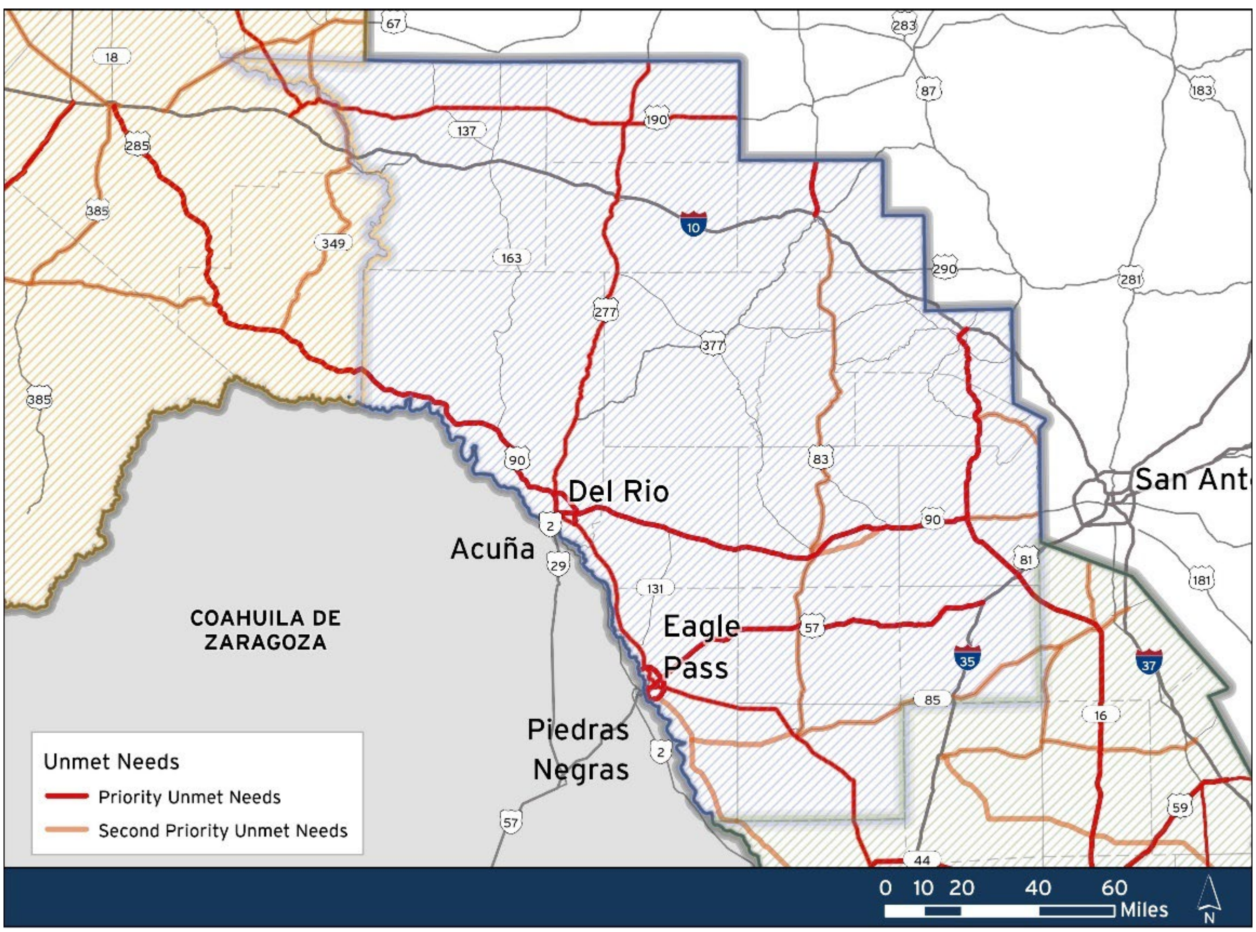
Priority Corridors – Unmet Needs	Limits
US 277, US 83	Ports to Plains Future Interstate (I-27)
US 90	US 285 to Del Rio to San Antonio
US 57	Eagle Pass to I-35 Eagle Pass to I-35
SH 16	US 83 to San Antonio
SH 173	West San Antonio Loop I-10 to SH 16
SL 79	Del Rio Loop
SL 480	Eagle Pass Loop

Table 47: Second Priority Corridors Selected for Strategy Considerations in Central Region

Second Priority Corridors – Unmet Needs	Limits
US 83	I-10 to US 277
US 85	FM 1021 to SH 97
SH 72	I-37 to SH 97
FM 624	I-35 to Jim Wells County Line
SH 16	Medina County Line to Bandera
FM 1021	Eagle Pass to Webb County Line
FM 1023	US 90 by Sabinal to Uvalde
US 90	SH 173 to Bexar County Line
FM 2644	El Indio To Carrizo Springs

Figure 59 depicts the geographic locations of the aforementioned priority and secondary priority corridors within the Central Region of the RBCN.

Figure 59: Corridors Selected for Strategy Considerations in Central Region



South Region

Table 48 and **Table 49** present the corridors, both priority and secondary priority classifications, and their respective limits within the RBCN that are included in the Considerations phase of this report.

Table 48: Priority Corridors Selected for Strategy Considerations in South Region

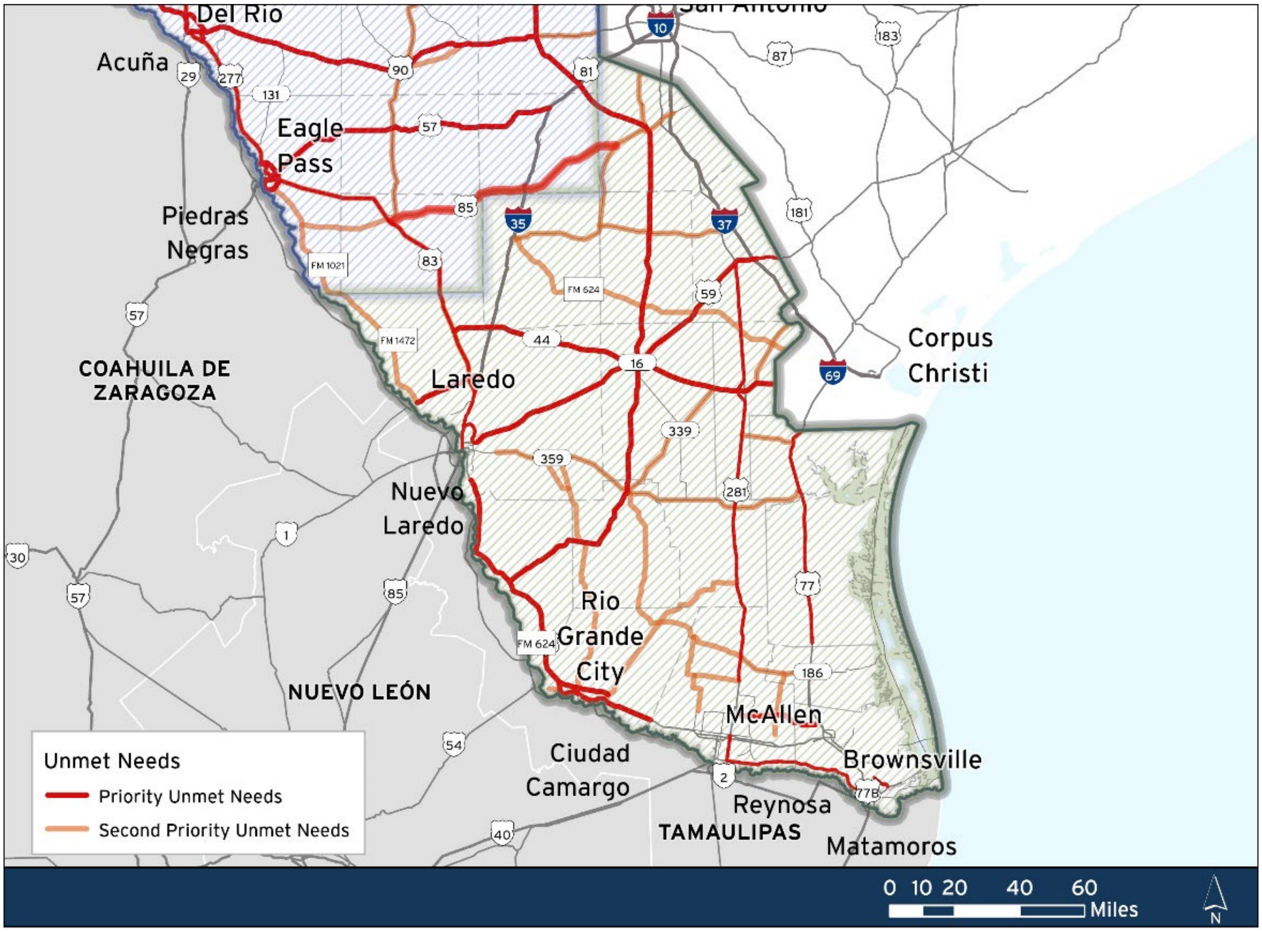
Priority Corridors – Unmet Needs	Limits
US 83	Ports to Plains Future Interstate (I-27)
US 59	Future Interstate (I-69)
US 281	Future Interstate (I-69
US 77	Future Interstate (I-69)
SH 44	US 83 to Corpus Christi
SH 255	Colombia to I-35
SH 16	US 83 to San Antonio
SH 173	West San Antonio Loop I-10 to SH 16
SL 195	Valley Loop

Table 49: Second Priority Corridors Selected for Strategy Considerations in South Region

Second Priority Corridors – Unmet Needs	Limits
SH 97	I-37 to I-35
SH 16	Bexar County Line to SH 173
SH 72	I-37 to SH 97
FM 624	I-35 to Jim Wells County Line
SH 359	Jim Wells County Line to SH 44 and San Diego to Laredo
FM 649	SH 359 to US 83
FM 1472	From Webb County Line to Laredo
Vaquillas Rd (240AA1005)	Aguilares to FM 649
FM 650	Fronton to US 83
FM 755	US 83 to US 281
FM1017	Hebbronville to Linn
SH 186	Hebbronville to US 77
FM 681	FM 1017 to W Mile 7 rd
FM 490	FM 681 to US 281
FM 1015	SH 186 to E Mile 11 N in Mila Doce
SH 285	Hebbronville to US 77
SH 141	US 281 to Kingsville

Figure 60 depicts the geographic locations of the aforementioned priority and secondary priority corridors within the South Region of the RBCN.

Figure 60: Corridors Selected for Strategy Considerations in South Region



Next Steps

The next steps to advance the Region-to-Region Connectivity Study are:

1. **Compare Needs to Planned Projects:** The identified needs (see **Chapter 5**) will be compared with the planned projects on the Regional Border Connectivity Network (RBCN). This comparison will be used to pinpoint any gaps and prioritize projects that address the most pressing needs.
2. **Incorporate Input from Stakeholder Workshops:** Insights and feedback will be gathered from various groups, including local communities, freight and warehouse industry leaders, local government representatives, and other regional transportation experts.
3. **Engage Districts and Stakeholders:** Ongoing engagement with TxDOT Districts and Mexican stakeholders will be vital for the success of our initiatives. This collaboration will help refine our strategies and ensure alignment with regional and local priorities.

This technical memo will be used to compare the needs to the planned projects in the Border Region Connectivity Network Plan to identify unmet border connectivity needs. The identified unmet border connectivity needs will be used to develop multimodal policy, program, and project strategies to address the unmet needs and to advance the projects on the RBCN. A final report that summarizes study process, stakeholder engagement, data inventory, existing and forecasted conditions and needs assessment, strategies and considerations, and implementation plan will be developed to conclude the study.

Texas-Mexico Border Region Connectivity Plan

Region-to-Region Needs Assessment Methodology

Texas Department of Transportation

Contents

Scoring and Weighing Methodology

The study identified region-to-region corridors within the study area and assessed their improvement needs based on the study's defined goals: Mobility, Reliability, and Connectivity; Safety and Security; Design and Modernization; and Customer Service and Stewardship.

A scoring methodology was developed that combined quantitative and qualitative criteria that addressed needs of the network. Such criteria measured performance of the network with related to the study’s goals mentioned above. Scores ranging from 1 to 3 were assigned to each criterion, with 3 indicating the most immediate need and 1 representing a future need. The criteria used in the scoring methodology and their respective weights are shown in Figure 1.The methodology allows for stakeholder and decision makers to adjust weighting of the criteria to focus on certain needs.

The scoring process involved two steps to ensure proper weighting of goals and objectives:

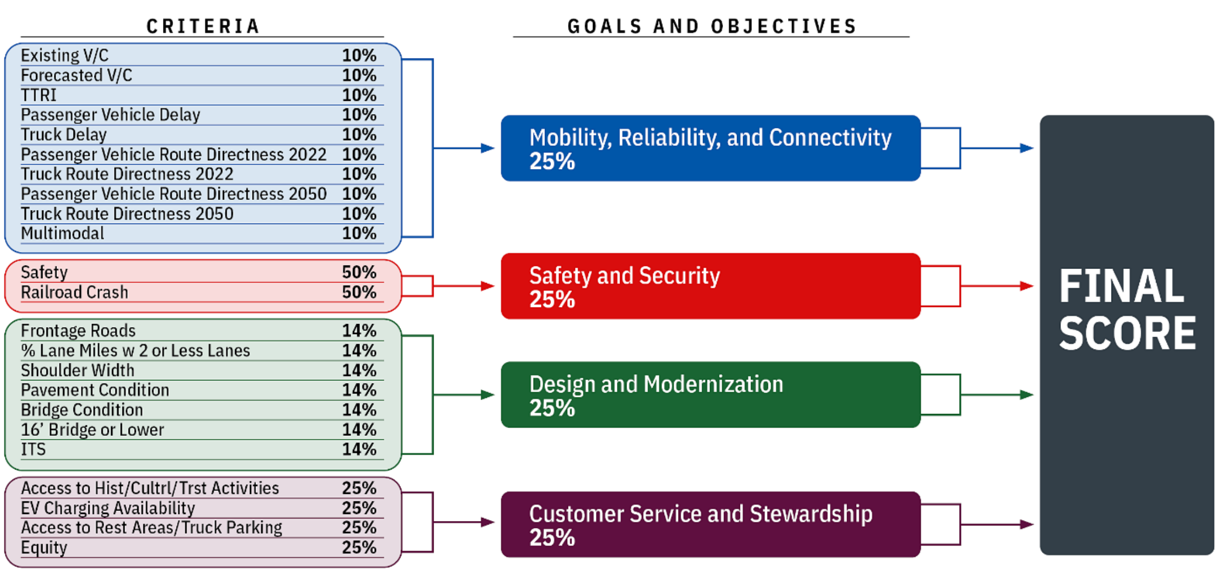
1. Within-Goal Weighting: Criteria under each goal share the total weight equally. For example, if "Mobility, Reliability, and Connectivity" includes 10 criteria, each receives 10% of the weight if deemed equally important.

2. Across-Goal Weighting: The four major goals are assigned overall importance. If all goals are equally important, each receives 25% of the total weight, distributed proportionally among the criteria. If one goal is prioritized, its weight increases accordingly, as shown in Figure 1.

Each corridor received four individual scores—one for each goal—and a combined final score based on these weighted assessments. Final scores were categorized into three levels of need:

- Low Need: Bottom 33rd percentile
- Medium Need: Middle 34th–66th percentile
- High Need: Top 67th–100th percentile

Figure 1. Categories of Corridor Issues Based on Goals and Sub-Criteria



Criteria Weights

The following table provides needs assessment criteria and their assigned weights and scores in detail. Description and data sources for the metrics shown in Table 1 are provided in Table 2.

Table 1. Assessment Criteria and Assigned Weights

Criterion	Goal	# of Criteria within each Goal	Criterion Weight within the Goal	Goal Weight within the Final Score	Criterion Score
Existing V/C	Mobility, Reliability, And Connectivity	10	0.1	0.25	1 to 3 based on tertiles
Forecasted V/C	Mobility, Reliability, And Connectivity	10	0.1	0.25	1 to 3 based on tertiles
TTRI	Mobility, Reliability, And Connectivity	10	0.1	0.25	1 to 3 based on tertiles
Delay_Psgr_S_Corr	Mobility, Reliability, And Connectivity	10	0.1	0.25	1 to 3 based on tertiles
Delay_Trk_S_Corr	Mobility, Reliability, And Connectivity	10	0.1	0.25	1 to 3 based on tertiles
Pv_Inefficiency_22	Mobility, Reliability, And Connectivity	10	0.1	0.25	1 to 3 based on low/med/high
Trk_Inefficiency_22	Mobility, Reliability, And Connectivity	10	0.1	0.25	1 to 3 based on low/med/high
Pv_Inefficiency_50	Mobility, Reliability, And Connectivity	10	0.1	0.25	1 to 3 based on low/med/high
Trk_Inefficiency_50	Mobility, Reliability, And Connectivity	10	0.1	0.25	1 to 3 based on low/med/high
Multimodal	Mobility, Reliability, And Connectivity	10	0.1	0.25	3 to 1 based on low/med/high
Safety	Safety And Security	2	0.5	0.25	1 to 3 based on tertiles
RR_Crash	Safety And Security	2	0.5	0.25	1 to 3 based on tertiles
Frontage Roads	Design and Modernization	7	0.14	0.25	0 if 1, 1 if 0
% Lane Mileage With 2 Or Less Lanes	Design and Modernization	7	0.14	0.25	1 to 3 based on tertiles
Shoulder Width	Design and Modernization	7	0.14	0.25	3 to 1 based on tertiles

Criterion	Goal	# of Criteria within each Goal	Criterion Weight within the Goal	Goal Weight within the Final Score	Criterion Score
Pavement Conditions	Design and Modernization	7	0.14	0.25	1 to 3 based on tertiles
Bridge Condition	Design and Modernization	7	0.14	0.25	3 to 1 based on tertiles
16' Bridge Or Lower	Design and Modernization	7	0.14	0.25	1 if 1, 0 if 0
ITS	Design and Modernization	7	0.14	0.25	1 if 1, 0 otherwise
Access To Historic, Cultural, And Tourist Activities	Customer Service and Stewardship	4	0.25	0.25	1 to 3 based on tertiles
EV Charging Inventory And Proximity	Customer Service and Stewardship	4	0.25	0.25	1 to 3 based on tertiles
Access To Rest Areas/Truck Parking	Customer Service and Stewardship	4	0.25	0.25	1 to 3 based on tertiles
Accessability	Customer Service and Stewardship	4	0.25	0.25	1 to 3 based on low/med/high

Criteria Sources

Table 2 shown below provides description and data sources for assessment criteria presented in Table 1.

Table 2 Assessment Criteria Description and Sources

Criterion	Description	Source
Existing V/C	Existing Volume to Capacity Ratio	SAM Version 4
Forecasted V/C	Forecasted Volume to Capacity Ratio	SAM Version 4
TTRI	Travel Time Reliability Index	NPMRDS, HPMS, FHWA
Delay_Psgr_S_Corr	Passenger Vehicle Delay	NPMRDS, HPMS, FHWA
Delay_Trk_S_Corr	Truck Delay	NPMRDS, HPMS, FHWA

Criterion	Description	Source
Pv_Inefficiency_22	Current Passenger Vehicle Route Directness	INRIX, NPMRDS
Trk_Inefficiency_22	Current Truck Route Directness	INRIX, NPMRDS
Pv_Inefficiency_50	Forecasted Passenger Vehicle Route Directness	INRIX, NPMRDS, SAM Version 4
Trk_Inefficiency_50	Forecasted Truck Route Directness	INRIX, NPMRDS, SAM Version 4
Multimodal	Existence of Multimodal Transportation Infrastructure	HNTB Analysis 2024
Safety	Frequency and Severity of Crashes for the Past Five Years	TxDOT CRIS
RR_Crash	Number of Railroad Crashes in the Past Five Years	TXDOT CRIS
Frontage Roads	Availability of Frontage Roads	TxDOT Roadway Inventory
% Lane Mileage With 2 Or Less Lanes	Share of Lane Miles with Two or Less Lanes	TxDOT Roadway Inventory
Shoulder Width	Width of Roadway Shoulder	TxDOT Roadway Inventory
Pavement Condition	Pavement Condition Index	TxDOT Pavement Management Information System (PMIS)
Bridge Condition	Superstructure Condition Rating in combination with Crash Data	TxDOT Superstructure Conditions Index Database, TxDOT CRIS
16' Bridge Or Lower	Existence of Bridges with 16 ft or Less Clearance	TxDOT Bridge Division Database
ITS	Availability of Information Technology System Infrastructure including DMS Signs, CCTV, and EV Readiness	TxDOT and US EPA
Access To Historic, Cultural, And Tourist Activities	Accessibility to Historic, Cultural, and Tourist Activities	HNTB Analysis 2024
EV Charging Inventory And Proximity	Existence and Proximity to Electric Vehicle (EV) Charging Station	US EPA
Access To Rest Areas/Truck Parking	Accessibility to Rest Area or Truck Parking	TxDOT Statewide Truck Parking Study 2020

Criterion	Description	Source
Access	Accessibility Index addressing Community Resilience, Population Growth, and Public Transportation Accessibility	American Community Survey, US Census

Corridor Scoring

Table 3 below illustrates the top ten corridors by need in the border region study area. The corridors are ranked from the highest Final Needs Score at the top to the lowest Final Needs Score at the bottom. The table shows corridor length and corridor score within each goal and objective. Four out of the top five corridors by need are located in the central region.

Table 3. Corridors Ranked From Highest to Lowest Needs Score

Rank	Corridor	Miles	Mobility, Reliability, and Connectivity	Safety and Security	Asset Preservation and Technology	Customer Service and Stewardship	Final Needs Score	Region
1	US 83 (Kimble to Dimmit County)	191	2.50	3.00	1.00	2.75	2.31	Central
2	SH 173 (Kerr to Frio County)	84	2.30	3.00	1.43	2.50	2.31	Central
3	US 90 (Medina to Val Verde County)	207	2.30	3.00	1.00	2.75	2.26	Central
4	US 83 (Starr to Webb County)	108	2.80	2.50	1.14	2.50	2.24	South
5	US 57	98	2.30	2.50	1.29	2.75	2.21	Central
6	US 62	115	2.20	3.00	0.86	2.75	2.20	West

Rank	Corridor	Miles	Mobility, Reliability, and Connectivity	Safety and Security	Asset Preservation and Technology	Customer Service and Stewardship	Final Needs Score	Region
7	US 90 (Terrell to Culberson County)	195	2.00	3.00	1.43	2.25	2.17	West
8	SH 44 (Jim Wells to Duval County)	43	2.40	3.00	1.00	2.25	2.16	South

Mobility, Reliability and Connectivity Scoring

When measured only by Mobility, Reliability, and Connectivity score, the top three corridors in the region are US 83 (Starr to Webb County), US 385, and US 83 (Kimble to Dimmit County). Table 4 shows the top three corridors by Mobility, Reliability, and Connectivity need score (highlighted in grey).

Table 4. Top Three Corridors by Mobility, Reliability, and Connectivity Need Score

Rank	Corridor	Miles	Mobility, Reliability, & Connectivity	Safety & Security	Asset Preservation and Technology	Customer Service & Stewardship	Final Needs Score	Region
1	US 83 (Starr to Webb County)	108	2.8	2.5	1.14	2.5	2.24	South
2	US 385	97	2.8	2.5	1.29	1.75	2.08	West
3	US 83 (Kimble to Dimmit County)	191	2.5	3	1	2.75	2.31	Central

Safety and Security

In terms of Safety and Security needs, the top corridors in the region are US 83 (Kimble to Dimmit County), SH 44 (Jim Wells to Duval County), and SH 173 (Kerr to Frio County). This is shown in Table 5 highlighted in grey.

Table 5. Top Three Corridors by Safety & Security

Rank	Corridor	Miles	Mobility, Reliability, & Connectivity	Safety & Security	Asset Preservation & Technology	Customer Service & Stewardship	Final Needs Score	Region
1	US 83 (Kimble to Dimmit County)	191	2.5	3	1	2.75	2.31	Central
2	SH 44 (Jim Wells to Duval County)	43	2.4	3	1	2.25	2.16	South
3	SH 173 (Kerr to Frio County)	84	2.3	3	1.43	2.5	2.31	Central

Asset Preservation and Technology

One of the main goals and objectives of the Needs Assessment is Design and Modernization. The top three corridors with the highest need in this regard are SH 173 (Kerr to Frio County), US 90 (Terrell to Culberson County), and US 385. Table 6 shows the top three corridors ranked from the highest score to the lowest score based on Design and Modernization need score, highlighted in grey.

Table 6. Top Three Corridors by Asset Preservation & Technology

Rank	Corridor	Miles	Mobility, Reliability, & Connectivity	Safety & Security	Asset Preservation & Technology	Customer Service & Stewardship	Final Needs Score	Region
1	SH 173 (Kerr to Frio County)	84	2.3	3.0	1.43	2.5	2.31	Central
2	US 90 (Terrell to Culberson County)	195	2	3.0	1.43	2.25	2.17	West
3	US 385	97	2.8	2.5	1.29	1.75	2.08	West

Customer Service and Stewardship

When measured by Customer Service and Stewardship, the top three corridors with the highest needs are US 57, US 83 (Kimble to Dimmit County), and US 90 (Medina to Val Verde County). All three corridors are located in the Central region. Table 7 illustrates the top three corridors by Customer Service and Stewardship needs score, highlighted in grey.

Table 7. Top Three Corridors by Customer Service & Stewardship

Rank	Corridor	Miles	Mobility, Reliability, & Connectivity	Safety & Security	Asset Preservation & Technology	Customer Service & Stewardship	Final Needs Score	Region
1	US 57	98	2.3	2.5	1.29	2.75	2.21	Central
2	US 83 (Kimble to Dimmit County)	191	2.5	3.0	1	2.75	2.31	Central
3	US 90 (Medina to Val Verde County)	207	2.3	3.0	1	*2.75*	2.26	Central

Texas–Mexico Border Transportation Master Plan (BTMP) Implementation

Travel Demand Modeling

Submitted to:

HNTB

Prepared by:

C&M

C&M Associates, Inc.

July 25, 2024

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Cover Letter

Axel Herrmann
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Date: July 25, 2024

To: HNTB
2100 Bryan Street, Suite 1500
Dallas, TX 75201

Subject: **Texas–Mexico Border Transportation Master Plan (BTMP) Implementation Travel Demand Modeling – Draft V1**

C&M Associates, Inc. is pleased to provide you with the *Texas–Mexico Border Transportation Master Plan Implementation – Travel Demand Modeling* Draft Report Version 1. This report presents a summary and analysis of existing information relevant to the project, current and forecasted conditions, and corresponding current and future needs assessments.

The C&M project team expresses its sincere gratitude to HNTB for providing the opportunity to participate in this project.

Respectfully,

Carlos M. Contreras
President

Axel Herrmann
Project Manager

Texas–Mexico Border Transportation Master Plan (BTMP) Implementation

Travel Demand Modeling

Prepared For:

HNTB

Prepared By:

C&M

C&M Associates, Inc.

July 25, 2024

Disclaimer

The results of this study constitute the opinion of C&M and were developed based on standard professional practices and the information available at the time the study was executed, subject to the time and budget constraints of the study's scope of work. C&M reasonably relied on the accuracy and completeness of information made available (both written and orally) by HNTB, TxDOT and its advisors, and independent parties. C&M is unaware of any material facts that would call into question the information that was received. Publicly available material has not been independently verified, and C&M does not assume responsibility for verifying such material.

As with any forecast, differences between projected and actual outcomes may occur due to future events and circumstances outside of C&M's control. C&M cannot guarantee or ensure future events in connection to this study, though the projections and other forward-looking statements included herein are, in C&M's opinion, based on reasonable assumptions as of the date this study was completed.

The information and results presented in this report should be considered as a whole. Selecting portions of any individual result without considering the intent of the whole may promote a misleading or incomplete view of this study's findings and the methodologies used to obtain these findings. C&M does not endorse the value or merit of partial information extracted from this report.

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LIST OF ACRONYMS AND ABBREVIATIONS

AADT........Annual Average Daily Traffic
ACS........American Community Survey
AM........Morning
ASPEP........Annual Survey of Public Employment and Payroll

BEA........U.S. Bureau of Economic Analysis
BLS........U.S. Bureau of Labor Statistics
BPR........Bureau of Public Roads
BTMP........Texas–Mexico Border Transportation Master Plan
BTS........Bureau of Transportation Statistics

CAGR........Compound Annual Growth Rate
CBD........Central Business District
CBP........U.S. Customs and Border Protection
Census CBP........U.S. Census Bureau County Business Patterns
CES........Current Employment Statistics
C&M........C&M Associates, Inc
CPS........Current Population Survey
CV........Commercial Vehicle

EB........Eastbound
EE........External-to-External
EI........External-to-Internal

GQ........Group Quarters

HBO........Home-Based Other
HBS........Home-Based K-12 School
HBW........Home-Based Work
HOT........High-Occupancy Toll
HOV........High-Occupancy Vehicle
HSR........High-Speed Rail
HT........Non-Freight Heavy Truck

ICR........Intercity Rail/Amtrak Rail
IE........Internal-to-External
ILDB........Infrequent Long-Distance Business
ILDO........Infrequent Long-Distance Other
ILLDB........Infrequent Long-Long-Distance Business
ILLDO........Infrequent Long-Long-Distance Other
IMX........Intermodal Rail

IPEDS ....Integrated Postsecondary Education Data System
IRS...Internal Revenue Service

LAUS ....Local Area Unemployment Statistics
LOS ....Level of Service
LRGV ....Lower Rio Grande Valley
LT...Non-Freight Light Truck

MD...Midday
MNL ....Multinomial Logit
Moody's..Moody's Analytics
MPO...Metropolitan Planning Organization
MT..Non-Freight Medium Truck
MTP...Metropolitan Transportation Plan

NAICS ....North American Industry Classification System
NB ....Northbound
NHBO ....Non-Home-Based Other
NHBV...Non-Home-Based Visitor
NHTS..National Household Travel Survey
NT ....Nighttime

OD ....Origin and Destination

PM ....Afternoon
POE..Port of Entry
PV..Passenger Vehicle

QCEW ....Quarterly Census of Employment and Wages

RGVMPO ....Rio Grande Valley Metropolitan Planning Organization

SB ....Southbound
SR2 ....Shared Ride 2
SR3+ ....Shared Ride 3 or More
SWP...State Water Plan

TAZ ....Traffic Analysis Zone
TDC..Texas Demographic Center
TDM ....Travel Demand Model
TexasLMI ....Texas Labor Market Information
Texas SAM ....Texas Statewide Analysis Model
TIP ....Transportation Improvement Program
TOD ....Time-of-Day
TPP...Transportation Planning and Programming Division
TWC...The Texas Workforce Commission
TWDB..Texas Water Development Board

TxDOT ....Texas Department of Transportation

VC ....Volume-to-Capacity
VDF..Volume Delay Function
VHT..Vehicle Hours Traveled
VMT...Vehicle Miles Traveled
VOT ....Value of Time

WB ....Westbound
W&P..Woods & Poole Economics, Inc.

Chapter 1: INTRODUCTION

As part of the Texas Department of Transportation's (TxDOT) Texas–Mexico Border Transportation Master Plan (BTMP) implementation, and on behalf of HNTB (the Client), C&M Associates, Inc. (C&M) conducted a border-network traffic assessment of the Texas–Mexico border. Using the Texas Statewide Analysis Model (Texas SAM), C&M evaluated both existing and future network needs, with a focus on border-related trips. This report details the travel demand modeling activities undertaken by C&M to update the Texas SAM, including the calibration process and the development of traffic forecasts for the study area.

1.1 Study Area

The study area was defined by extending 100 miles from the U.S.–Mexico border, with El Paso, Odessa, Laredo, and Pharr as main districts.

C&M identified the study area's roadway network and assessed both the existing and future capacities of its facilities. Figure 1-1 shows the selected network and the study area extension.

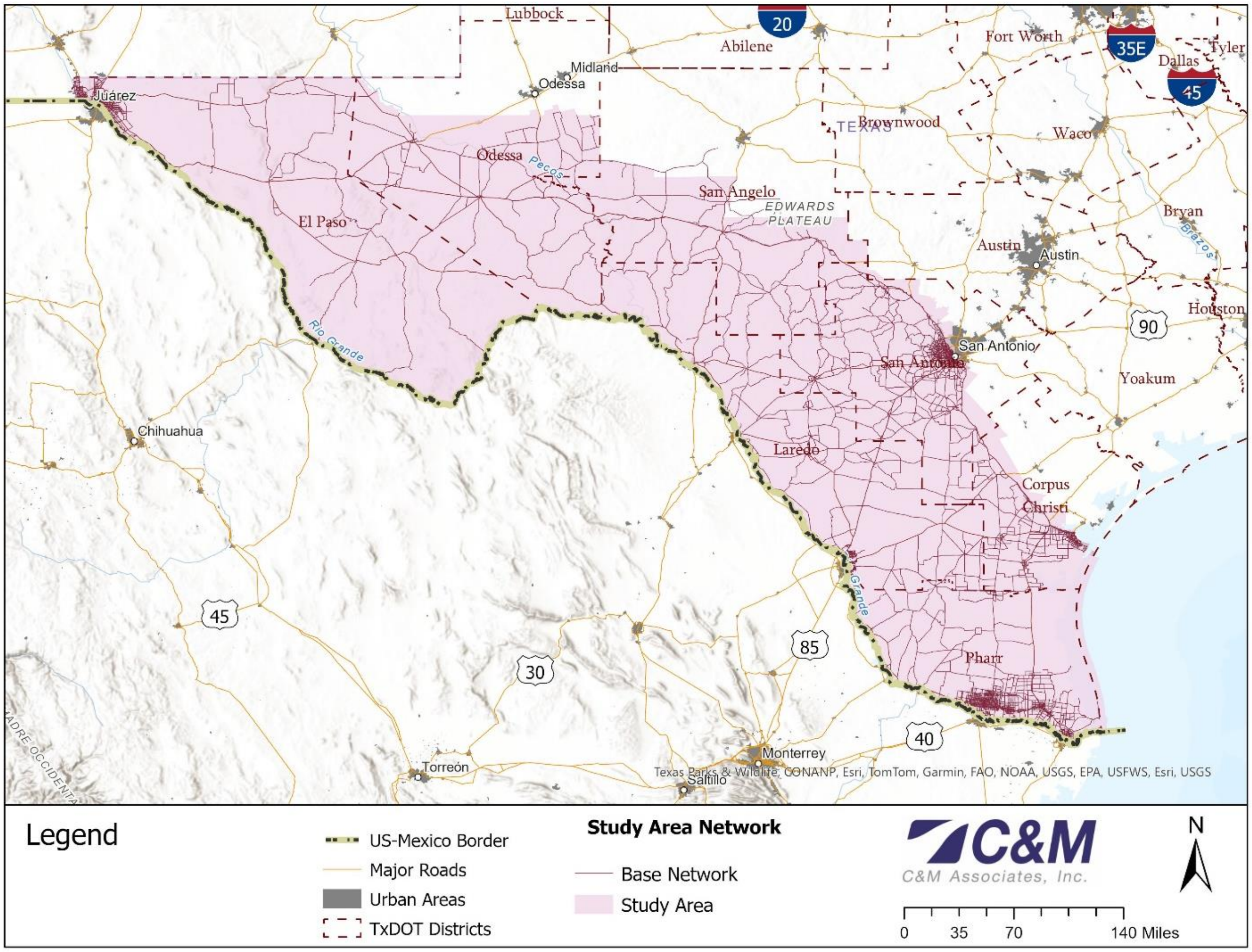


Figure 1-1. Study Area Network

The Texas border comprises 12 Ports of Entry (POE), including two dams, one hand-drawn ferry, and 25 international bridges that allow commercial, vehicular, and pedestrian traffic. When comparing TxDOT districts, the El Paso district has four POEs, including seven international border crossings; the Laredo district has three POEs and eight international crossings; and the Pharr district includes five POEs and 13 international crossings (see Table 1-1).

Table 1-1. POEs and Border Crossings by District

District	Port of Entry	Border Crossing
Pharr	Brownsville	Gateway International Bridge
		Brownsville & Matamoros (B&M) Bridge
		Veterans International Bridge
		Free Trade Bridge
	Progreso	Weslaco-Progreso International Bridge
		Donna International Bridge
	Hidalgo	Pharr-Reynosa International Bridge
		McAllen-Hidalgo International Bridge
		Anzalduas International Bridge
	Rio Grande City	Camargo Bridge
		Los Ebanos Ferry
	Roma	Lake Falcon Dam International Crossing
		Roma-Ciudad Miguel Aleman International Bridge
Laredo	Laredo	Colombia Solidarity Bridge
		World Trade Bridge
		Gateway to the Americas Bridge
		Juarez-Lincoln International Bridge
	Eagle Pass	Eagle Pass International Bridge
		Camino Real International Bridge
	Del Rio	Lake Amistad Dam Crossing
		Del Rio International Bridge
El Paso	El Paso	Paso del Norte Bridge
		Good Neighbor Bridge
		Bridge of the Americas
	Ysleta	Ysleta Bridge
	Tornillo	Fort Hancock-El Porvenir Bridge
		Tornillo-Guadalupe International Bridge
	Presidio	Presidio-Ojinaga International Bridge

1.2 Objectives and Scope

Through updating, operating, and analyzing the Texas SAM travel demand model (TDM), C&M will provide support for the following activities within the scope of the BTMP:

- Developing a project management plan, public and stakeholder engagement plan, and project goals and objectives.
- Enhancing binational coordination with various stakeholders.
- Creating an implementation framework, progress roadmap, and tracking tools.
- Analyzing and implementing considerations to reduce border congestion, improve technology use at border crossings, and enhance connectivity and mobility.
- Developing a framework for coordinating and assessing binational datasets.
- Addressing planning and development, and improving binational coordination, public education, and awareness.
- Coordinating binational studies and ensuring compliance with federal legislation.

1.3 Organization of the Report

The remainder of this report is organized as follows:

- **Chapter 2** presents a summary and analysis of existing information relevant to the Project, providing overall understanding of the study area, the traffic conditions, network, sociodemographic data, and an overview of the travel demand MPO models and Texas SAM.
- **Chapter 3** presents a summary and analysis of the current needs assessment related to the update of the Texas SAM inputs (socioeconomics, future projects, network), the calibration process and validation, and the base year assignment results.
- **Chapter 4** presents a summary and analysis of the future needs assessment; considering the Texas SAM update and calibration, C&M presents future forecast inputs (socioeconomics, future projects) to assess future traffic conditions within the study area.

Chapter 2: Data Inventory Collection & Analysis

This chapter presents an overview of existing traffic-related data corresponding to the study area, including available travel demand models (TDM), origin and destination (OD) data, the historical data of nearby roadway networks and international bridges, historical trends, and current traffic patterns, which were used for the present study's traffic forecast. To analyze traffic pattern changes within the study area, C&M updated the received Texas SAM traffic data, including international border-crossing statistics.

This chapter begins with a review of the existing roadway networks and related historical traffic and border-crossing data in the study area, followed by an overview of the different available TDMs and the OD data, travel times, and future projects in the network.

2.1 Introduction

For the present study, C&M collected, reviewed, and analyzed the latest available historical and current data, including the following:

- Traffic count data
- Historical traffic trends
- Border crossings
- Overview of TDMs:
  - El Paso Metropolitan Planning Organization (MPO) TDM
  - Laredo MPO TDM
  - Lower Rio Grande Valley (LRGV) TDM
- Overview of Texas SAM
- OD data
- Future projects
- Travel time data

2.1.1 Study Area Network

Per HNTB's request, C&M identified the roadway network and assessed both the existing and future capacities of its facilities. The study area was defined by extending 100 miles from the U.S.–Mexico border, with El Paso, Odessa, Laredo, and Pharr as main districts.

Figure 2-1 shows the selected network and the study area.

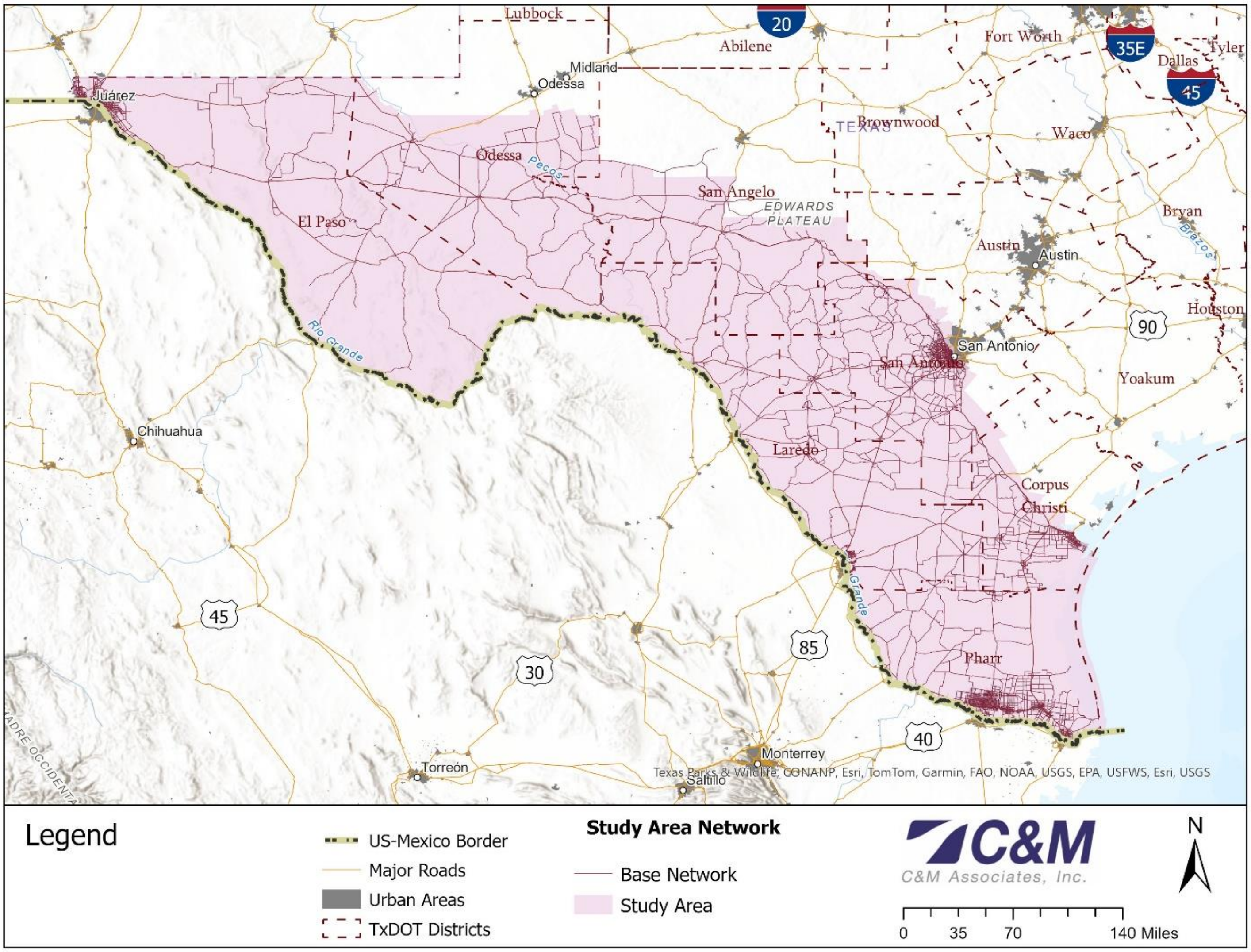


Figure 2-1. Study Area Network

2.1.2 Network/Corridor Analysis

2.1.2.1 Interstate 10

I-10 enters Texas near Anthony, northwest of El Paso, running southward alongside US 85 and US 180. US 85 splits off in West El Paso at Exit 13, heading south through downtown to the Mexican border. In 2016, construction aimed to link frontage roads. I-10 meets I-110 and US 54 at the "Spaghetti Bowl" interchange, then diverges with US 180 east of downtown. Frontage roads are Desert Boulevard in West El Paso and Gateway Boulevard in Central and East El Paso, with Gateway Boulevard being the longest. Continuing eastward, I-10 runs alongside the Rio Grande before turning eastward near Van Horn, entering the Central Time Zone. It intersects with I-20 near Kent, then heads southeast towards San Antonio.

2.1.2.2 Interstate 35

I-35 is a major north–south interstate highway. Its southern region includes La Salle and Webb Counties, and the northern region includes Cooke, Dallas, Denton, Ellis, Johnson, and Tarrant Counties. Its southern terminus is in Laredo, Texas, and it connects to the Juarez–Lincoln International Bridge. Its northern terminus is in Duluth, Minnesota roughly 150 miles from the U.S.–Canada border. In addition to the Dallas–Fort Worth and Minneapolis–Saint Paul metropolitan areas, other major cities along the I-35 corridor include—from south to north—San Antonio, Austin, Oklahoma City, Wichita, Kansas City, and Des Moines.

Within the study area, I-35 functions as an expressway with overpasses, frontage roads, and entrance and exit ramps at major crossroads. The highway has a posted speed of 75 mph, which decreases in the urban area of Laredo. From US 59, the speed limit ranges from 50 to 65 mph to Park Street, 50 mph between Park Street and Moctezuma Street, and then decreasing to 35 mph until the Juárez-Lincoln International Bridge.

2.1.2.3 U.S. Route 281

North of its interchange with I-2/US 83, US 281 shares its alignment with I-69C and becomes a limited-access highway that serves as Hidalgo County's most crucial north–south route, connecting Hidalgo County not only to San Antonio and other northern Texas cities, but also to the rest of the country. Just south of I-2/US 83, US 281 serves as a signalized main thoroughfare in the City of Pharr. In addition to the numerous retail properties located near this corridor, there are also low-density residential areas scattered along southbound US 281, as well as agricultural and industrial zones where it approaches the Pharr–Reynosa International Bridge at the Texas–Mexico border.

In the northbound direction, US 281 begins as a four-lane road with a speed limit of 55 mph. Once entering residential zones near the city of Las Milpas, the speed limit drops to 45 mph. Outside of the residential areas, it resumes its 55-mph speed limit. The speed limit drops to 30 mph when approaching downtown Pharr. Past Ferguson Avenue, it becomes a six-lane road with a speed limit of 50 mph. Shortly after passing East Canton Road and entering the outskirts of the city of Edinburg, US 281 becomes a four-lane road. Its speed limit returns to 55 mph after passing East Richardson Road.

2.1.2.4 Interstate 2/U.S. Route 83

I-2/US 83 is a major east–west, limited-access regional highway in Hidalgo County, Texas, running parallel to the border with Mexico for approximately 48 miles. Within Hidalgo County, I-2/US 83 extends from Sullivan City at the Starr County line in the west, to the city of Mercedes at the Cameron County line in the east. Beyond the study area, the road continues out of Hidalgo County into the city of Harlingen in Cameron County to the east, and into the city of Laredo in Webb County to the west.

Starting from the east at the Cameron County line, I-2/US 83 begins as a six-lane road, with a speed limit of 75 mph, and then changes to 70 mph about one mile before Exit 160. The speed limit drops to 65 mph after Exit 144. Later, I-2/US 83 briefly becomes an eight-lane road about three miles before Exit 142, and then resumes as a six-lane road about two miles before Exit 142. I-2/US 83 becomes a four-lane road about four miles before Exit 141, and once again becomes a six-lane road one mile before Exit 138. When West Palma Drive's ramp merges into I-2/US 83, I-2/US 83 becomes a four-lane road, and the speed limit decreases to 55 mph shortly thereafter. When entering the outskirts of the city of La Joya, the speed limit drops to 45 mph.

2.1.2.5 Interstate 69 East/U.S. Route 77

I-69 E/US 77 runs in a north–south direction from Corpus Christi—parallel to the Gulf of Mexico shoreline—to the Veterans International Bridge. I-69 E/US 77 is one of the main corridors connecting the southern part of Texas—especially the Brownsville area—to major cities such as San Antonio and Houston. This route mainly serves agricultural zones but also includes some residential areas such as Harlingen, Raymondville, Kingsville, and Robstown.

2.1.2.6 Interstate 37

I-37 spans 143 miles in southern Texas, connecting Corpus Christi and San Antonio. Starting at the junction of US 181 and SH 35 in Corpus Christi, it heads north to San Antonio, ending at I-35. Beyond I-35, US 281 continues the route. I-37 provides access to downtown Corpus Christi, the port, and the airport. In San Antonio, it connects to the downtown area, Brooks City-Base, the Alamodome, the Tower of the Americas, the River Walk, and the Alamo, and serves as a vital link between I-35 and the Texas Gulf Coast.

2.2 Traffic Data Analysis

The C&M team analyzed existing daily traffic count data within the study area network to calibrate the model to existing conditions (see Chapter 3). C&M analyzed count data from 2022, as this was the most recent year for which comprehensive traffic data was available at the time this study was conducted; Table 2-1 summarizes the main sources for the annual average daily traffic (AADT) count location model calibration.

Table 2-1. Sources of Traffic Count Data

Traffic Road Data	Source	Link
Hourly Traffic by Vehicle Classification	TxDOT MS2Soft	http://txdot.ms2soft.com/tcds/tsearch.asp?loc=Txdot&mod=
AADT: Texas	TxDOT	https://gis-txdot.opendata.arcgis.com/datasets/txdot-aadt-annuals/explore

2.2.1 MS2Soft Traffic Counts Data Collection

C&M selected locations from TxDOT's MS2Soft interface that contain not only general traffic counts but classification data that describe usage by vehicle type (i.e., passenger and commercial vehicles).[1] C&M selected 40 stations both within the study area and nearby toward San Antonio and Austin, corresponding to main roads that could describe the behavior of traffic on main corridors, traffic directions, and the hourly flow of traffic per day.

Table 2-2 shows a summary of the selected stations and their characteristics, including the functional class of the road where the station is positioned. The locations of these stations are also illustrated in Figure 2-2.

Table 2-2. Characteristics of Traffic Counts – MS2Soft Stations

ID	District	Facility	Function Class	Rural/Urban
S276	Austin	I-35	(1) Interstate	U
S245	Austin	I-35	(1) Interstate	R
S15	Brownwood	US 281	(3) Principal Arterial-Other	R
M1704	Corpus Christi	SH 44	(5) Major Collector	R
205H101	Corpus Christi	SH 359	(5) Major Collector	R
13H71	Corpus Christi	US 59	(3) Principal Arterial-Other	R
M1690	Corpus Christi	SH 72	(5) Major Collector	R
2405	El Paso	I-10	(1) Interstate	U
72H30	El Paso	US 62	(3) Principal Arterial-Other	U
A123	El Paso	I-10	(1) Interstate	U
A189	El Paso	US 54	(2) Principal Arterial-Other Freeways and Expressways	U
S152	El Paso	I-10	(1) Interstate	R
S255	El Paso	US 62	(3) Principal Arterial-Other	R
S280	El Paso	SH 118	(5) Major Collector	R
S279	El Paso	US 385	(5) Major Collector	R
S281	El Paso	SH 118	(5) Major Collector	R
S219	Laredo	I-35	(1) Interstate	R
S28	Laredo	SH 359	(3) Principal Arterial-Other	U
2207	Laredo	US 59	(3) Principal Arterial-Other	R
S29	Laredo	US 277	(3) Principal Arterial-Other	R
S294	Laredo	US 90	(3) Principal Arterial-Other	R
S271	Laredo	US 90	(3) Principal Arterial-Other	R
S274	Laredo	US 277	(3) Principal Arterial-Other	R
2204	Laredo	US 57	(3) Principal Arterial-Other	R
S266	Odessa	I-10	(1) Interstate	R
S282	Odessa	US 90	(3) Principal Arterial-Other	R
S402	Odessa	I-20	(1) Interstate	U
S409	Odessa	US 285	(3) Principal Arterial-Other	R
66SP74	Pharr	US 77	(3) Principal Arterial-Other	R
MS97	Pharr	US 281	(3) Principal Arterial-Other	R
S269	Pharr	US 83	(3) Principal Arterial-Other	R
S51	San Angelo	US 277	(3) Principal Arterial-Other	U
A321	San Antonio	I-37	(1) Interstate	R
S160	San Antonio	US 181	(3) Principal Arterial-Other	R
S329	San Antonio	US 281	(3) Principal Arterial-Other	U
S328	San Antonio	SH 16	(3) Principal Arterial-Other	U
1504	San Antonio	US 90	(3) Principal Arterial-Other	R
S231	San Antonio	I-10	(1) Interstate	R
S164	Yoakum	I-10	(1) Interstate	R
S22	Yoakum	SH 60	(5) Major Collector	R

Source: TxDOT MS2Soft[1]

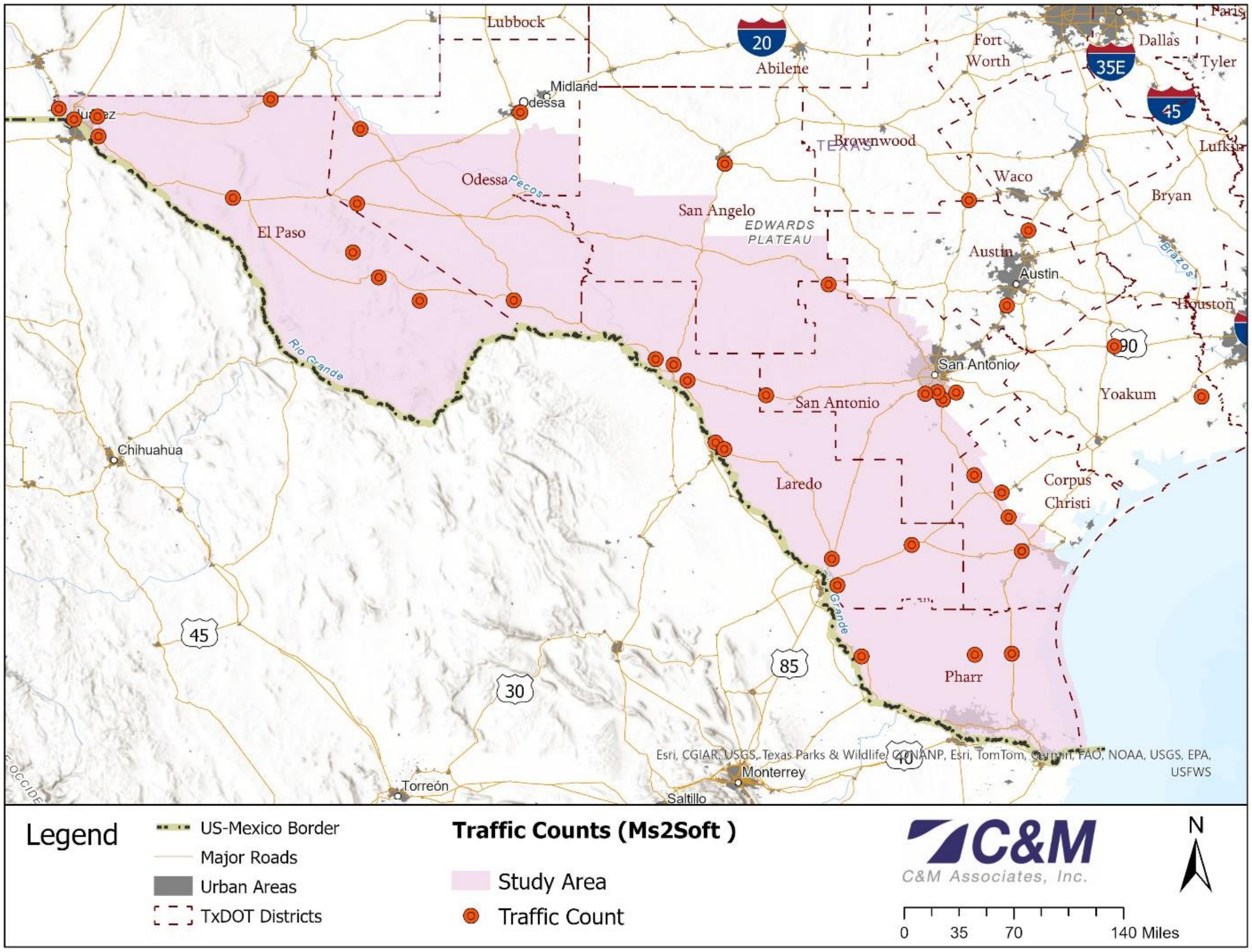
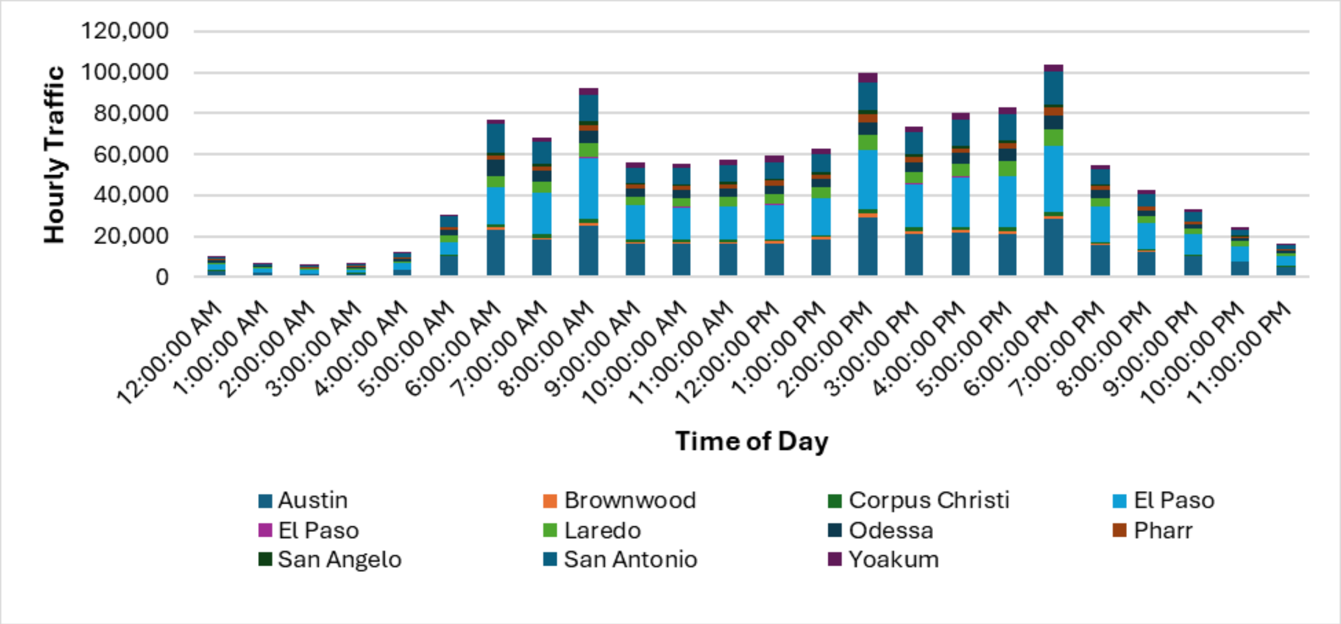


Figure 2-2. Traffic Counts – TxDOT MS2Soft Stations

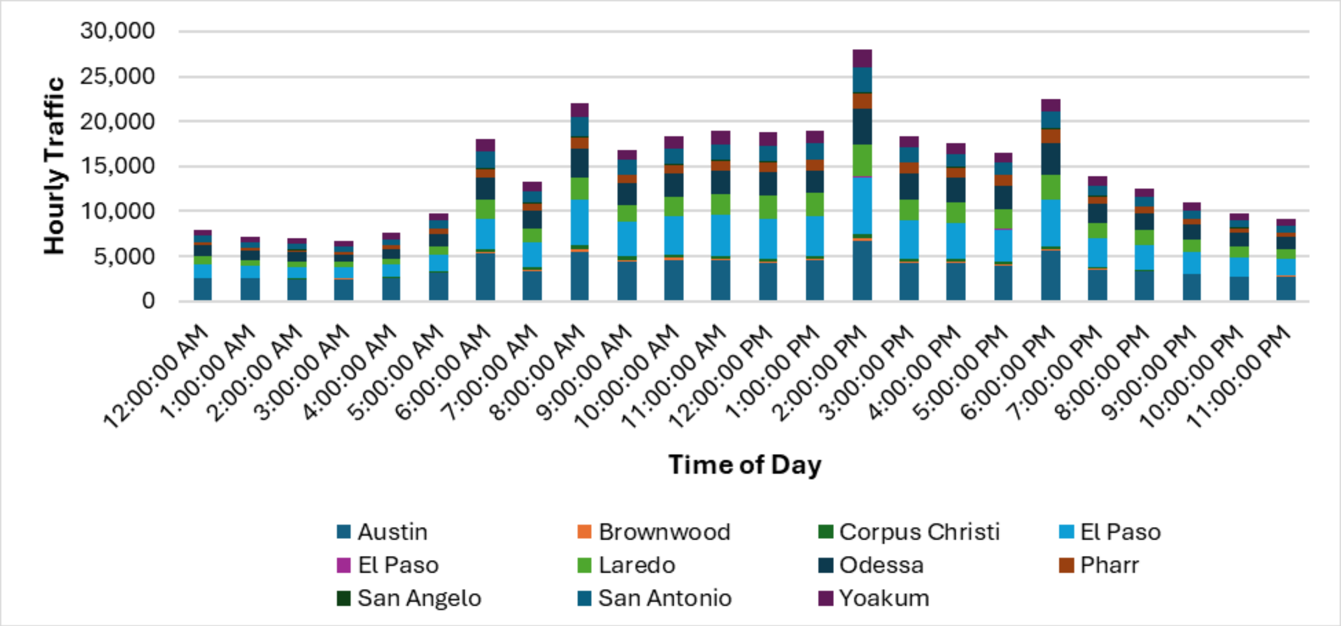
Figure 2-3 illustrates the weekday traffic profiles within the main districts for passenger vehicles. As shown, the districts with the highest passenger vehicle volumes are Austin, El Paso, and San Antonio. Furthermore, the peak hour is observed from 6:00 p.m. to 7:00 p.m.



Source: TxDOT MS2Soft[1]

Figure 2-3. Passenger Vehicle Weekday Hourly Profile by District

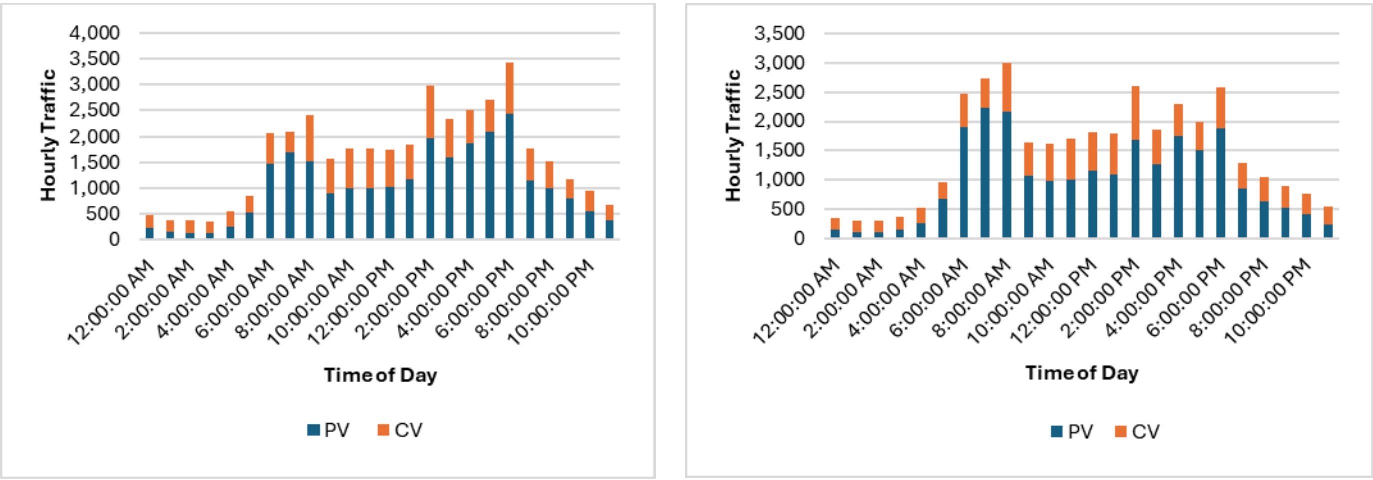
Figure 2-4 illustrates the weekday traffic profiles within the main districts for commercial vehicles. As shown, the districts with the highest commercial vehicle volumes are Austin and El Paso. Furthermore, the peak hour is observed from 2:00 p.m. to 3:00 p.m.



Source: TxDOT MS2Soft[1]

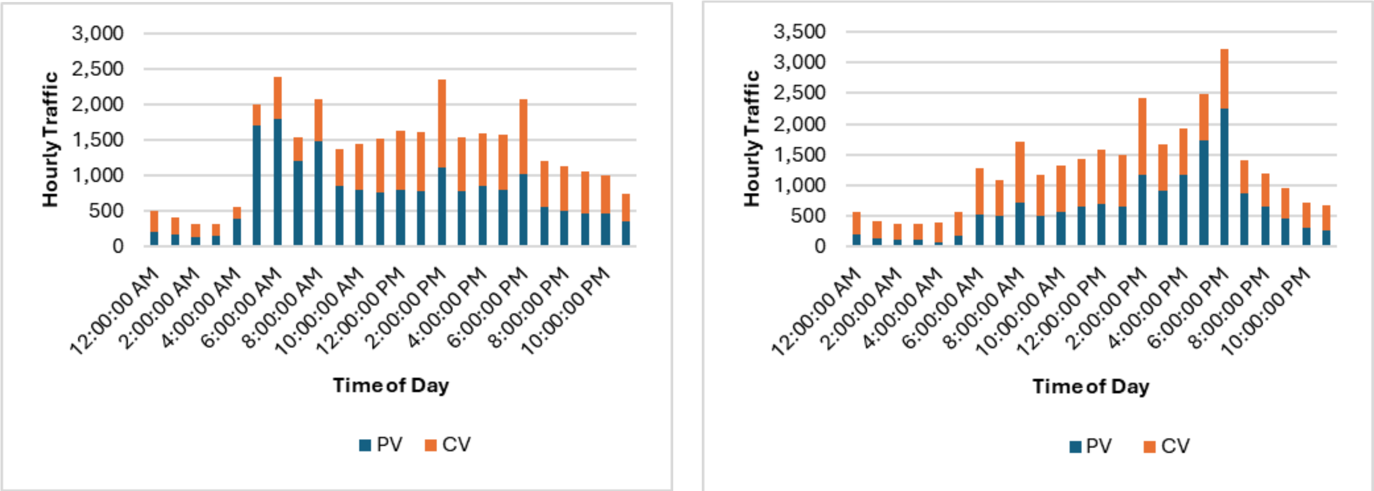
Figure 2-4. Commercial Vehicle Weekday Hourly Profile by District

Figure 2-5 through Figure 2-8 show the hourly traffic volumes at four stations located along main corridors of the study area, by vehicle length (i.e., passenger vehicles [PV] and commercial vehicles [CV]) and direction. Counts at I-10 and I-35 show clear pendular traffic, with a westbound and northbound morning peak and eastbound and southbound afternoon peak. However, counts at US 77 and US 281 in both directions exhibit a peak at 2:00 p.m., which starts to decrease at 6:00 p.m. For all stations, commercial vehicles have an increase in daytime traffic, with a decrease at 6:00 p.m. and 7:00 p.m.



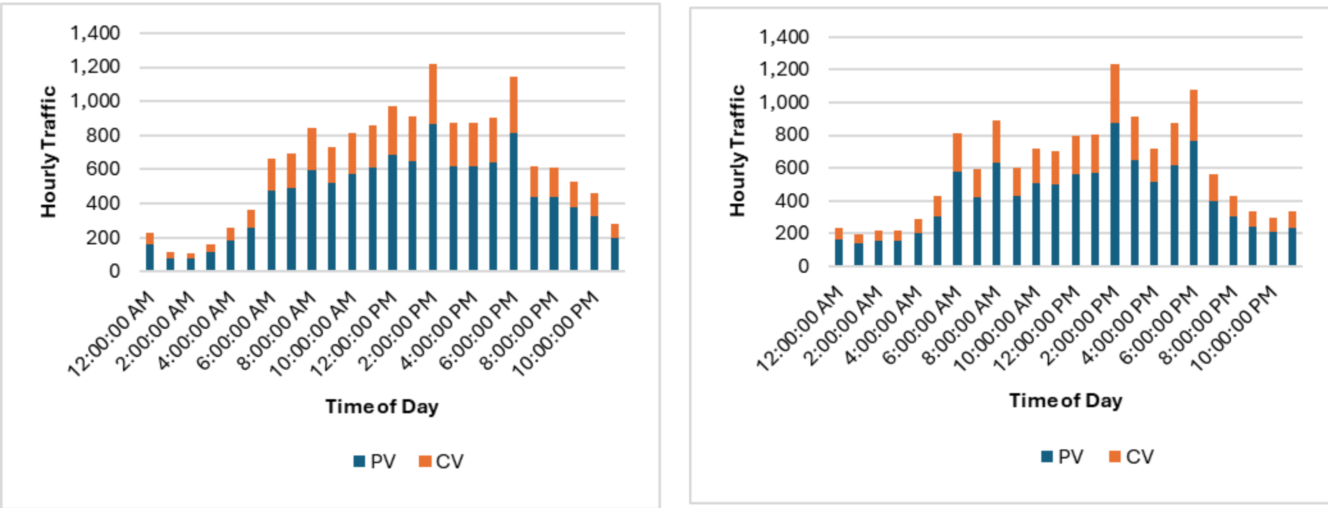
Source: TxDOT MS2Soft[1]

Figure 2-5. Hourly Classified Volumes at Station 2405 (I-10), EB (left) and WB (right)



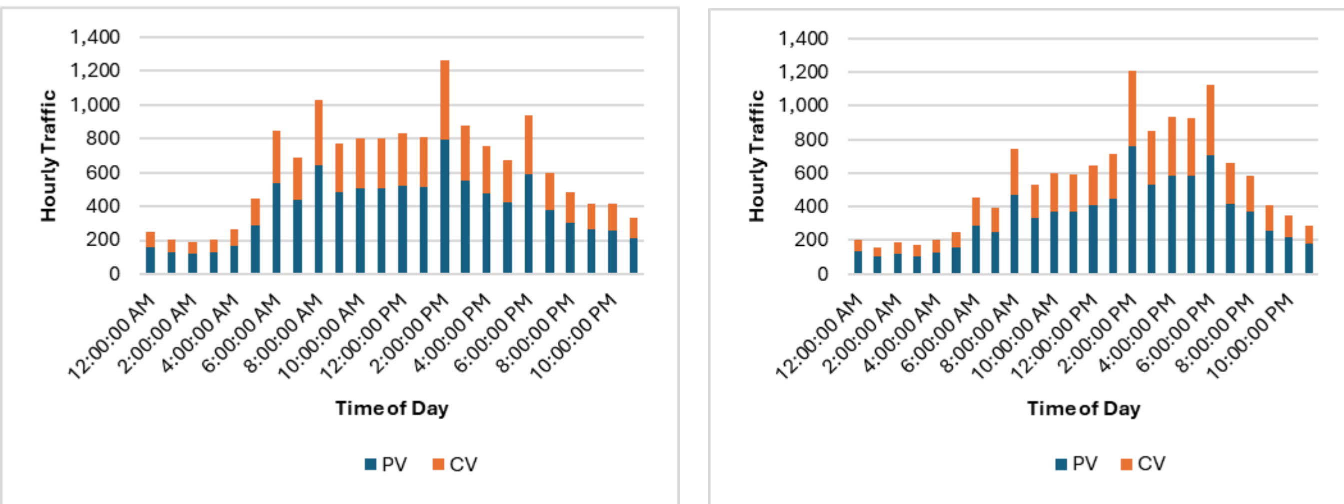
Source: TxDOT MS2Soft[1]

Figure 2-6. Hourly Classified Volumes at Station S219 (I-35), NB (left) and SB (right)



Source: TxDOT MS2Soft[1]

Figure 2-7. Hourly Classified Volumes at Station 66SP74 (US 77), NB (left) and SB (right)



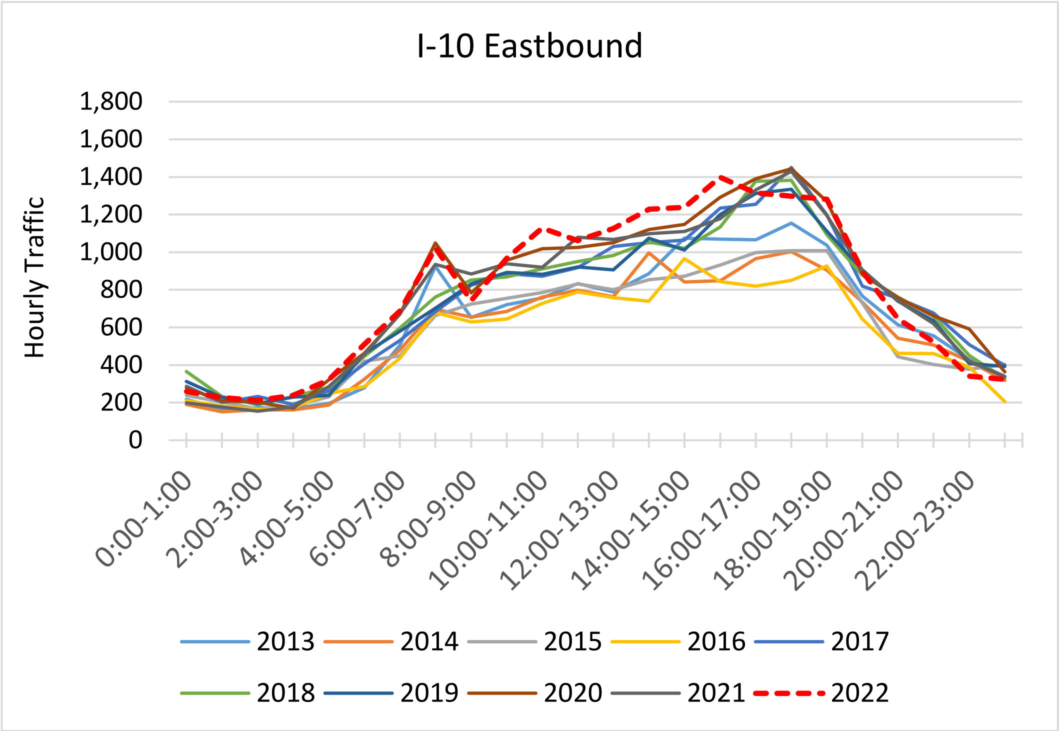
Source: TxDOT MS2Soft[1]

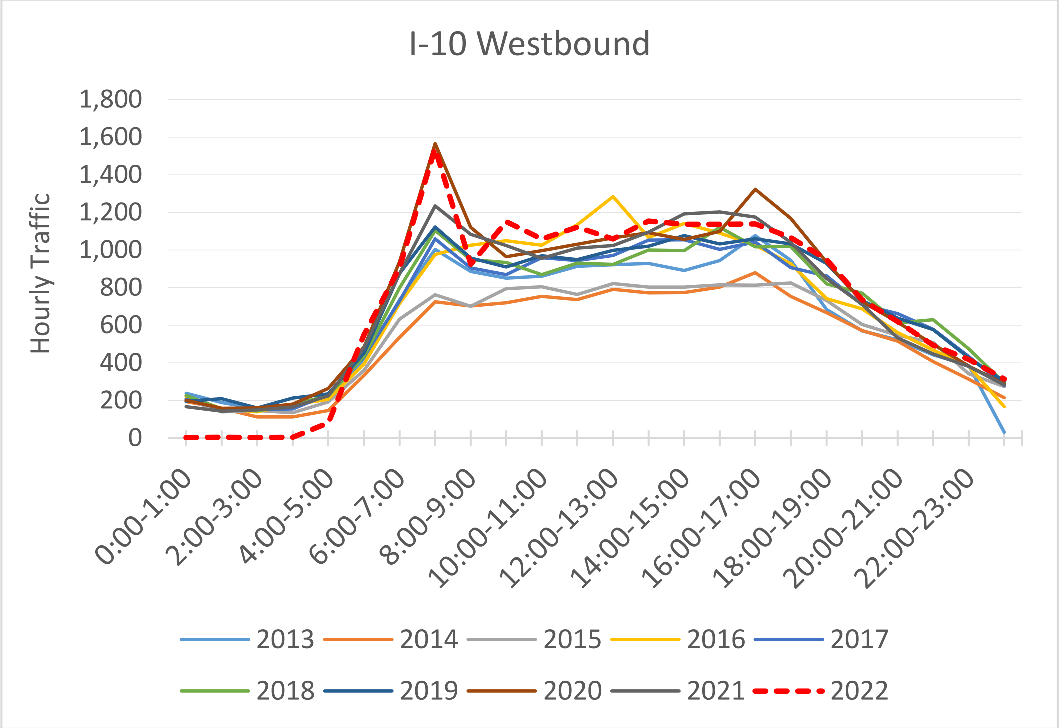
Figure 2-8. Hourly Classified Volumes at Station MS97 (US 281), NB (left) and SB (right)

2.2.1.1 Historical Traffic Trend Analysis

Figure 2-9 through Figure 2-12 show the hourly vehicle volume at four stations located along main corridors in the study area, by year and direction. Counts at I-10 and I-35 show clear pendular traffic, with a westbound and northbound morning peak and eastbound and southbound afternoon peak; this is replicated in each year that is presented. However, counts at US 77 and US 281 in both directions do not have persistent peaks throughout the day in the years presented.

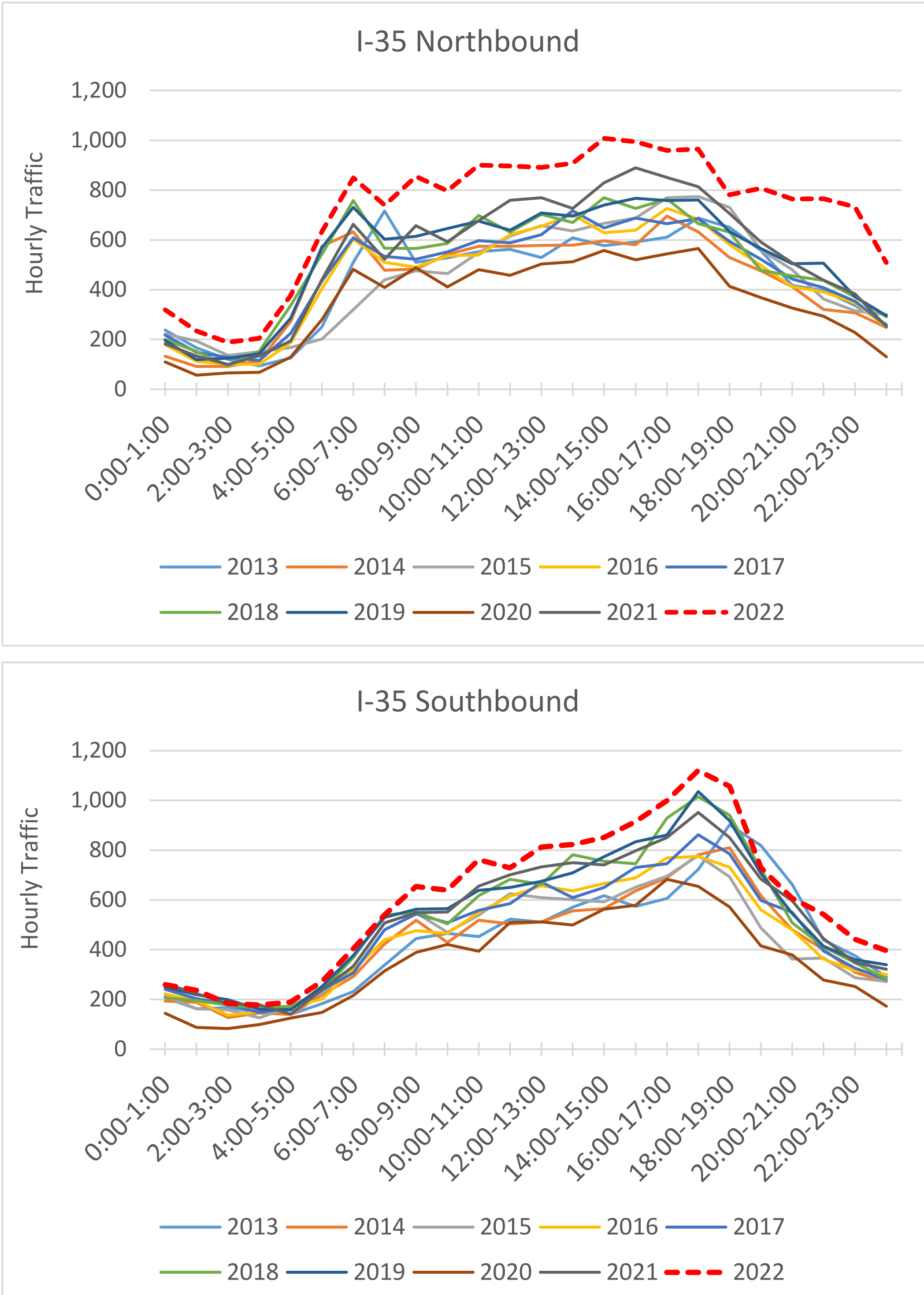
Along most of the corridors, the latest hourly volumes are higher than in 2020 during the worldwide COVID-19 pandemic. However, US 281 presents a decrease in traffic flows from 2013 onwards.





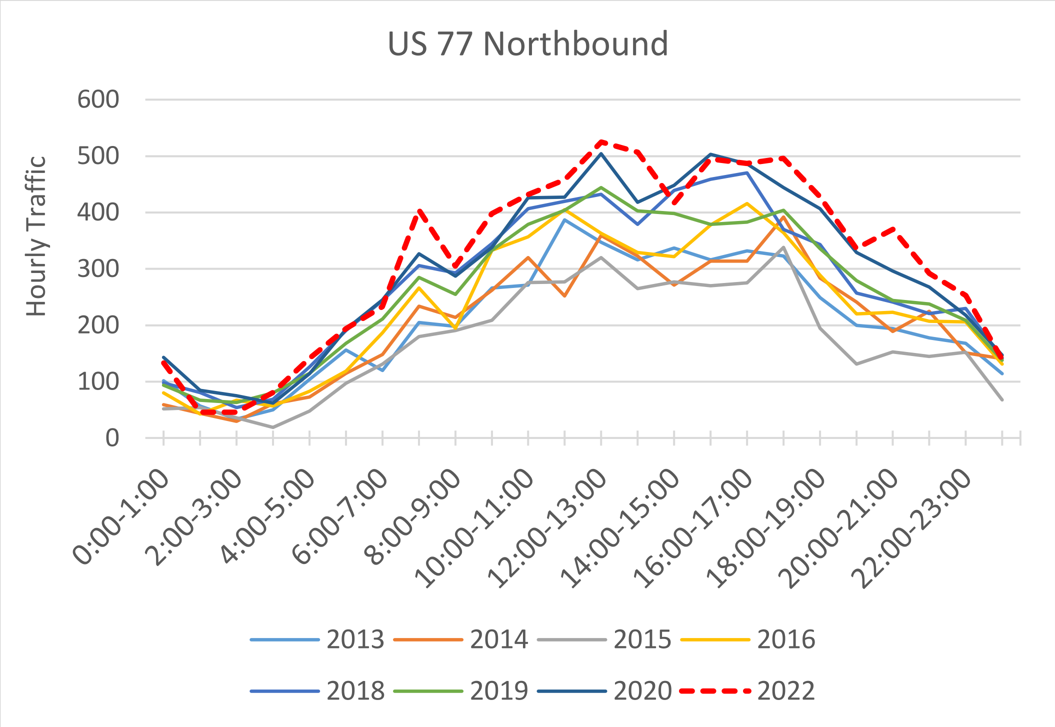
Source: TxDOT MS2Soft[1]

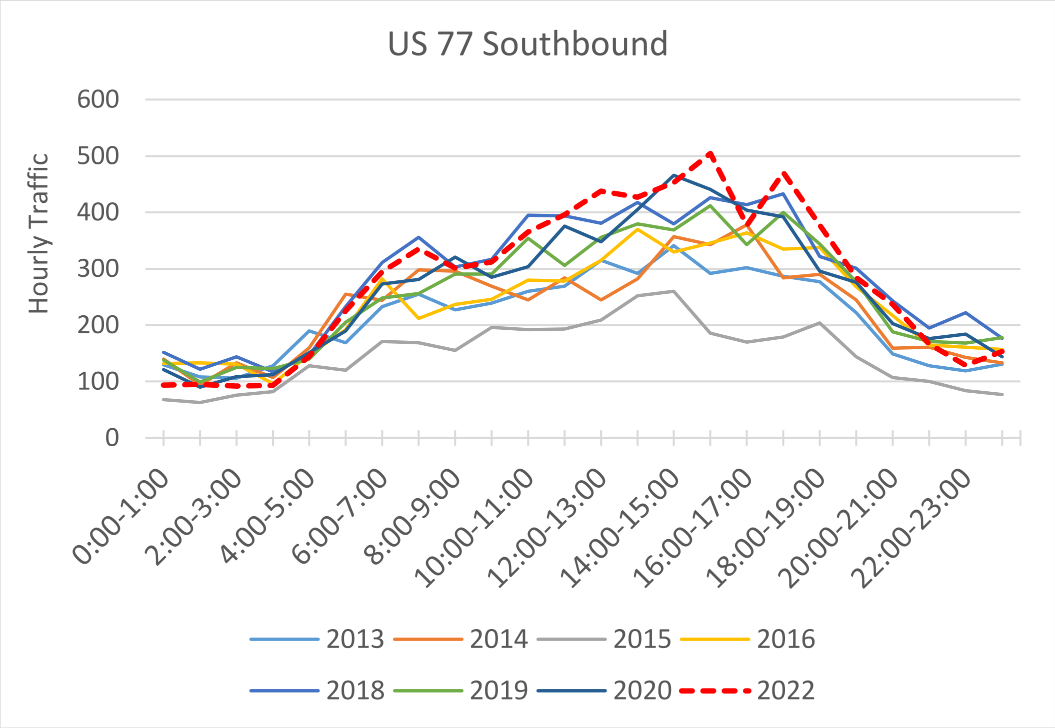
Figure 2-9. Hourly Total Volume at Station 2405 (I-10) by Year and Direction



Source: TxDOT MS2Soft[1]

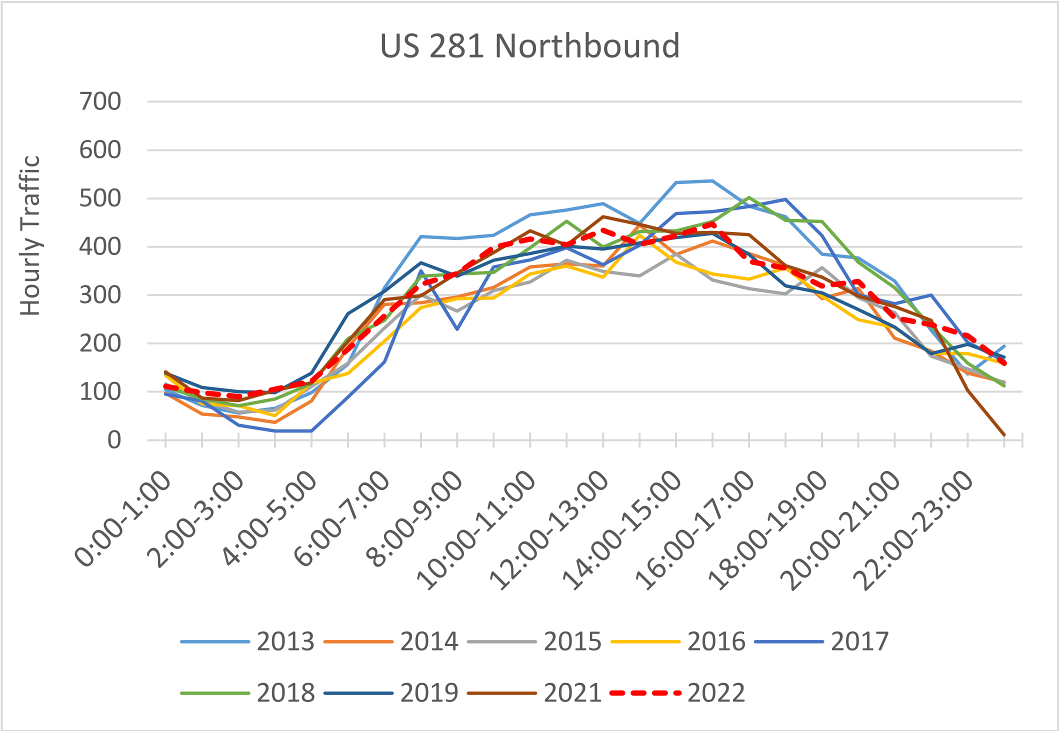
Figure 2-10. Hourly Total Volume at Station S219 (I-35) by Year and Direction

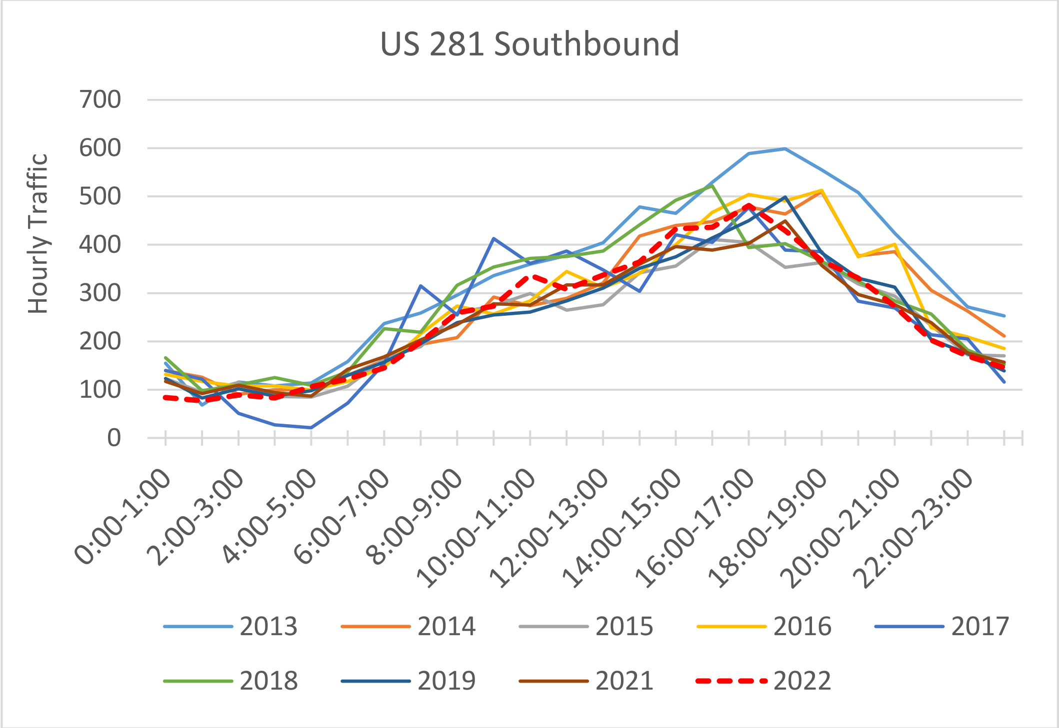




Source: TxDOT MS2Soft[1]

Figure 2-11. Hourly Total Volume at Station 66SP74 (US 77) by Year and Direction





Source: TxDOT MS2Soft[1]

Figure 2-12. Hourly Total Volume at Station MS97 (US 281) by Year and Direction

2.2.2 TxDOT Traffic Count Data Collection

For the present study, C&M performed model validation using points employed during calibration. The primary objective of model validation is to confirm the model's accurate representation of the real-world system it aims to simulate, ensuring the dependability of the model's predictions and outcomes. C&M used 40 stations from TxDOT's 2022 traffic counts for the validation process.[2] The available data are in the form of AADTs, and C&M completed additional processing to achieve comparable data with the model between weekdays and weekends.

Table 2-3 shows a summary of the selected stations and their characteristics, including the functional class of the road where the station is positioned; Figure 2-13 shows the location of each selected station.

Table 2-3. Characteristics of Traffic Counts –TxDOT Stations

ID	District	Facility	Function Class	Rural/Urban
126H110	Corpus Christi	US 281	(3) Principal Arterial-Other	R
126H66	Corpus Christi	SH 44	(5) Major Collector	R
126H59B	Corpus Christi	US 281	(3) Principal Arterial-Other	R
126H6	Corpus Christi	US 281	(3) Principal Arterial-Other	R
137H42	Corpus Christi	SH 285	(5) Major Collector	R
178H7701	Corpus Christi	US 77	(3) Principal Arterial-Other	R
205H68	Corpus Christi	I-37	(1) Interstate	R
149SP232	Corpus Christi	I-37	(1) Interstate	R
149H30	Corpus Christi	US 59	(3) Principal Arterial-Other	R
137H50	Corpus Christi	US 77	(3) Principal Arterial-Other	R
116H1002	El Paso	I-10	(1) Interstate	U
72H200	El Paso	I-10	(1) Interstate	U
123H17A	El Paso	I-10	(1) Interstate	U
254H12	Laredo	US 83	(3) Principal Arterial-Other	R
240H311	Laredo	SH 359	(5) Major Collector	R
240H3	Laredo	US 83	(3) Principal Arterial-Other	R
240H106	Laredo	I-35	(1) Interstate	U
67H22	Laredo	SH 359	(5) Major Collector	R
67H107	Laredo	US 59	(3) Principal Arterial-Other	R
67H108	Laredo	SH 44	(5) Major Collector	R
195H60	Odessa	I-20	(1) Interstate	U
186H24	Odessa	I-10	(1) Interstate	U
186H2001	Odessa	I-10	(1) Interstate	U
52H8	Odessa	US 385	(5) Major Collector	R
186H121	Odessa	I-10	(1) Interstate	U
186H109	Odessa	FM 305	(6) Collector	U
69H2001	Odessa	I-20	(1) Interstate	U
52D1	Odessa	US 385	(5) Major Collector	R
125D1	Pharr	SH 285	(3) Principal Arterial-Other	R

Table 2-3. Characteristics of Traffic Counts –TxDOT Stations (Cont'd.)

ID	District	Facility	Function Class	Rural/Urban
218H20A	San Angelo	I-10	(1) Interstate	U
70H7A	San Angelo	SH 55	(5) Major Collector	R
218H1001	San Angelo	I-10	(1) Interstate	U
134H1001	San Angelo	I-10	(1) Interstate	U
232H64B	San Antonio	SH 55	(3) Principal Arterial-Other	R
7H20A	San Antonio	I-37	(1) Interstate	R
7H21	San Antonio	I-37	(1) Interstate	R
15H1005	San Antonio	I-10	(1) Interstate	U
131H24	San Antonio	I-10	(1) Interstate	U
15H11	San Antonio	I-10	(1) Interstate	U
15H1002	San Antonio	I-10	(1) Interstate	U

Source: TxDOT[2]

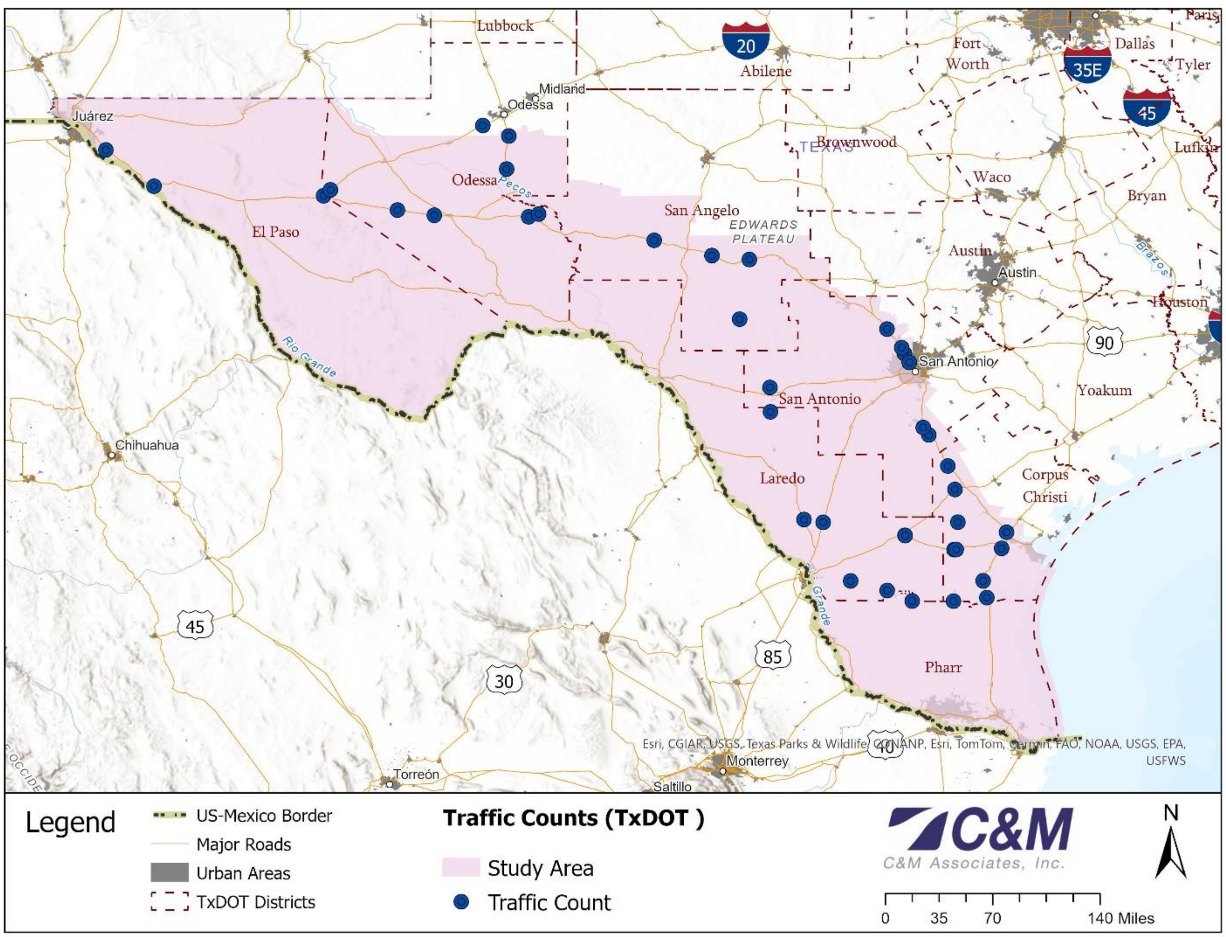


Figure 2-13. Traffic Counts – TxDOT Stations

2.2.2.1 Historical Traffic Trend Analysis

Figure 2-14 shows historical traffic trends on main corridors in the study area (I-10, I-35, US 77, and US 281); the data represent AADTs from 2003 to 2022 and include trends for all vehicle classes and traffic volumes in both directions.

As shown, trends have been impacted by events such as the Great Recession, with a notable decrease in traffic volumes from 2008 to 2009, and the impact of the worldwide COVID-19 pandemic, with a decrease in traffic volumes in 2020. However, an increase in traffic volumes is observed after 2020 on routes such as I-35, which connects Laredo to San Antonio, and US 77, which connects Brownsville to Corpus Christi. Likewise, I-10 maintains the trend with slight changes in traffic volumes, as shown in Figure 2-14.

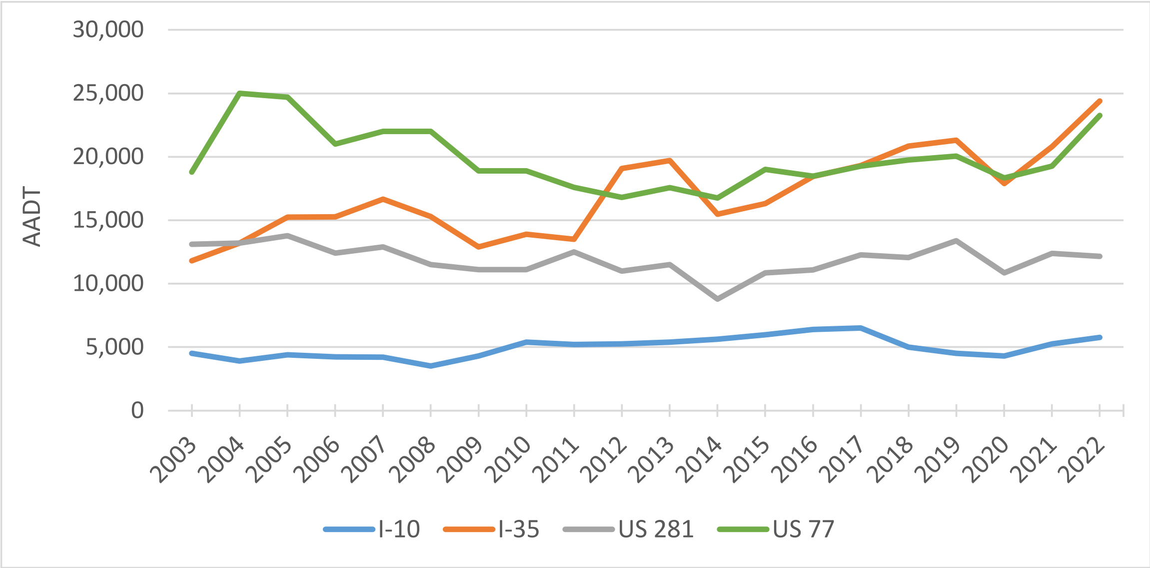


Figure 2-14. Historical Traffic Trends, 2003–2022

2.3 Border-Crossing Analysis

There are 28 existing international border crossings connecting Texas to Mexico, thus providing access to retail, industrial, and educational centers on both sides of the border (see Figure 2-15). Table 2-4 summarizes the POEs and corresponding border crossings that were considered within each district of the study area.

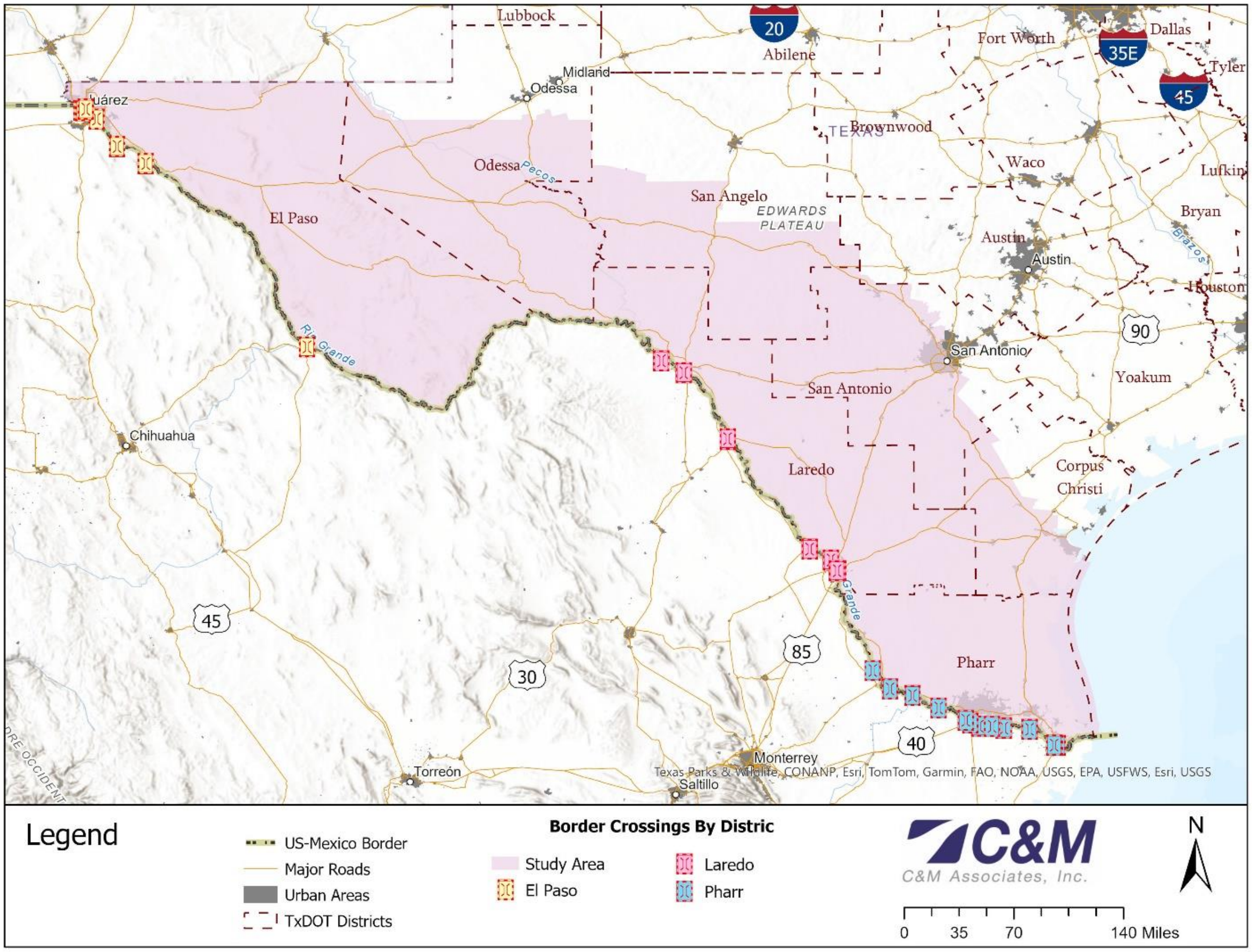


Figure 2-15. POEs and Border Crossings by District

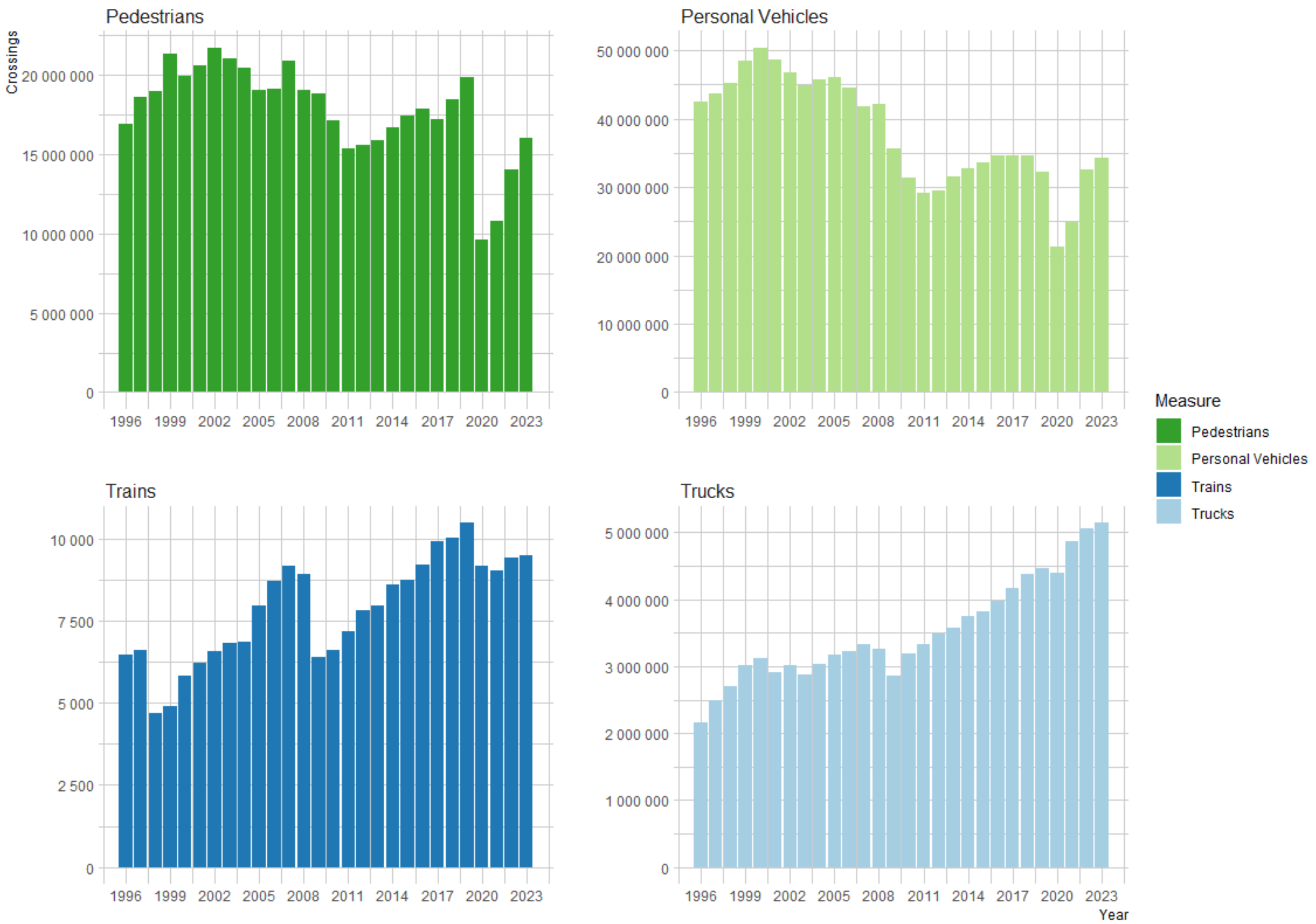
Table 2-4. POEs and Border Crossings by District

District	Port of Entry	Border Crossing
Pharr	Brownsville	Gateway International Bridge
		Brownsville & Matamoros (B&M) Bridge
		Veterans International Bridge
		Free Trade Bridge
	Progreso	Weslaco–Progreso International Bridge
		Donna–Rio Bravo International Bridge
	Hidalgo	Pharr–Reynosa International Bridge
		McAllen–Hidalgo International Bridge
		Anzalduas International Bridge
	Rio Grande City	Camargo Bridge
		Los Ebanos Ferry
	Roma	Lake Falcon Dam International Crossing
		Roma–Ciudad Miguel Aleman International Bridge
Laredo	Laredo	Colombia Solidarity Bridge
		World Trade Bridge
		Gateway to the Americas Bridge
		Juarez–Lincoln International Bridge
	Eagle Pass	Eagle Pass International Bridge
		Camino Real International Bridge
	Del Rio	Lake Amistad Dam Crossing
		Del Rio International Bridge
El Paso	El Paso	Paso del Norte Bridge
		Good Neighbor Bridge
		Bridge of the Americas
	Ysleta	Ysleta Bridge
	Tornillo	Fort Hancock–El Porvenir Bridge
		Tornillo–Guadalupe International Bridge
	Presidio	Presidio–Ojinaga International Bridge

Figure 2-16 illustrates statewide northbound historical border crossings since 1996 for pedestrians, passenger vehicles, commercial vehicles, and trains based on data from the Bureau of Transportation Statistics (BTS).[3] The annual crossings for each vehicle class and pedestrians indicate unique trends. The volumes presented herein represent the cumulative crossing volumes of all land POEs within the study area.

As shown in Figure 2-16, pedestrians and passenger vehicles exhibit a different historical trend, with northbound crossings mainly affected by the 9/11 terrorist attacks in the United States and the subsequent changes to visa and border inspection processes. Other important factors impacting those border crossings are the safety issues in Mexico from 2006 to 2012, and the COVID-19 pandemic in 2020, which had major impacts on pedestrian and passenger vehicle border crossings.

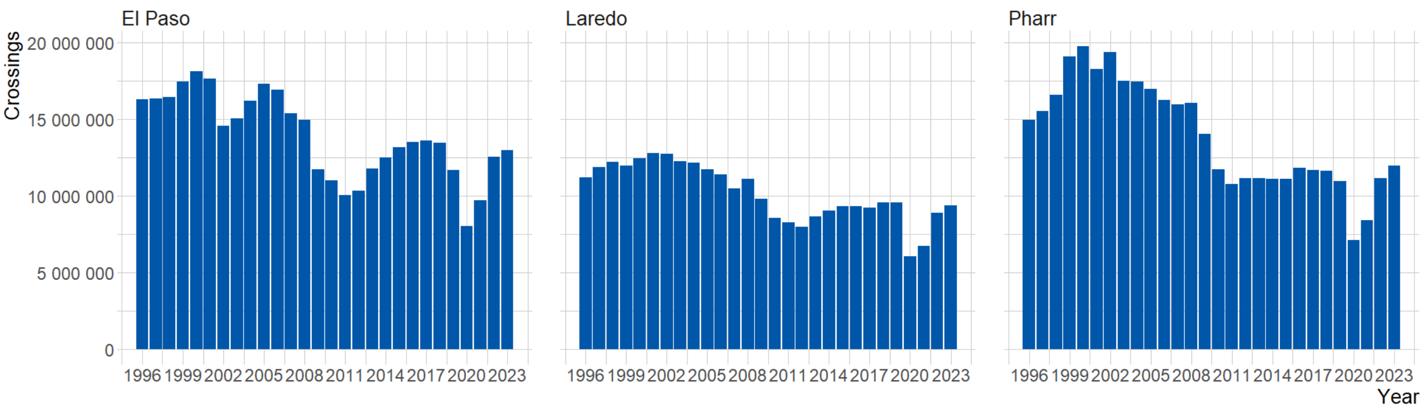
Conversely, the historical performance of trains and commercial vehicles exhibits a trend of growth, having been less impacted than pedestrians and passenger vehicles by events such as 9/11 and the pandemic. The greatest increase in northbound train and commercial vehicle crossings occurred in the years immediately following NAFTA's approval in 1994. Overall, commercial and train traffic continued to increase until 1999, with the sharpest decrease in traffic exhibited from 2008 to 2009 during the Great Recession. After 2009, northbound crossings returned to a healthy growth rate and were minimally impacted by the COVID-19 pandemic.



Source: BTS[3]

Figure 2-16. Northbound Statewide (Texas) Border Crossings by Vehicle

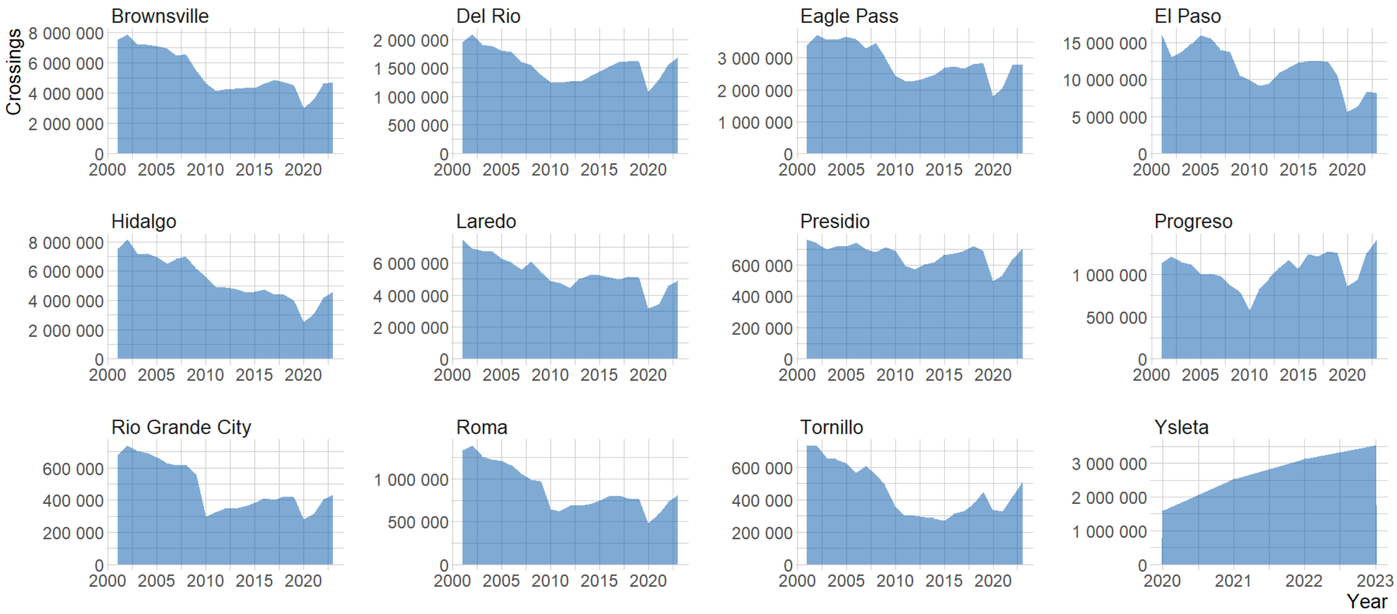
Figure 2-17 shows the historical northbound passenger vehicle border crossings by district from 1996 to 2023, with data obtained from the BTS. As shown, the El Paso district was the most important district for passenger vehicle border crossings from 1996 to 2023, with its highest volumes exhibited in 1999 and 2005. The Pharr and Laredo districts also registered their highest volumes between 1999 and 2005. Although El Paso remains the most important district for passenger vehicle border crossings, its share has been decreasing over the past year. The El Paso district, as shown in Table 2-4, covers POEs such as El Paso, Ysleta, Tornillo, and Presidio.



Source: BTS[3]

Figure 2-17. Northbound Passenger Vehicle Border Crossings by Texas District

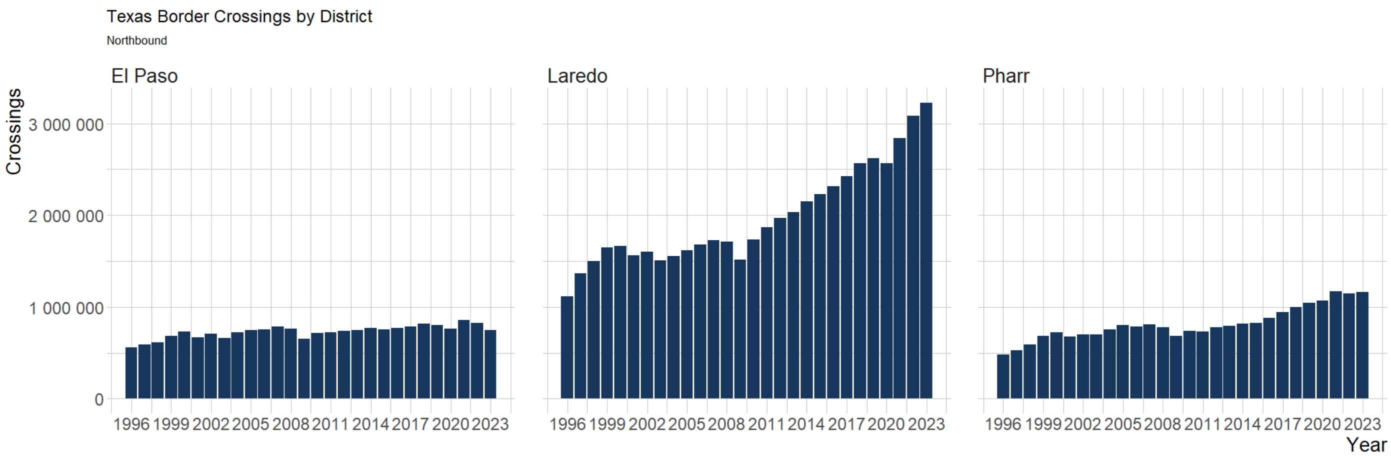
To complement the previous analysis, Figure 2-18 shows the historical northbound passenger vehicle border crossings by Texas POE from 2000 to 2023. Most of the POEs shows a constant and variable decrease in passenger vehicle border crossings. However, Progreso, Presidio, and Ysleta show more stability in passenger vehicle border crossings than the rest of the POEs. Progreso, located in the Pharr district, covers bridges such as the Weslaco–Progreso International Bridge and the Donna–Rio Bravo International Bridge. Presidio and Ysleta, located in the El Paso district, cover bridges such as the Presidio–Ojinaga International Bridge and Ysleta Bridge, respectively.



Source: BTS[3]

Figure 2-18. Northbound Passenger Vehicle Border Crossings by Texas POE

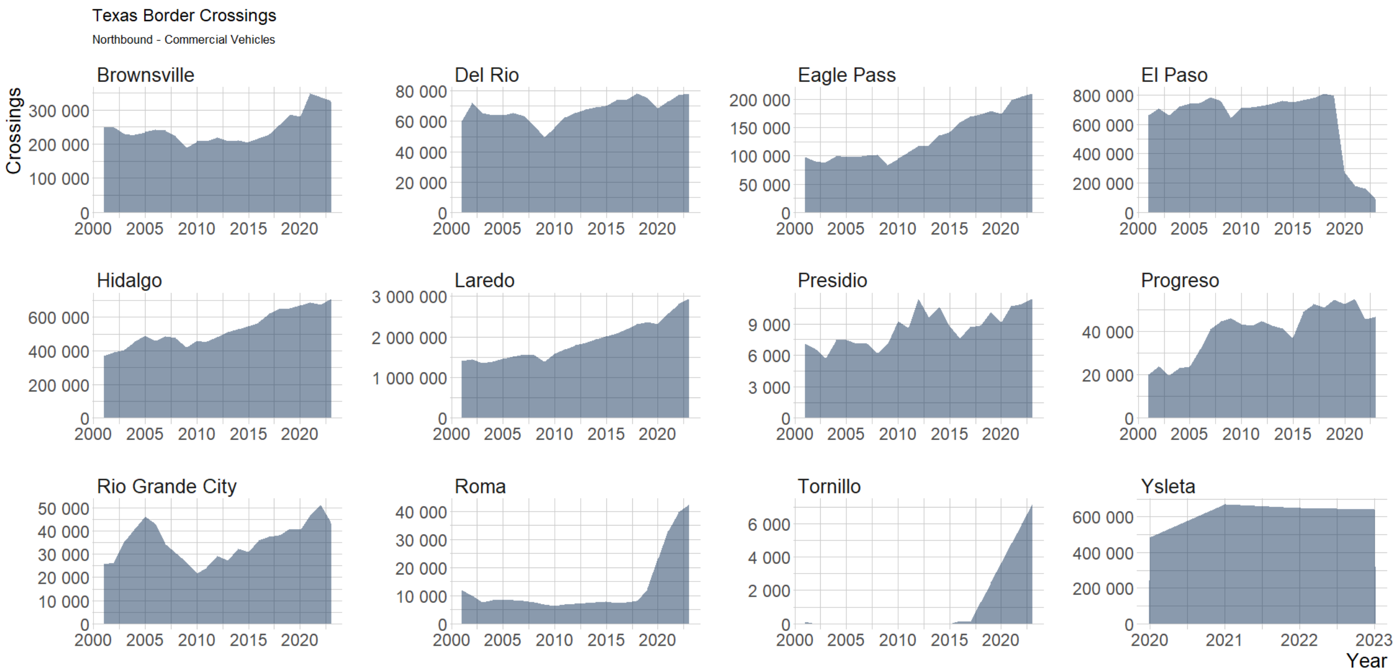
Figure 2-19 shows the historical northbound commercial vehicle border crossings by district from 1996 to 2024, with data obtained from U.S. Customs and Border Protection (CBP).[4] As shown in Figure 2-19, the Laredo district was the most important district for commercial vehicle border crossing from 1996 to 2023, with a notable growth trend; this behavior is similar for El Paso and Pharr commercial vehicle border crossings. Notably, the Laredo district covers POEs such as Laredo, Eagle Pass, and Del Rio.



Source: CBP[4]

Figure 2-19. Northbound Commercial Vehicle Border Crossings by District

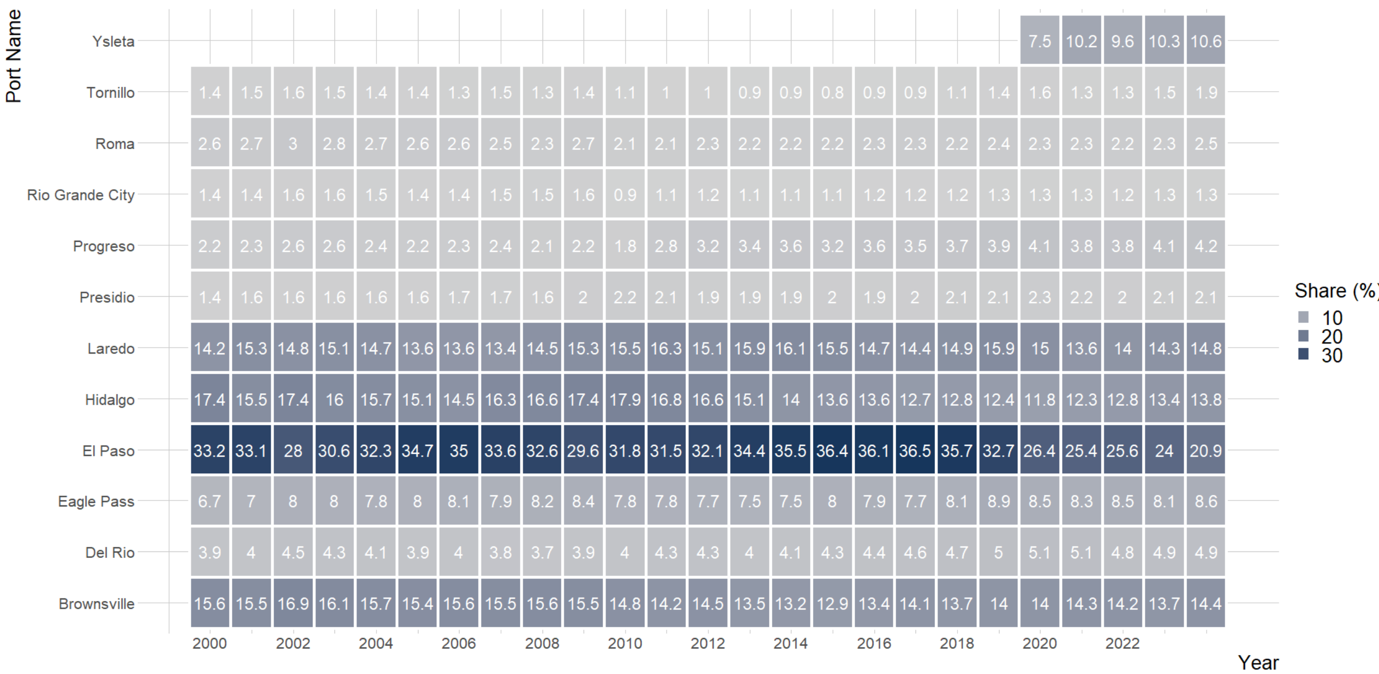
To complement the previous analysis, Figure 2-20 shows the historical northbound commercial vehicle border crossings by POE from 2000 to 2023. Most of the POEs show a variable increase in commercial vehicle border crossings. However, El Paso has a notable decrease in its commercial vehicle border crossings, as only its Bridge of the Americas is open for commercial vehicles.



Source: BTS[3]

Figure 2-20. Northbound Commercial Vehicle Border Crossings by POE

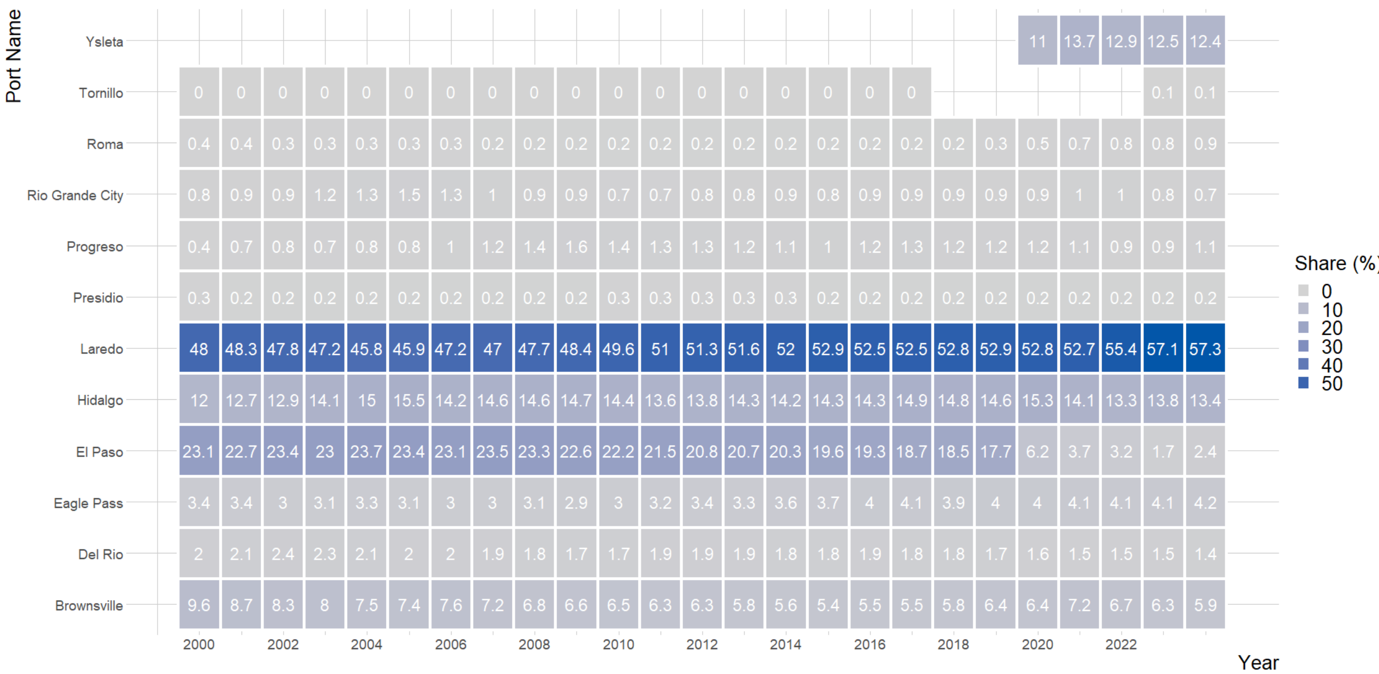
Figure 2-21 shows the historical share of northbound passenger vehicle border crossing for all Texas POEs from 2000 to 2023, according to BTS data. As shown, the most important POE for passenger vehicles is El Paso, which includes border crossings such as Paso del Norte Bridge, Good Neighbor Bridge, and Bridge of the Americas, with a share between 20% and 35%. However, El Paso shows a decrease over the years in its passenger vehicle border-crossing share, from 33.2% in 2000 to 20.9% in 2023. The same decreasing trends are observable in POEs such as Laredo and Hidalgo, with a decrease between 1% and 2%, respectively, from 2000 to 2023. However, these POEs are currently the most important for passenger vehicle border crossings.



Source: BTS[3]

Figure 2-21. Northbound Passenger Vehicle Border-Crossing Shares by POE

Figure 2-22 shows the shows the historical northbound commercial vehicle border-crossing shares for all Texas POEs from 1996 to 2023, according to CBP data. As shown, the most representative POE for commercial vehicles is Laredo, which includes border crossings such as the Colombia Solidarity Bridge and World Trade Bridge, with a share between 47% and 57%; the Gateway to the Americas Bridge and Juarez–Lincoln International Bridge are not open for commercial vehicles. Consequently, the most important POEs for commercial vehicles are currently Hidalgo and Ysleta. The Laredo POE has shown a persistent increase in its commercial vehicle crossing share over the years, from 47.2% in 2000 to 57.3% in 2024. A similar trend is seen with the Hidalgo POE, with an increase from 12% in 2000 to 13.8% in 2023. However, POEs such as El Paso and Brownsville have had major decreases in their commercial vehicle border crossings. El Paso registered a 23.1% share in 2000, which decreased to 1.7% in 2023; Brownsville registered a 9.6% share in 2000 and a 6.3% share in 2023.



Source: CBP[4]

Figure 2-22. Northbound Commercial Vehicle Border Crossing Shares by POE

2.4 MPO Travel Demand Models

C&M reviewed the MPO TDMs along with the Texas SAM to assess the regional travel outlook within the corresponding model regions and the study area. The following section describes the different regional models considered by C&M as well as Texas SAM's characteristics.

2.4.1 El Paso MPO Travel Demand Model

2.4.1.1 El Paso Model Description

The El Paso MPO Destino Model is a regional TDM that was developed as a tool to forecast traffic and travel through the region and support the Metropolitan Transportation Plan (MTP). The traditional four-step model can support the evaluation of proposed roadway and transit projects, help evaluate potential impacts of proposed development projects, and support various other studies of the region, subareas, corridors, and other planning activities.

The changes to the Destino Model (from the previous version) include updating the model base year to 2017, integrating the TripCAL6 trip generation program, adding walk market segmentation sensitivity to the mode choice model, adding sensitivity to the mode choice model to better forecast bicycle trips, adding select link analysis capability to the trip assignment model, and calibrating and validating the various model components to base year conditions.

The model contains future-year data reflecting forecast 2050 conditions. Interim-year data representing several intermediate timeframes are also maintained in the travel model dataset.

2.4.1.2 EL Paso TDM Study Area

The study area of the El Paso TDM is focused on El Paso County, as shown in Figure 2-23.

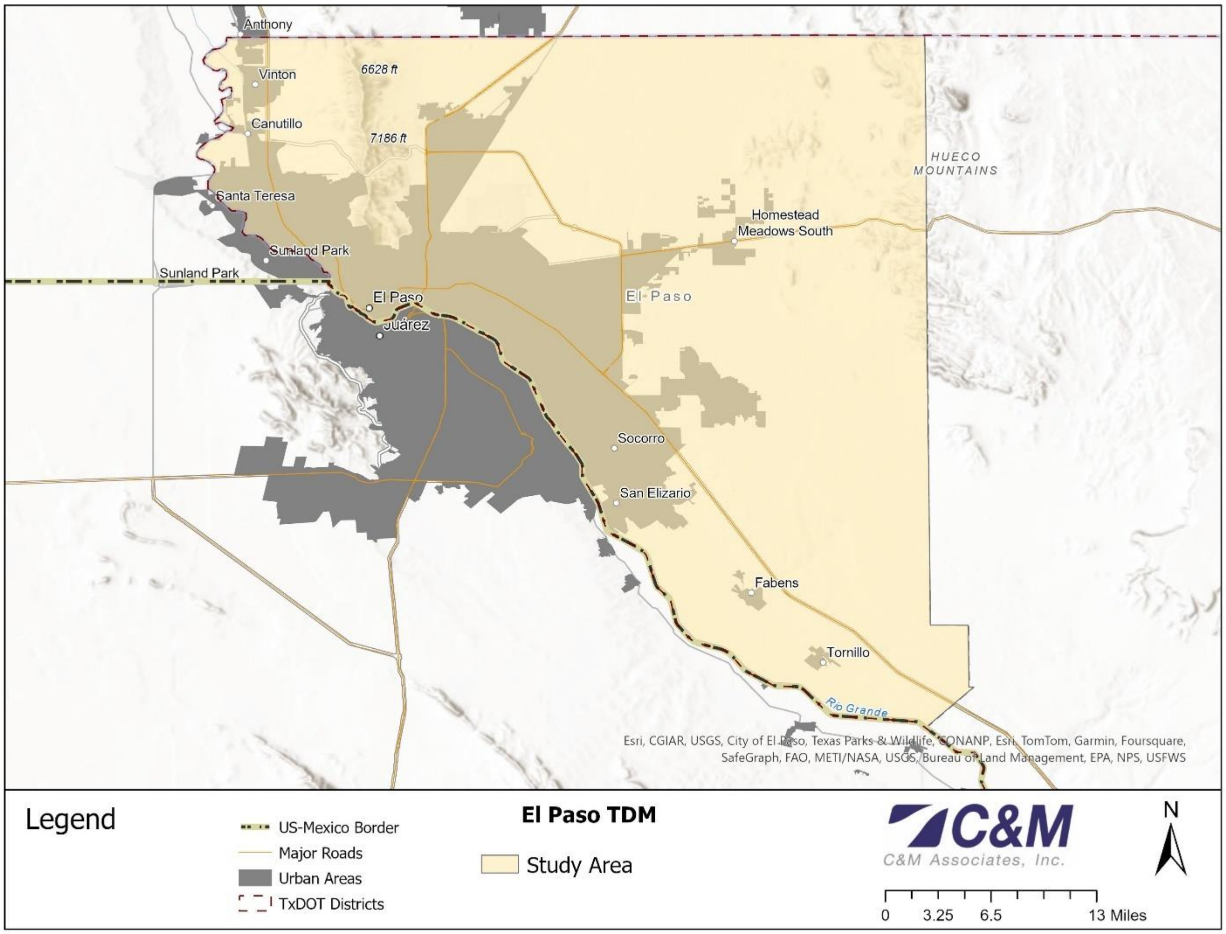


Figure 2-23. El Paso TDM's Study Area

2.4.1.3 El Paso TDM Metrics

The El Paso Destino Model uses a variety of metrics in each of the model's four steps:

- **Trip Generation** includes metrics such as the number of trips produced and attracted in each traffic analysis zone (TAZ), trips generated per household segmented by trip purpose, and number of trips attracted per employee.
- **Trip Distribution** includes metrics such as trip table matrices that contain intrazonal trips, average trip length distribution that considers trip distances or travel times for different purposes, and trip travel time distribution.
- **Mode Choice** includes metrics such as mode share that distributes all person trips (including non-motorized, auto, and transit trips), separated as drive alone, shared ride by occupancy, walk access and drive access, and bicycle and walk modes. An estimation of trips by mode and purpose is also considered.

- **Traffic Assignment** primarily comprises the traffic volume, which estimates the number of vehicles using a specific road. Other metrics including level of service (LOS), vehicle miles traveled (VMT), vehicle hours traveled (VHT), and congestion indicators were considered in the El Paso Destino Model.

2.4.2 Laredo MPO Travel Demand Model

2.4.2.1 Laredo Model Description

The Laredo MPO TDM is a traditional four-step model that provides a means of making informed decisions regarding proposed transportation improvements. The Laredo TDM was a cooperative process among the Laredo MPO, TxDOT's Laredo District, and the TxDOT Transportation Planning and Programming (TPP) Division.[i]

The Laredo TDM provides a tool to identify existing and future transportation system deficiencies and assess proposed regional mobility improvements. The Laredo MPO TDM supports the development of the region's long-range MTP for 2020–2045 and is used to identify transportation system deficiencies and evaluate potential improvements. The Laredo TDM also provides future traffic designs for the Laredo metropolitan area.

The Laredo TDM considers 2008 and 2040 as the base and future year model inputs, respectively. The Laredo MPO provided all inputs and results for the Laredo TDM, including socioeconomic data, model networks, trip tables, and assigned traffic volumes.

The latest version of the Laredo TDM is a daily model using a traditional four-step modeling methodology, including trip generation, trip distribution, and assignment steps. The mode choice step is simplified due to trip generation directly generating auto trips.

2.4.2.2 Laredo TDM Study Area

The Laredo TDM study area is focused on Webb County, as illustrated in Figure 2-24.

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[i] TxDOT-TPP is responsible for developing TDMs to support updates to regional long-range MTPs and associated long-range planning activities within 22 urban areas in Texas. In general, the TDM development process in Texas depends upon cooperation between TxDOT–TPP, TxDOT districts, and the MPOs that TxDOT–TPP assists with their model development. TxDOT–TPP is ultimately responsible for developing and validating the MPO's TDM. The role of MPOs and districts in model development is to provide base- and future-year demographic data and regional roadway information.

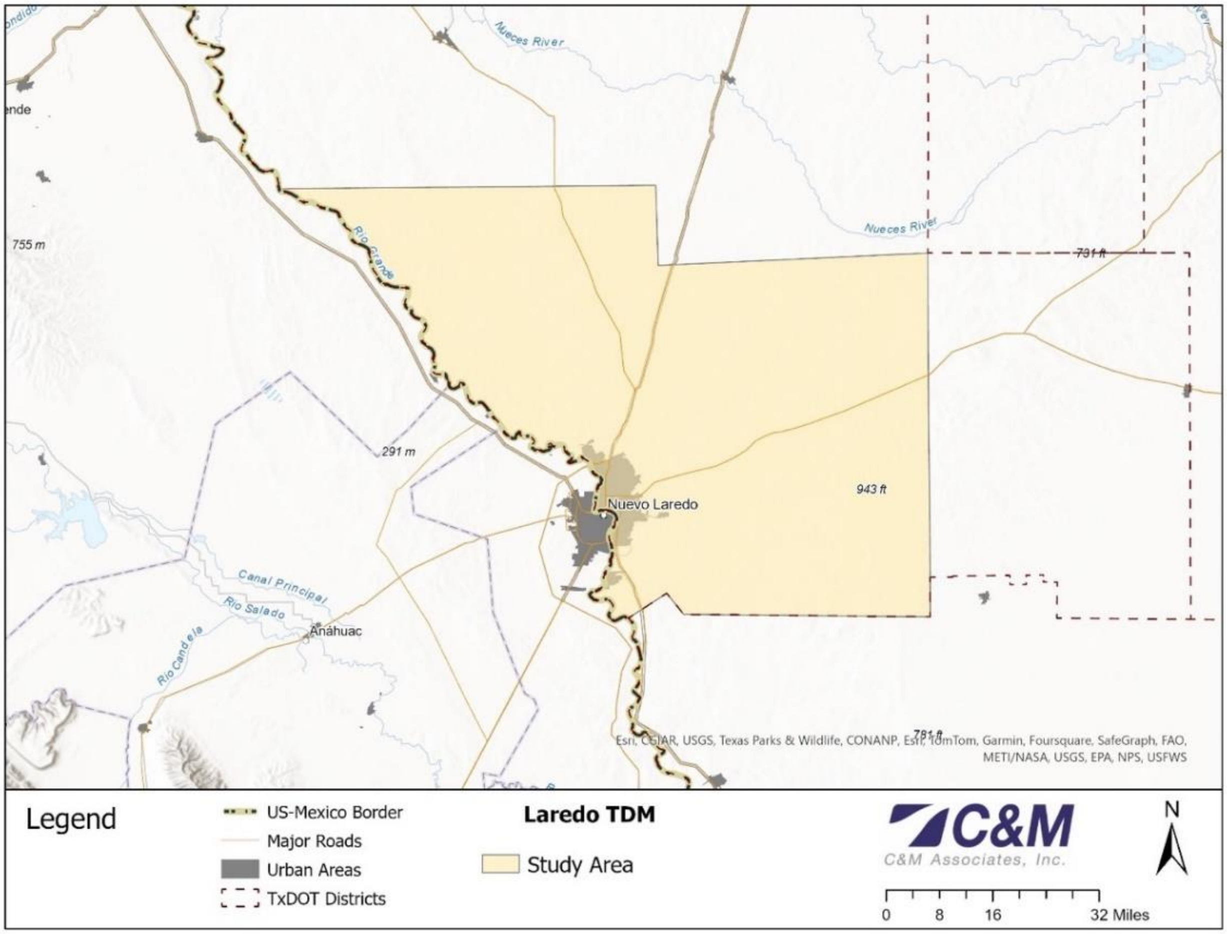


Figure 2-24. Laredo TDM's Study Area

2.4.2.3 Laredo TDM Metrics

The Laredo TDM uses a variety of metrics in each of the model's four steps:

- **Trip Generation** includes metrics such as the number of trips produced and attracted in each TAZ, trips generated per household segmented by trip purpose, and number of trips attracted per employee.
- **Trip Distribution** includes metrics such as trip table matrices which contain both intrazonal trips, average trip length distribution that considers trip distances or travel times for different purposes, and trip travel time distribution.
- **Mode Choice** includes metrics such as mode share that distributes all person trips (including non-motorized, auto, and transit trips), separated as drive alone, shared ride by occupancy, walk access and drive access, and bicycle and walk modes. An estimation of trips by mode and purpose is also considered.
- **Traffic Assignment** primarily comprises traffic volume, which estimates the number of vehicles using a specific road. Other metrics including LOS, vehicle miles traveled, vehicle hours traveled, and congestions indicators were considered in the Laredo MPO TDM.

2.4.3 Lower Rio Grande Valley MPO Travel Demand Model

2.4.3.1 Lower Rio Grande Valley Model Description

The Lower Rio Grande Valley (LRGV) TDM is the traffic planning model of the Rio Grande Valley MPO (RGVMPO) and was developed through a cooperative process between the RGVMPO, TxDOT's Pharr District, and TxDOT–TPP.

The LRGV TDM supports the development of long-range plans in the region and is used to identify transportation system deficiencies and evaluate potential improvements. The LRGV TDM provides future traffic designs for the model area to support the locally developed Texas Mobility Plans, including the long-term 2045 MTP and the short-term Transportation Improvement Program (TIP). As part of the development process for the LRGV TDM, a household survey, an external travel survey, a commercial vehicle survey, and a workplace survey were conducted within Hidalgo and Cameron Counties.

The latest version of the LRGV TDM improves upon previous versions with the following technical features:

- Generalized cost multi-class assignment technique that allows the assignment of commercial vehicle-only and passenger vehicle-only toll lanes, including the assignment of facility types such as high-occupancy vehicle (HOV) and high-occupancy toll (HOT) lanes.
- Time-of-day (TOD) model.
- Generation of person trips rather than direct generation of auto trips.
- Preservation of trips by income category.
- Stronger accounting of commercial vehicle/freight flows.
- Mode choice.

For the model years 2014, 2019, and 2040, the RGVMPO provided all inputs and results for the LRGV TDM, including the inputs and results of the trip generation, trip distribution, and traffic assignment steps.

2.4.3.2 Study Area

The study area of LRGV TDM is focused on Cameron, Hidalgo, Starr, and Willacy Counties, as shown in Figure 2-25.

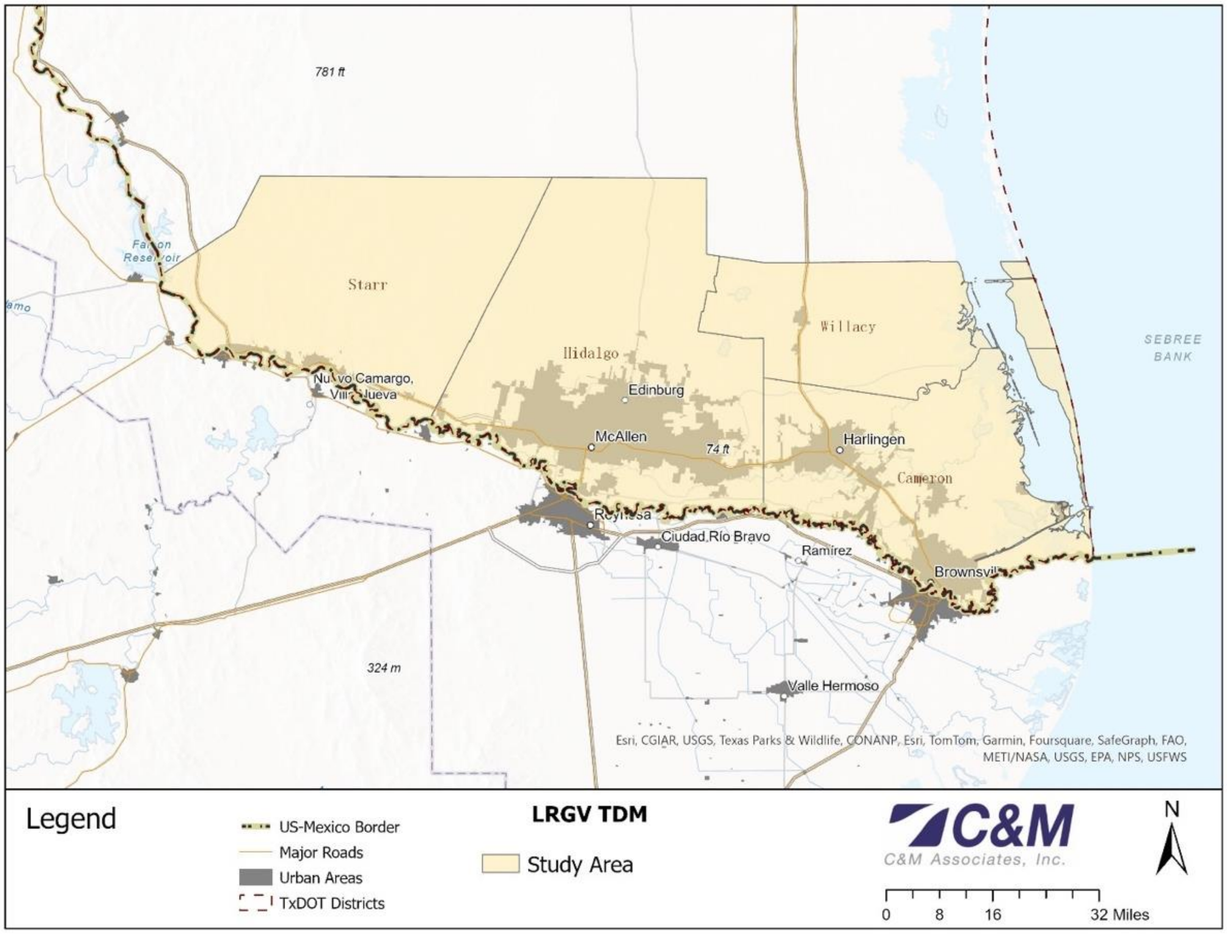


Figure 2-25. LRGV TDM's Study Area

2.4.3.3 LRGV TDM Metrics

The LRGV TDM uses a variety of metrics in each of the model's four steps:

- **Trip Generation** includes metrics such as the number of trips produced and attracted in each TAZ, trips generated per household segmented by trip purpose, and number of trips attracted per employee.
- **Trip Distribution** includes metrics such as trip table matrices which contain both intrazonal trips, average trip length distribution that considers trip distances or travel times for different purposes, and trip travel time distribution.
- **Mode Choice** includes metrics such as mode share that distributes all person trips (including non-motorized, auto, and transit trips), separated as drive alone, shared ride by occupancy, walk access and drive access and bicycle and walk modes. An estimation of trips by mode and purpose is also considered.
- **Traffic Assignment** primarily comprises the traffic volume, which estimates the number of vehicles using a specific road. Other metrics including LOS, vehicle miles traveled, vehicle hours traveled, and congestions indicators were considered in the LRGV TDM.

2.4.4 Texas Statewide Travel Demand Model

2.4.4.1 Texas Statewide Model Description

The Texas SAM, developed by TxDOT and Alliance Transportation Group, is a comprehensive transportation modeling tool for evaluating large intercity transportation projects throughout Texas. The latest available version of the Texas SAM, SAM-V4, was completed in 2017. SAM-V4 established 2015 as the base year and 2025 and 2050 as future forecasted years.

SAM-V4 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. SAM-V4 includes passenger and freight models that follow a traditional four-step structure. Figure 2-26 presents the SAM-V4 model flow chart.

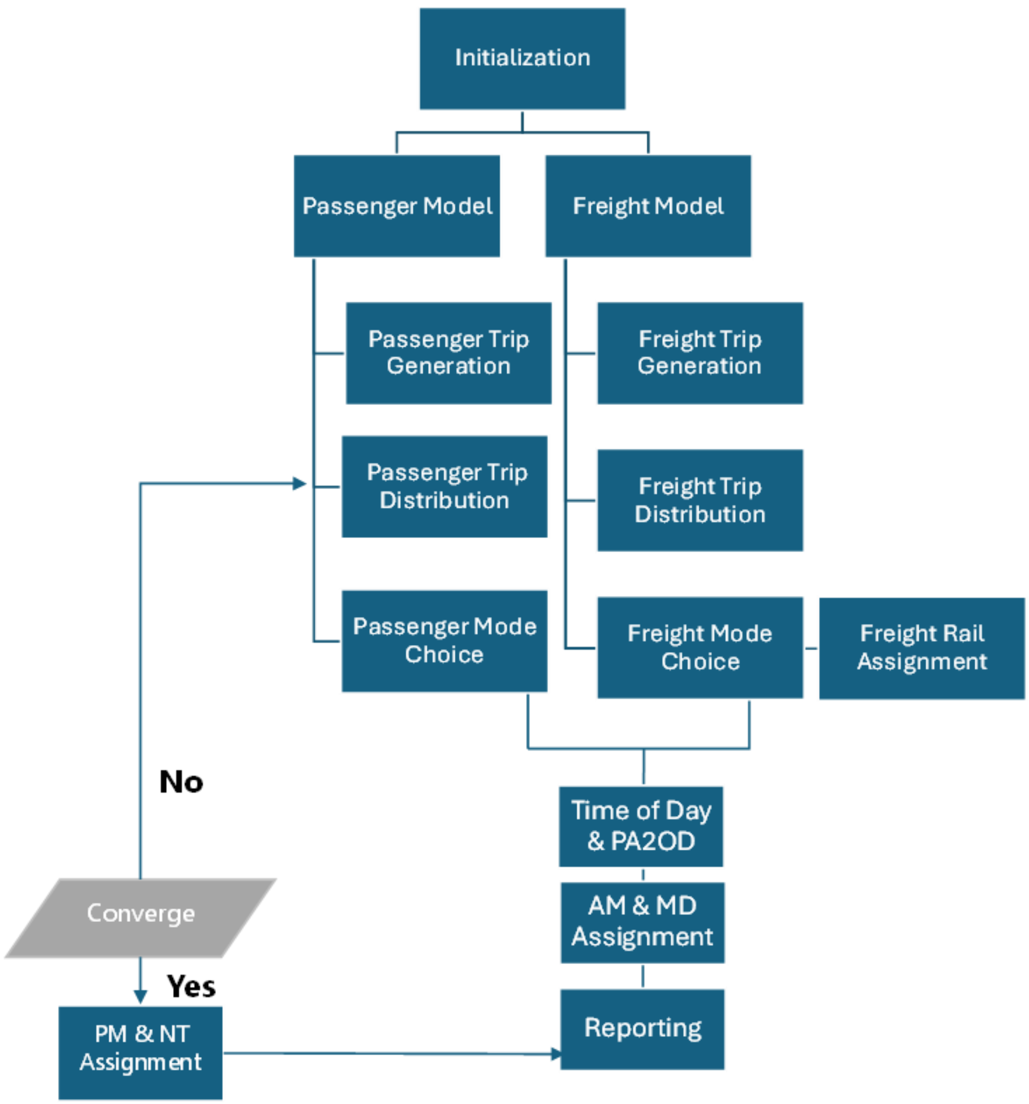


Figure 2-26. Texas SAM-V4 Flow Chart

2.4.4.2 Texas Statewide Model Area

Figure 2-27 shows the model area for Texas SAM-V4. The model includes:

- 254 Texas counties.
- 49 U.S. zones representing states and the District of Columbia (without Texas);
- 32 Mexican States; and
- 13 Canadian Provinces.

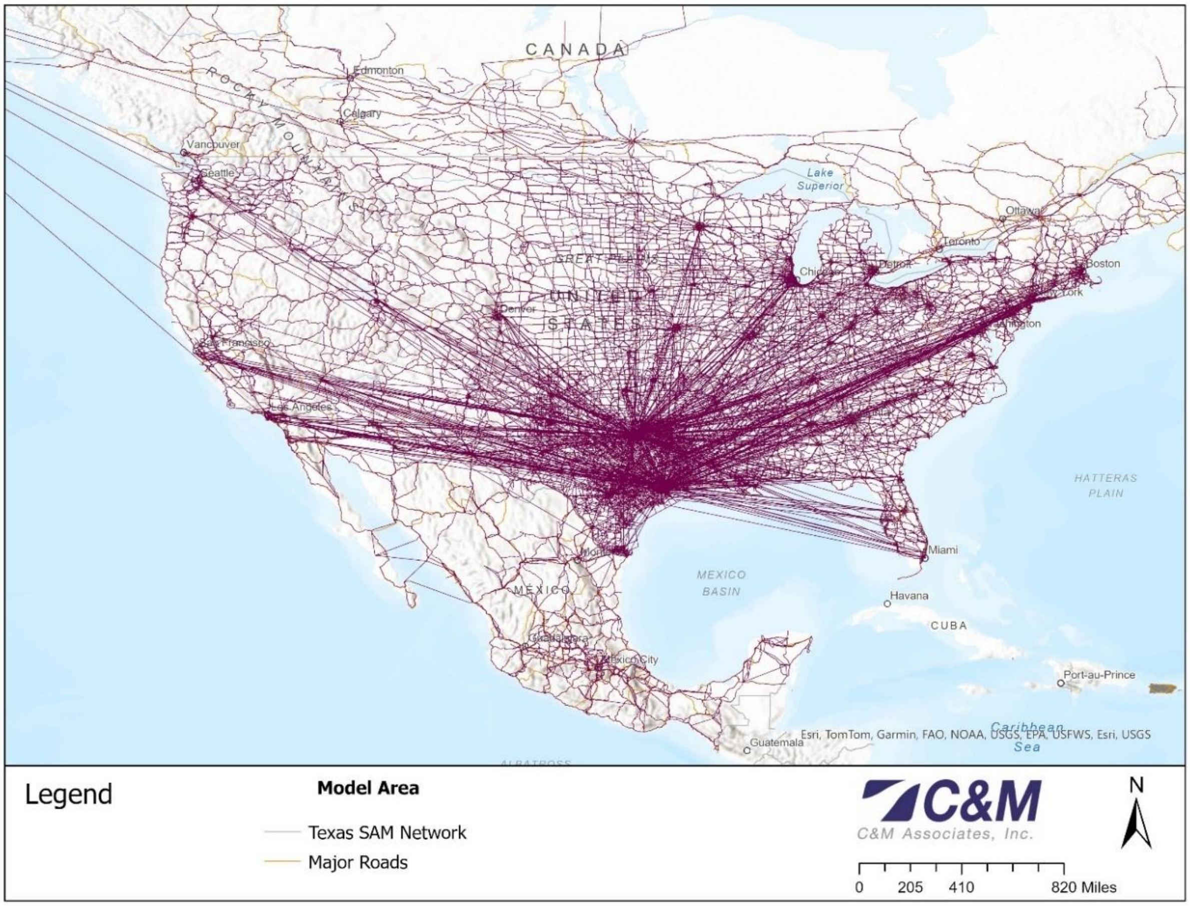


Figure 2-27. Texas SAM-V4 Model Area

2.4.4.3 Texas Statewide Metrics

Texas SAM-V4 uses a variety of metrics in each of the four TDM steps, which will be detailed in Chapter 3:

- **Trip Generation:**
  - Household size and income variables
  - Location size variables
  - Household income sub-models
  - Employment variables
  - Trip production and attraction rates
  - External trips

- **Trip Distribution Metrics:**
    - Destination choice models
    - Trip-length frequency distribution
- **Mode Choice Metrics:**
    - Short-distance mode share model
    - Long-distance mode choice model
- **Traffic Assignment Metrics:**
    - Highway assignment
    - Transit assignment
    - Freight rail tonnage assignment
    - Transearch-based trip table assignment

2.5 Origin–Destination Data Collection

To identify the main regional OD trips within the study area, C&M reviewed information from different available sources to obtain data comparable to the original Texas SAM-V4's version and its 2022 scenario year interpolation. The data collected includes the following sources:

- **Replica** provides multiple datasets and metrics across mobility, demographics, economic activity, and infrastructure.[5] For the mobility datasets, Replica provides a seasonal model with a network-link level granularity. The model represents activities and movements of residents, visitors, and commercial vehicles on a typical weekday and weekend for a given location and season. Furthermore, Replica works with weekly data trends with a national activity-based model updated each week with near-real time data on mobility, consumer spending, and land use down to the Census-tract level.

  C&M based the analysis using the AADT data and hourly auto volume profiles for 2022 as one of Replica's main outputs. This dataset contains information on almost all major roads and is derived from vehicle trajectories from connected vehicle and location-based services data and ground truth network-link volumes.
- **INRIX** provides insights into traffic patterns and congestion and mobility trends from various sources, including GPS data from vehicles and mobile devices.[6] C&M based the analysis using the traffic data and analytics. INRIX gathers and processes traffic information through a comprehensive methodology that combines data from multiple sources and employs advanced analytics. Here is an overview of their methodology:
    - Data Collection: INRIX collects data from GPS-enabled devices, including smartphones, navigation systems, and connected vehicles. This provides real-time information on vehicle locations, speeds, and travel times.
    - Roadside Sensors: Data is also gathered from roadside infrastructure such as cameras, induction loops, and radar sensors that monitor traffic flow and density.
    - Public and Private Data Sources: INRIX integrates data from public agencies, such as Departments of Transportation (DOTs), and private partners, including fleet operators and telematics providers.
- **Texas SAM-V4** provides 2022 model data using Texas SAM-V4 2015-2025 interpolation.

The main results of the comparative analysis are described below.

Figure 2-28 shows the OD pairs for all vehicle classes in the main four districts of the study area: El Paso, Odessa, Laredo, and Pharr. The analysis compares the three sources described above and does not consider intrazonal trips. As shown, all sources identify a similar distribution of OD pairs. For example, Laredo–Pharr is the most relevant pair in the study area, with a value of 26.9% from Replica's data, 27.7% from INRIX's data, and 38.4% from Texas SAM-V4's data. US 83, US 281, and US 359 are the roads most typically used for this OD pair. Other relevant pairs in the area are Phar–Laredo, Odessa–El Paso, and El Paso–Odessa.

There is a slight overestimation of the modeled trips in the Laredo–Pharr and Pharr–Laredo pairs according to the observed data from INRIX and Replica.

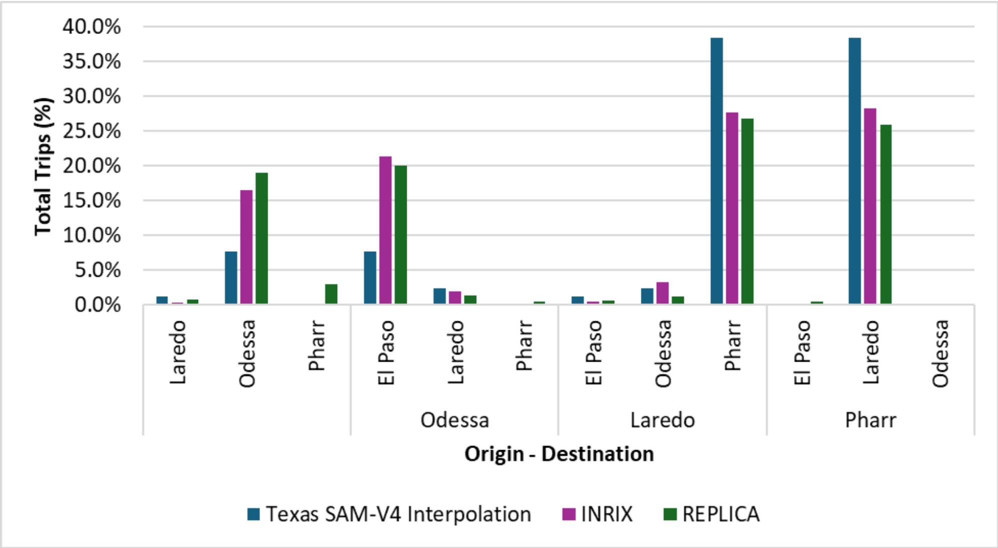


Figure 2-28. Regional OD Trips

Figure 2-29 shows the regional OD pairs from intrazonal trips. As shown, the Pharr–Pharr OD is the most important set of trips in terms of intrazonal trips, with a value of 49.8% from Replica's data, 52.8% from INRIX's data, and 49.4% from Texas SAM-V4's data. Furthermore, slightly lower values are observed in the Texas SAM-V4 interpolation data.

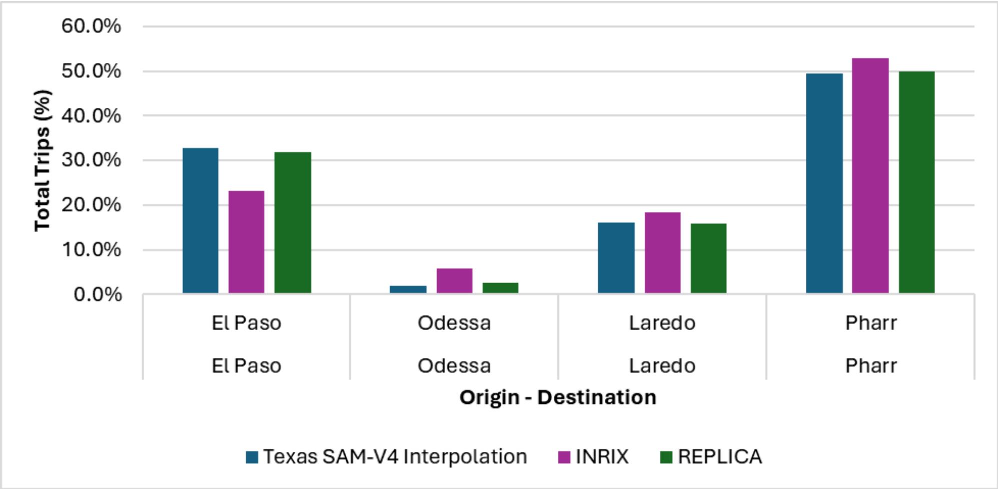


Figure 2-29. Regional OD Intrazonal Trips

2.6 Future Project Data Collection

C&M considered a series of future projects as part of the network updates. For this task, C&M reviewed relevant public information about future infrastructure projects in the study area. The main sources are listed in Table 2-5.

Table 2-5. Sources for Future Projects

Data Source	Link
TxDOT, Project Tracker	https://apps3.txdot.gov/apps-cq/project_tracker/
Texas Freight Mobility Plan 2050	https://ftp.txdot.gov/pub/txdot/move-texas-freight/resources/formatted-appendicestx-delivers-2050.pdf
	https://www.txdot.gov/projects/planning/freight-planning/texas-delivers-2050.html
El Paso MTP Projects	https://www.elpasompo.org/media/MTP/RMS2050MTP/ProjectList/RMS2050MTP_D23-26TIP_2023UTP_ProjectList.pdf
Laredo & Web County MTP Projects	https://www.laredompo.org/wp-content/uploads/2024/01/Resolution_2024-02_MTP.pdf
	https://www.laredompo.org/wp-content/uploads/2022/05/2023-2026-TIP.pdf
Corpus Christi MPO Projects	https://www.corpuschristi-mpo.org/01_mtp/2020-2045/publicmeeting_2/2020-2045_MTP_Project-Map-and-Project-List.pdf
Permian Basin MPO Projects	https://www.permianbasinmpo.com/_files/ugd/61b1ef_a6a1cf2662f143598cd83d2240867b42.pdf
Rio Grande Valley MPO Projects	https://www.rgvmpo.org/home/showpublisheddocument/1486
Alamo MPO MTP & TIP Projects	https://www.alamoareampo.org/Plans/MTP/files/lists/MTP_RDWY_Project_List.pdf
	https://www.alamoareampo.org/Plans/TIP/files/lists/TIP_RDWY_Project_List.pdf

The update process consisted of reviewing the future project list and comparing it with Texas SAM-V4 network data. Once this process was carried out, the network attributes were reviewed and updated for the following fields.

Table 2-6. Network Attributes for Future Projects Review

Network Field	Description
BuiltYear	Year a facility (link) is active. This field is used to control whether a link will be active in a model run year.
RemovedYear	Year a facility (link) is inactive. This field is used to control whether a link will be active in a model run year.
ProjectNetYear	Project year
CSJ	CSJ number for projects if available
ProjSource	Project source
ProjType	Project type
AB_LANES	Number of lanes for AB direction and year or scenario
BA_LANES	Number of lanes for BA direction and year or scenario
PSTEDSP	Roadway posted speed in the year or scenario
FUNCL	Rodway functional class
FTYPE	Roadway facility type

C&M identified 207 future projects on 1,374 network links—including short, medium, and long-term future projects within and near the study area—that were divided into construction, freeway operational improvements, rehabilitation and reconstruction, and widening project types for the fiscal period 2021–2041. Figure 2-30 and Table 2-7 present these future projects.

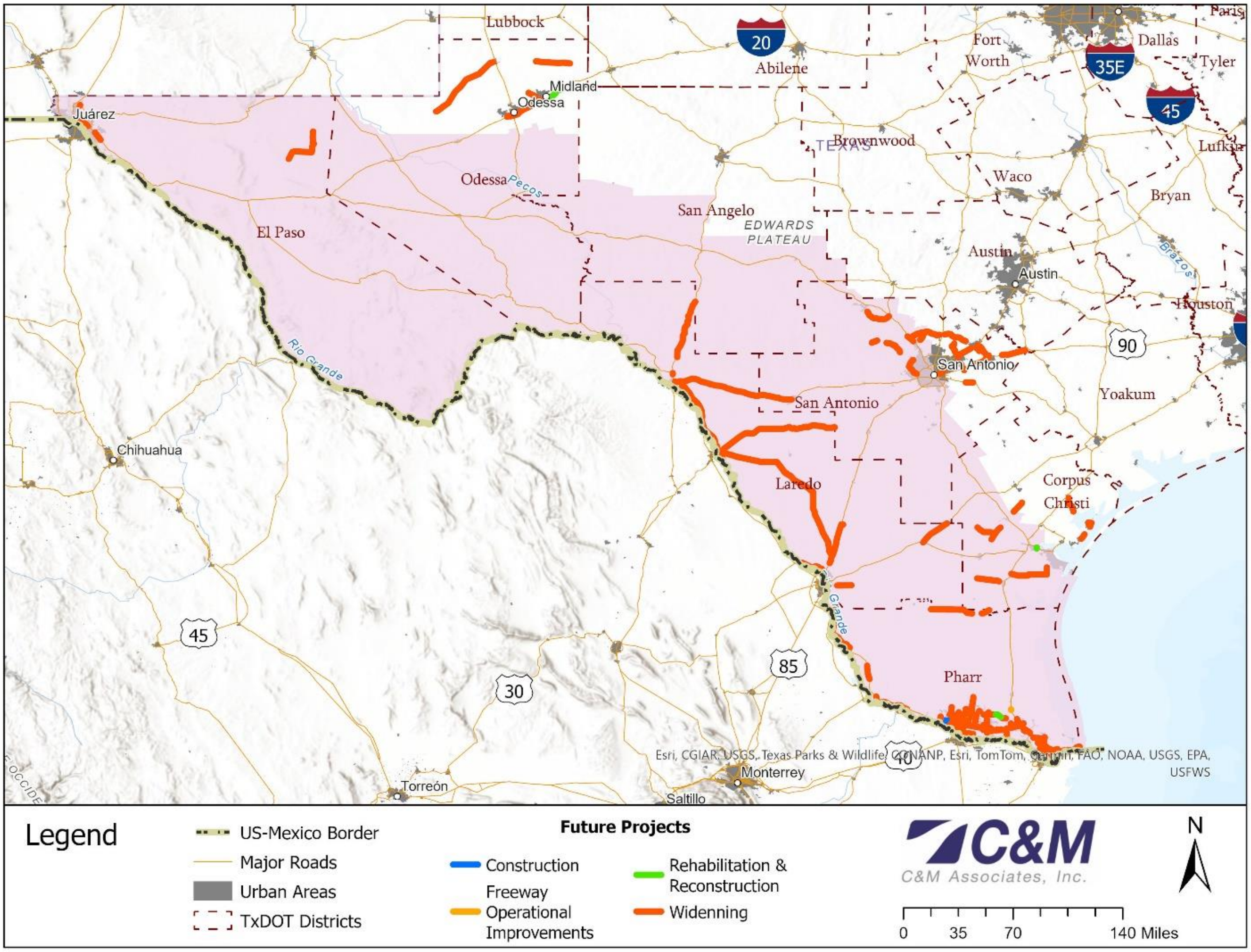


Figure 2-30. Future Projects

Table 2-7. List of Future Projects

District	Year	CSJ	Road	Work	Category
Corpus Christi	2024	15506213	FM 2678	Widen Road - Add Lanes	D
		38303024	SH 141	Super-2 Highway	C
		38304060	SH 141	Widen Road - Add Lanes	D
	2025	8702053	SH 359	Widen Road - Add Lanes	D
	2026	155803114	FM 70	Widen Road - Add Lanes	D
	2028	32601061	SH 286	Super-2 Highway	C
		98901031	FM 624	Super-2 Highway	C
	2030	32601067	SH 286	Super-2 Highway	C
	2034	8705030	SH 359	Widen Road - Add Lanes	D
		18005073	Commercial	Widen Road - Add Lanes	D
		154901055	FM 1781	Widen Road - Add Lanes	D
		155803119	FM 70	Widen Road - Add Lanes and Shoulders	D
		155803120	FM 70	Widen Road - Add Lanes and Shoulders	D
		155803122	FM 70	Widen Road - Add Lanes and Shoulders	D
		155803123	FM 70	Widen Road - Add Lanes	D
		155803124	FM 70	Widen Road - Add Lanes and Shoulders	D
		202301021	FM 2165	Widen Road - Add Lanes	D
		311601029	SH 35	Widen Road - Add Lanes	D
	2037	214201022	FM 2292	Widen Road - Add Lanes	D
El Paso	2021	212104114	I-10	Widen Road - Add Lanes	D
	2025	115805002		Widen Road - Add Lanes and Shoulders	D
	2026	92406625	Railroad Dr	Widen Road - Add Lanes	D
	2033	212103162		Widen Road - Add Lanes and Shoulders	D
	2034	212103163		Widen Road - Add Lanes and Shoulders	D
	2041	212104113	I-10	Widen Road - Add Lanes and Shoulders	D
Laredo	2023	8601073	SH 359	Widen Roadway from 3-Lane to 5-Lane Undivided Highway	D
	2027	1805094	I-35	Widen Freeway	D
		3710041	US 83	Widen Non-Freeway	D
	2030	1803057	I-35	Widen Freeway	D
		1804061	I-35	Widen Freeway	D
		215004092	FM 1472	Widen Road - Add Lanes	D
		215004093	FM 1472	Widen Road - Add Lanes	D
	2033	3710044	US 83	Widen Road - Add Lanes	D
	2034	1804058	I-35	Widen Road - Add Lanes	D
		27601045	US 57	Widen Road - Add Lanes	D
		27602030	US 57	Widen Road - Add Lanes	D
		54204035	US 59	Widen Road - Add Lanes	D
		215004086	FM 1472	Widen Road - Add Lanes	D

District	Year	CSJ	Road	Work	Category
	2035	29914036		Widen Road - Add Lanes	D
	2036	1803060	I-35	Widen Road - Add Lanes and Shoulders	D
		2301101	US 90	Widen Road - Add Lanes	D
		2302045	US 90	Widen Road - Add Lanes	D
		2303052	US 90	Widen Road - Add Lanes	D
		2304068	US 90	Widen Road - Add Lanes	D
		3706109	US 83	Widen Road - Add Lanes	D
		3708045	US 83	Widen Road - Add Lanes	D
		3709035	US 83	Widen Road - Add Lanes	D
		3710046	US 83	Widen Road - Add Lanes	D
		16004052	US 277	Widen Road - Add Lanes	D
		16005051	US 277	Widen Road - Add Lanes	D
		16006036	US 277	Widen Road - Add Lanes	D
		16007035	US 277	Widen Road - Add Lanes	D
		27603044	US 57	Widen Road - Add Lanes	D
		27604032	US 57	Widen Road - Add Lanes	D
		27605029	US 57	Widen Road - Add Lanes	D
		29901077	US 277	Widen Road - Add Lanes	D
		29902038	US 277	Widen Road - Add Lanes	D
		29903075	US 277	Widen Road - Add Lanes	D
		29904084	US 277	Widen Road - Add Lanes	D
		30001110	US 277	Widen Road - Add Lanes	D
		30002044	US 277	Widen Road - Add Lanes	D
		30003080	US 277	Widen Road - Add Lanes	D
	2039	23702020	SH 44	Widen Road - Add Lanes	D
Odessa	2024	513064	I-20	Widen Freeway	D
		514093	I-20	Widen Freeway	D
		514094	I-20	Widen Freeway	D
	2025	35404044	SH 115	Widen Road - Add Lanes and Shoulders	D
		35406040	SH 115	Widen Road - Add Lanes and Shoulders	D
		35406042	SH 115	Widen Road - Add Lanes and Shoulders	D
	2026	54802042	SH 176	Rehabilitation of Existing Road	C
	2027	514092	I-20	Widen Freeway to 6 Lanes, Reconstruction of Frontage Roads, Ramps, U-turns, Interchanges. Convert Frontage Roads to One-Way Operation. Widen from 4 to 6 Lanes.	C
		35404043	SH 115	Widen Road - Add Lanes and Shoulders	D
		35406041	SH 115	Widen Road - Add Lanes and Shoulders	D
	2029	407135	I-20	Widen Freeway to 6 Lanes, Reconstruction of Frontage Roads, Ramps, U-turns, Interchanges. Convert Frontage Roads to One-Way Operation. Widen from 4 to 6 Lanes.	C

District	Year	CSJ	Road	Work	Category
		513063	I-20	Widen Freeway	D
	2030	515093	I-20	Reconstruction of Frontage Roads, Ramps, U-turns, Interchanges. Convert Frontage Roads to One-Way Operation. Widen from 4 to 6 Lanes.	C
	2040	46302076	SH 158	Widen Road - Add Lanes	D
Pharr	2023	92102327	S TAYLOR RD	Widen from 2 to 4 lanes Roadway	D
		106401032	MILE 5 N/FM 676	Widen from 2 to 4 Lane Divided	D
	2024	86401068	N SHARY RD/FM 494	Widen from 2 to 4 Lanes	D
		106401043	MILE 5 N/FM 676	Widen from 2 to 4 Lane Divided	D
		180302035	E MONTE CRISTO RD/FM 1925	Widen from 2 to 4 Lane Divided	D
	2025	52801118	SH 107/N CONWAY AVE	Widen from 4 to 6 Lanes with Raised Median	D
		92102512	N BENTSEN RD	Widen to 4 Lanes and Continuous Turn Lane with Curb and Gutter	D
		106401027	MILE 5 N/FM 676	Widen from 2 to 4 Lanes with Left Turn Lane	D
		180301092	W MONTE CRISTO RD/FM 1925	Widen from to 2 to 6 Lanes with Raised Median	D
	2026	22004050	US 281/MILITARY HWY	Widen from 2 to 4 Lanes, Rural	D
		86501108	MILE 1 N	Construct 4-Lane Divided Urban Section	A
		92102194	LIBERTY BLVD	Widening and New Location, from 2 to 4 Lanes with Dedicated Left Turn Lane	D
		92102440	W FREDDY GONZALEZ DR	Widen and Reconstruct to 4 Lanes Divided Urban	C
		92102447	MILE 6 W	Widen from 2 to 4 Lanes	D
	2027	271701027	E ALTON GLOOR BLVD	Widen from 4 to 6 Lanes with Raised Median	D
	2028	3804064	US 83	Widen Road - Add Lanes	D
	2029	34203040	FM 107	Widen from 2 to 4-Lane Roadway	D
		69802060	MILE 5 W/FM 88	Widen from 2 to 4 Lanes	D
		92106290	OLD AICE RD	Widen from 2 to 4-Lane Urban Roadway	D
	2030	3805043	US 83	Widen Road - Add Lanes	D
		92102449	W 6TH ST	Widen to 4 Lanes	D
		92102466	W SPRAGUE ST	Widen to 4 Lanes	D
		92102468	W TRENTON RD	Widen 6 Lanes Divided with Landscaped Median	D
	2034	3802033	US 83	Widen Road - Add Lanes	D
		3803038	US 83	Widen Road - Add Lanes	D
		3803039	US 83	Widen Road - Add Lanes	D
	2035	3912057	BUS 77	Widen from 4 to 6 Lanes with Raised Median	D
		10207046	SH 285	Widen Road - Add Lanes	D
		32710063	I-69 E/US 77	Freeway Operational Improvements	B
		34202052	STATE HWY 107	Reconstruct and Widen to 4 Lane, Rural	C
		48202034	SH 285	Widen Road - Add Lanes	D
		48203034	SH 285	Widen Road - Add Lanes	D
		62101112	N 10TH ST/SH 336	Widen to 6 Lanes	D

District	Year	CSJ	Road	Work	Category
		66901062	MOORE FIELD RD/FM 681	Widen Roadway	D
		92102451	N AIRPORT DR	Widen to 4 Lanes	D
		92102453	S BORDER AVE/MILE 5 1/5 W	Widen Road - Add Lanes	D
		92102455	BENTSEN PALM DR	Widen to 4 Lanes Divided	D
		92102457	JACKSON AVE	Widen to 4 Lanes	D
		92102459	MILE 6 N	Widen to 4 Lanes	D
		92102463	W SCHUNIOR ST	Widen to 4 Lanes	D
		92102467	N SUGAR RD	Widen to 4 Lanes	D
		92102469	S WESTGATE DR/MILE 6 W	Widen to 4 Lanes Divided	D
		158601075	ALAMO RD/FM 907	0	D
		180202014	NOLANA LP/FM 3461	Widen to 6 Lanes	D
	2040	3806050	US 83	Widen Road - Add Lanes	D
		3807076	US 83	Widen Road - Add Lanes	D
		3807077	US 83	Widen Road - Add Lanes	D
		3807079	US 83	Widen Road - Add Lanes	D
		3901098	US 83	Widen Road - Add Lanes	D
		3903108	BUS 83	Widen Road - Add Lanes	D
		3904131	BUS 83	Widen Road - Add Lanes	D
		3906048	BUS 83	Widen Road - Add Lanes	D
		3907261	I-69 E/US 77	Widen Road - Add Lanes	D
		3910085	BOCA CHICA BLVD	Widen Road - Add Lanes and Shoulders	D
		3910092	W ELIZABETH ST	Widen Road - Add Lanes	D
		3910094	SH 4	Widen Road - Add Lanes	D
		21901063	MILITARY HWY/FM 1016	Widen Road - Add Lanes	D
		21901064	S CONWAY AVE/SH 107	Widen Road - Add Lanes	D
		22004056	MILITARY HWY	Widen Road - Add Lanes and Shoulders	D
		22005082	BOCA CHICA BLVD	Widen Road - Add Lanes and Shoulders	D
		22005085	BOCA CHICA BLVD	Widen Road - Add Lanes	D
		22007070	SH 48/BRO-PORT ISABEL HWY	Widen Road - Add Lanes	D
		25507151	I-69C/US 281	Widen Road - Add Lanes	D
		25509107	INTERNATIONAL BLVD/US 281	Widen Road - Add Lanes	D
		25511023	S CLOSNER BLVD/BUS 281	Widen Road - Add Lanes and Shoulders	D
		32708110	BUS 77	Widen Road - Add Lanes	D
		33101051	SH 100	Widen Road - Add Lanes and Shoulders	D
		34201096	EDINBURG AVE	Widen Road - Add Lanes and Shoulders	D
		34201097	EDINBURG AVE	Widen Road - Add Lanes and Shoulders	D
		34202058	SH 107	Widen Road - Add Lanes	D
		62101111	0	Widen Road - Add Lanes and Shoulders	D
		68401076	FM 511	Widen Road - Add Lanes	D
		68401077	FM 511/N INDIANA AVE	Widen Road - Add Lanes	D

District	Year	CSJ	Road	Work	Category
		68401078	SH 550 RAMP	Widen Road - Add Lanes	D
		68401079	SH 550 RAMP	Widen Road - Add Lanes	D
		68402030	FM 511/DOCKBERRY	Widen Road - Add Lanes	D
		69803105	S TEXAS BLVD/FM 88	Widen Road - Add Lanes	D
		86101072	TEXAS AVE	Widen Road - Add Lanes	D
		86301079	N SALINAS RD/FM 493	Widen Road - Add Lanes	D
		87204036	FM 506	Widen Road - Add Lanes and Shoulders	D
		87301028	FM 507	Widen Road - Add Lanes and Shoulders	D
		106502043	OSCAR WILLIAMS	Widen Road - Add Lanes and Shoulders	D
		113601021	FM 800/BASS BLVD	Widen Road - Add Lanes and Shoulders	D
		114003019	FM 802	Widen Road - Add Lanes and Shoulders	D
		150401040	INTERNATIONAL BLVD	Widen Road - Add Lanes and Shoulders	D
		180101058	FM 1847/PAREDES LINE RD	Widen Road - Add Lanes and Shoulders	D
		180101060	FM 1847	Widen Road - Add Lanes and Shoulders	D
		180101061	FM 1847/PAREDES LINE RD	Widen Road - Add Lanes and Shoulders	D
		180401085	SPUR 115	Widen Road - Add Lanes and Shoulders	D
		180401086	N 23RD ST/FM 1926	Widen Road - Add Lanes and Shoulders	D
		236901034	FM 509	Widen Road - Add Lanes and Shoulders	D
		271702011	DR HUGH EMERSON BLVD	Widen Road - Add Lanes and Shoulders	D
		304401016	FM 2994/WILSON RD	Widen Road - Add Lanes and Shoulders	D
		309801020	W DICKER RD/FM 3072	Widen Road - Add Lanes and Shoulders	D
San Antonio	2021	1606047	I-35	Widen Road - Add Lanes	D
	2022	2503097	I-10	Widen Road - Add Lanes	D
	2023	1710168	I-35	Added Capacity: Non-Toll	D
		29106053	SH 16	Widen Non-Freeway	D
		350801029	SH 151	Added Capacity: Non-Toll	D
	2024	46502027	FM 1518	Added Capacity: Non-Toll	D
		91546045	RUDELOFF RD	Added Capacity: Non-Toll	D
	2025	1710292	I-35	Widen Freeway	D
	2026	21509029	FM 725	Added Capacity: Non-Toll	D
		223001020	FM 1560	Added Capacity: Non-Toll	D
		223001021	FM 1560	Added Capacity: Non-Toll	D
	2027	14303049	US 87	Widen Non-Freeway	D
	2028	1605111	I-35	Added Capacity: Non-Toll	D
		1606115	I-35	Added Capacity: Non-Toll	D
		53501077	I-10	Added Capacity: Non-Toll	D
	2033	2503101	I-10	Added Capacity: Non-Toll	D
		21501051	SH 46	Added Capacity: Non-Toll	D
		21501054	SH 46	Widen Road - Add Lanes	D
		21502059	SH 46	Widen Road - Add Lanes	D

District	Year	CSJ	Road	Work	Category
		21506045	SH 46	Widen Road - Add Lanes	D
		21507049	SH 46	Added Capacity: Non-Toll	D
		21507052	SH 46	Widen Road - Add Lanes	D
		29107033	SH 16	Widen Road - Add Lanes	D
		29108023	SH 16	Widen Road - Add Lanes	D
	2034	7206082	I-10	Added Capacity: Non-Toll	D
		7206089	I-10 FRONTAGE RD	Added Capacity: Non-Toll	D
		53502047	I-10	Added Capacity: Non-Toll	D
		321204008	FM 3351	Added Capacity: Non-Toll	D
		321205014	FM 3351	Added Capacity: Non-Toll	D
	2035	1605129	I-35	Widen Road - Add Lanes	D
		2305091	US 90	Widen Road - Add Lanes	D
		14205083	SH 27	Widen Road - Add Lanes	D
		14206027	SH 27	Widen Road - Add Lanes	D
		21601059	SH 46	Added Capacity: Non-Toll	D
		21602067	SH 46	Added Capacity: Non-Toll	D
		310701046	FM 3009	Widen Road - Add Lanes	D

* A: Construction, B: Freeway Operational Improvements, C: Rehabilitation & Reconstruction, D: Widening

2.7 Travel Times Data Collection

C&M utilized Google's API to gather diverse travel time data categorized by TOD for various routes.[7] First, seven major cities within the study area were identified, encompassing a 100-mile buffer from the U.S.–Mexico border, including Brownsville, McAllen, Corpus Christi, Laredo, San Antonio, Odessa, and El Paso. Subsequently, based on Google Maps' route suggestions and the highest traffic volume, C&M developed 42 routes on Google Earth.

To acquire extensive trip time data, C&M used Google's Distance Matrix API, which estimates journey times between several sites while taking current traffic conditions into consideration. This API makes use of Google's extremely comprehensive and often updated traffic data collected from a variety of sources, including road sensors, anonymized mobile phone locations, and user contributions. C&M was able to collect vast datasets of journey times by iterating through various route combinations and time periods utilizing the API.

Employing an R package to interface with the API, C&M extracted the travel times for these routes across various TODs, such as AM hours, midday (MD) hours, PM hours, and nighttime (NT) hours. The Google API provided access to real-time traffic data as well as historical data, enabling C&M to capture accurate travel time estimates accounting for factors like congestion and recurring patterns like rush hour effects. Figure 2-31 through Figure 2-37 illustrate the collected data, showcasing the travel times for different routes to and from all seven locations. Given the long distances of the selected routes, it is observed that travel times vary primarily with the length of the routes. Additionally, there are minor variations in travel times within different time periods due to congestion, which is more significant in urban areas. The collected travel times will serve as a baseline for calibrating the modeled travel times. More details will be provided in Chapter 3.

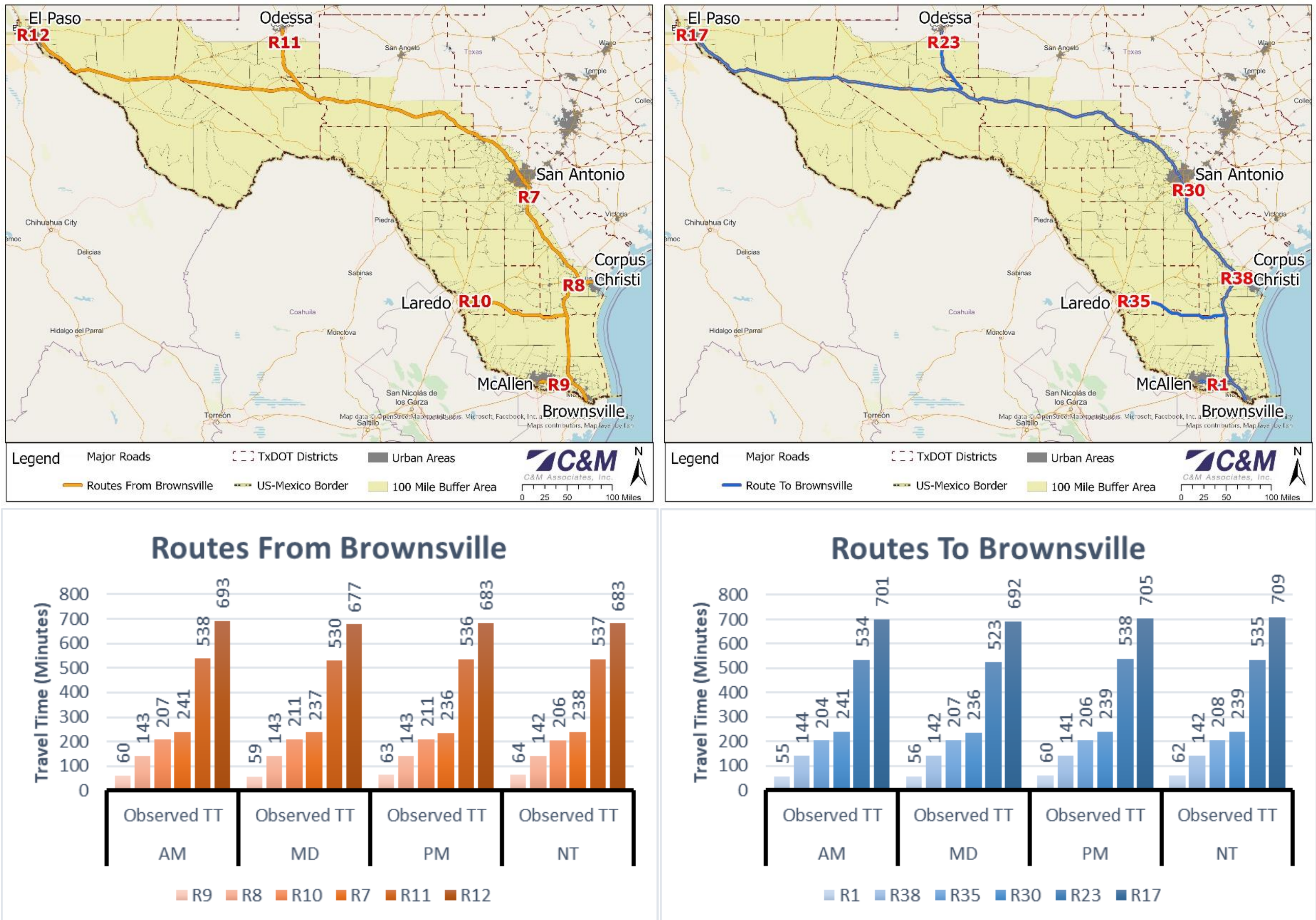


Figure 2-31. Routes to and from Brownsville and Observed Travel Times by TOD

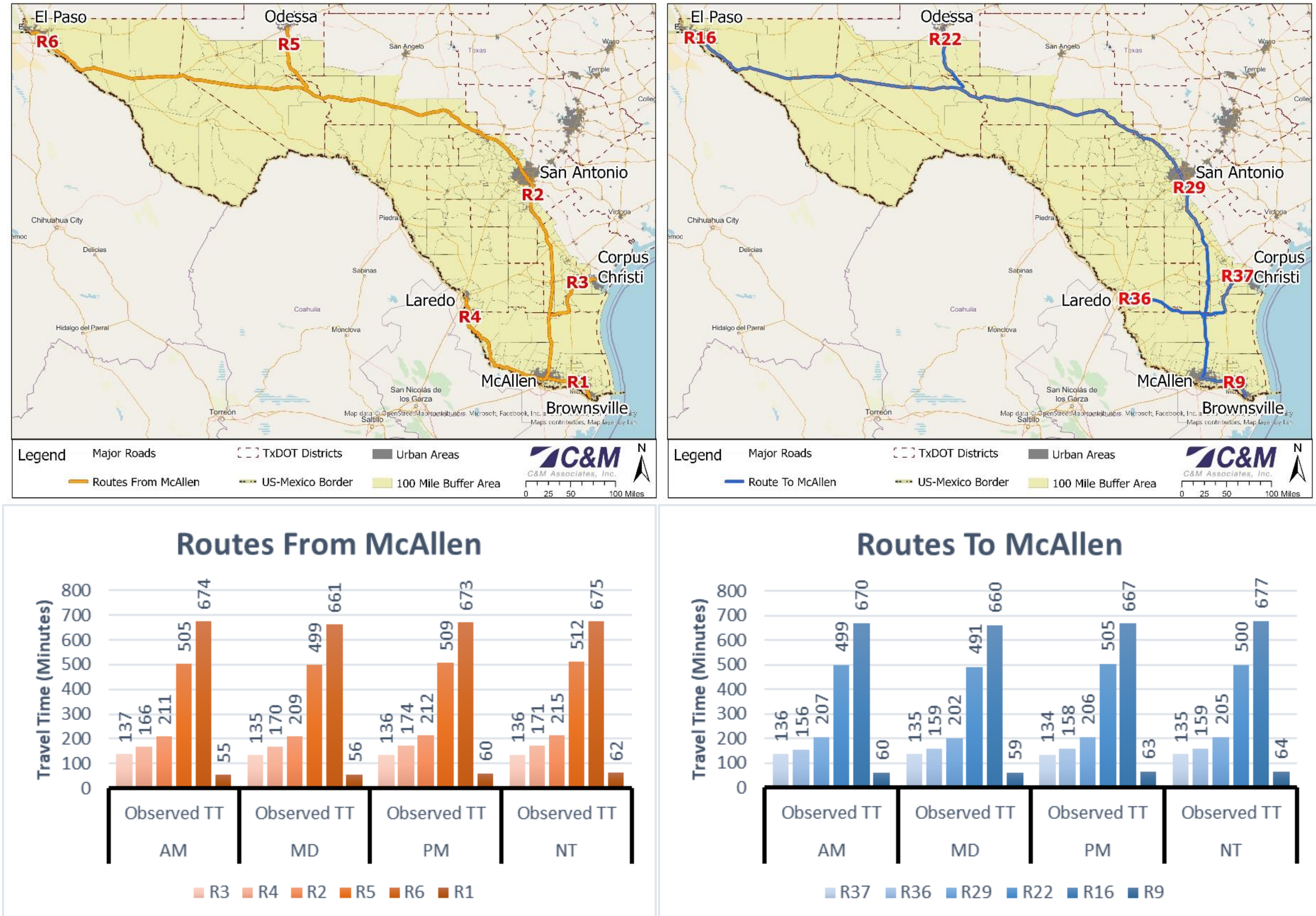


Figure 2-32. Routes to and from McAllen and Observed Travel Times by TOD

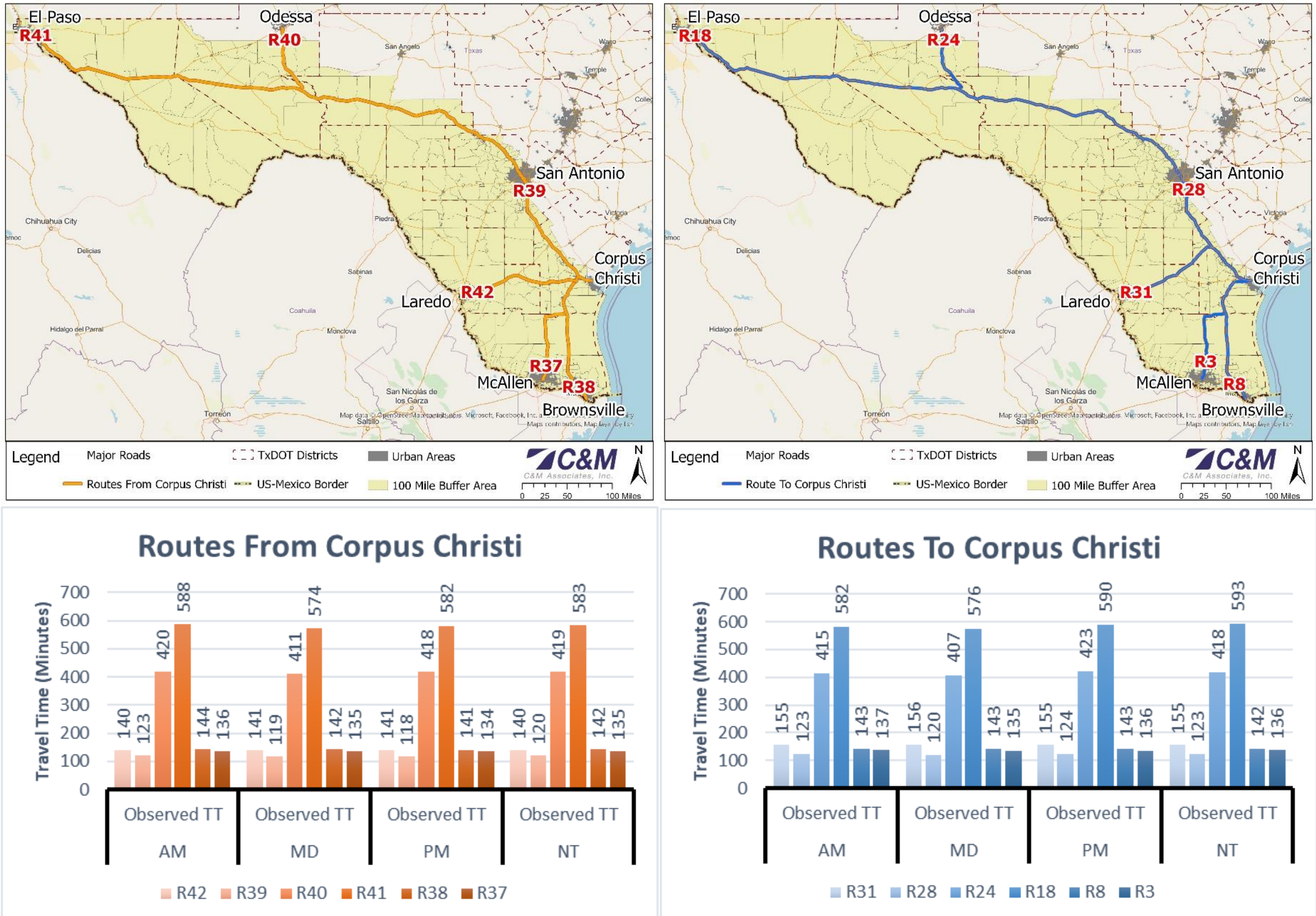


Figure 2-33. Routes to and from Corpus Christi and Observed Travel Times by TOD

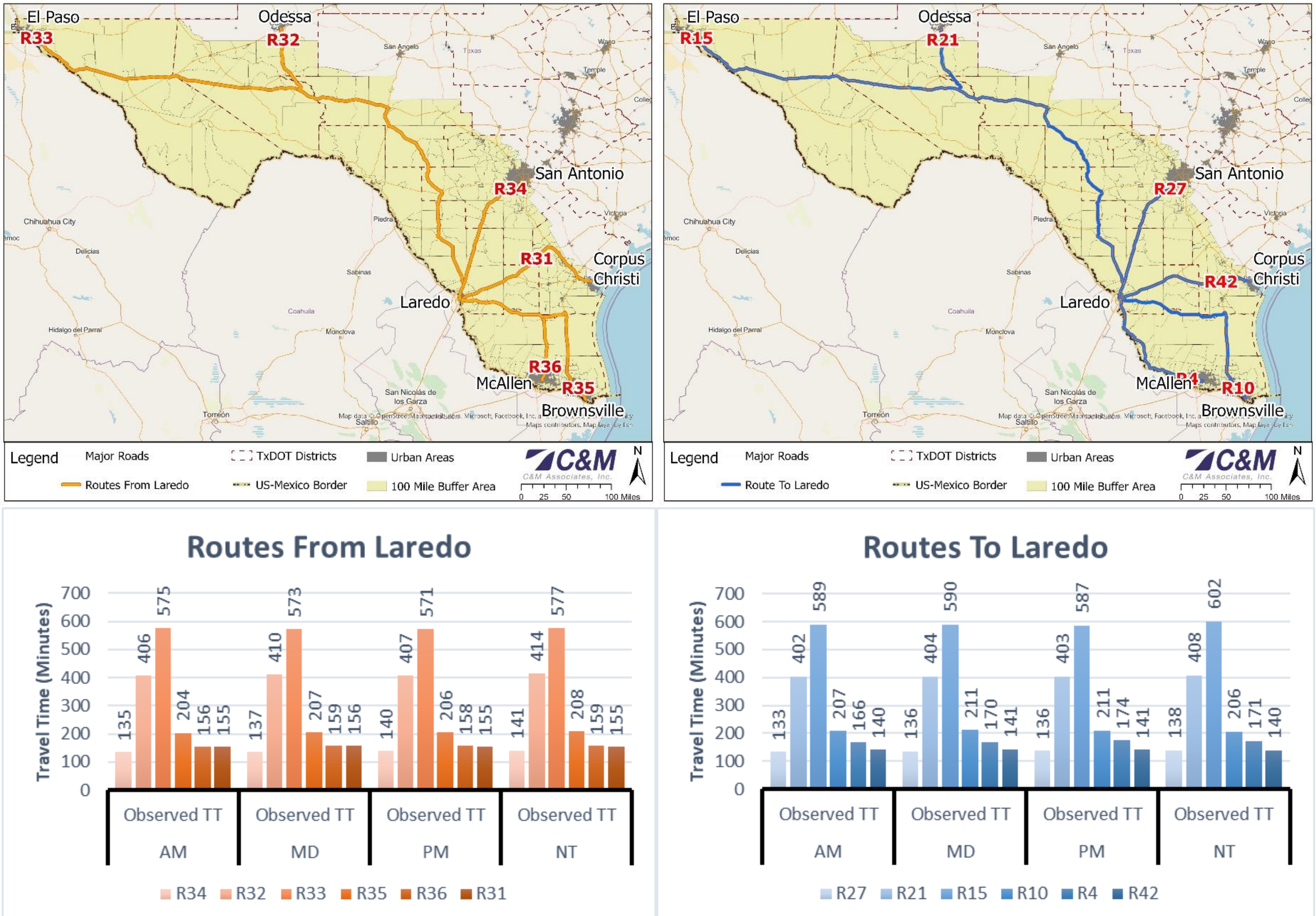


Figure 2-34. Routes to and from Laredo and Observed Travel Times by TOD

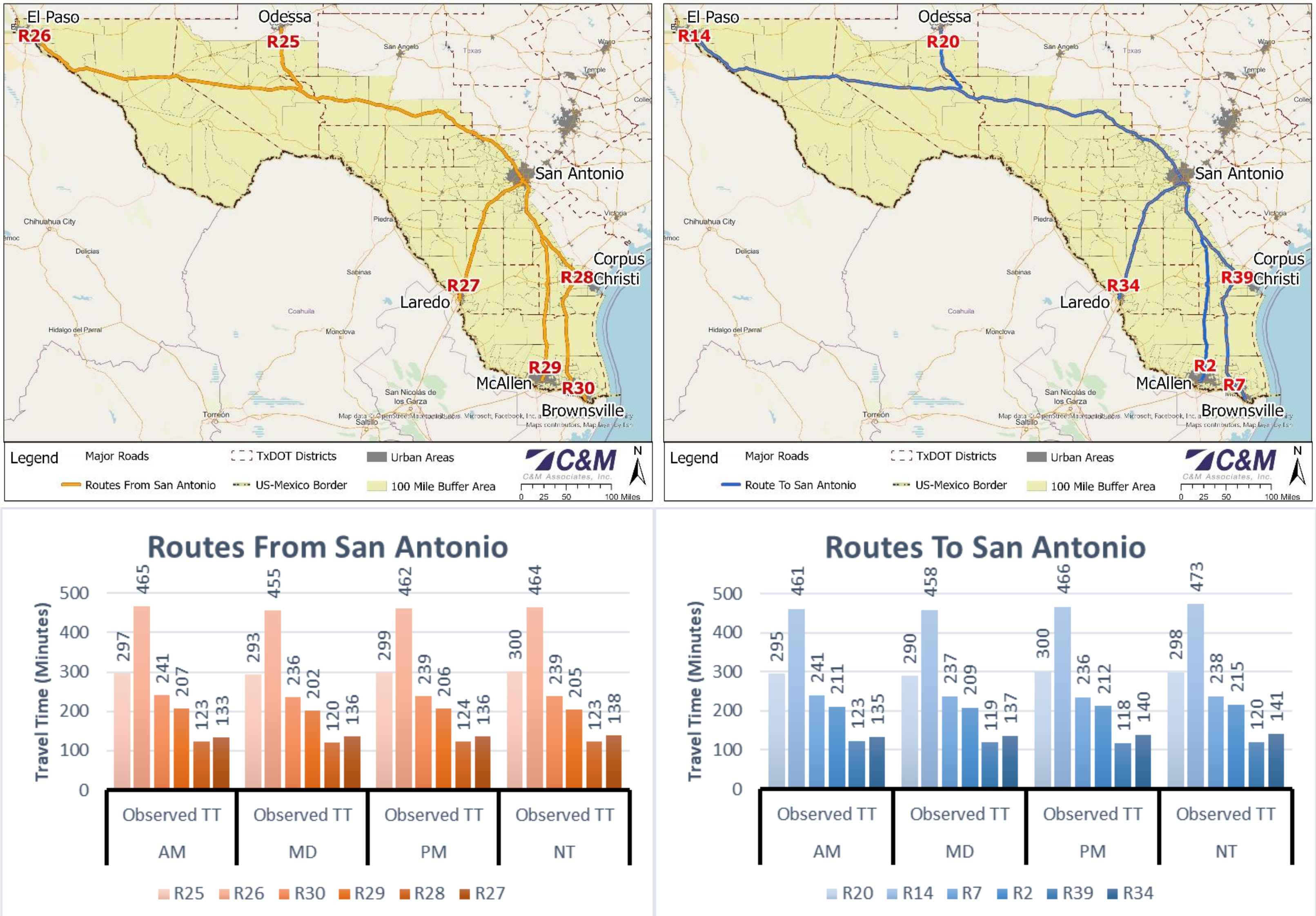


Figure 2-35. Routes to and from San Antonio and Observed Travel Times by TOD

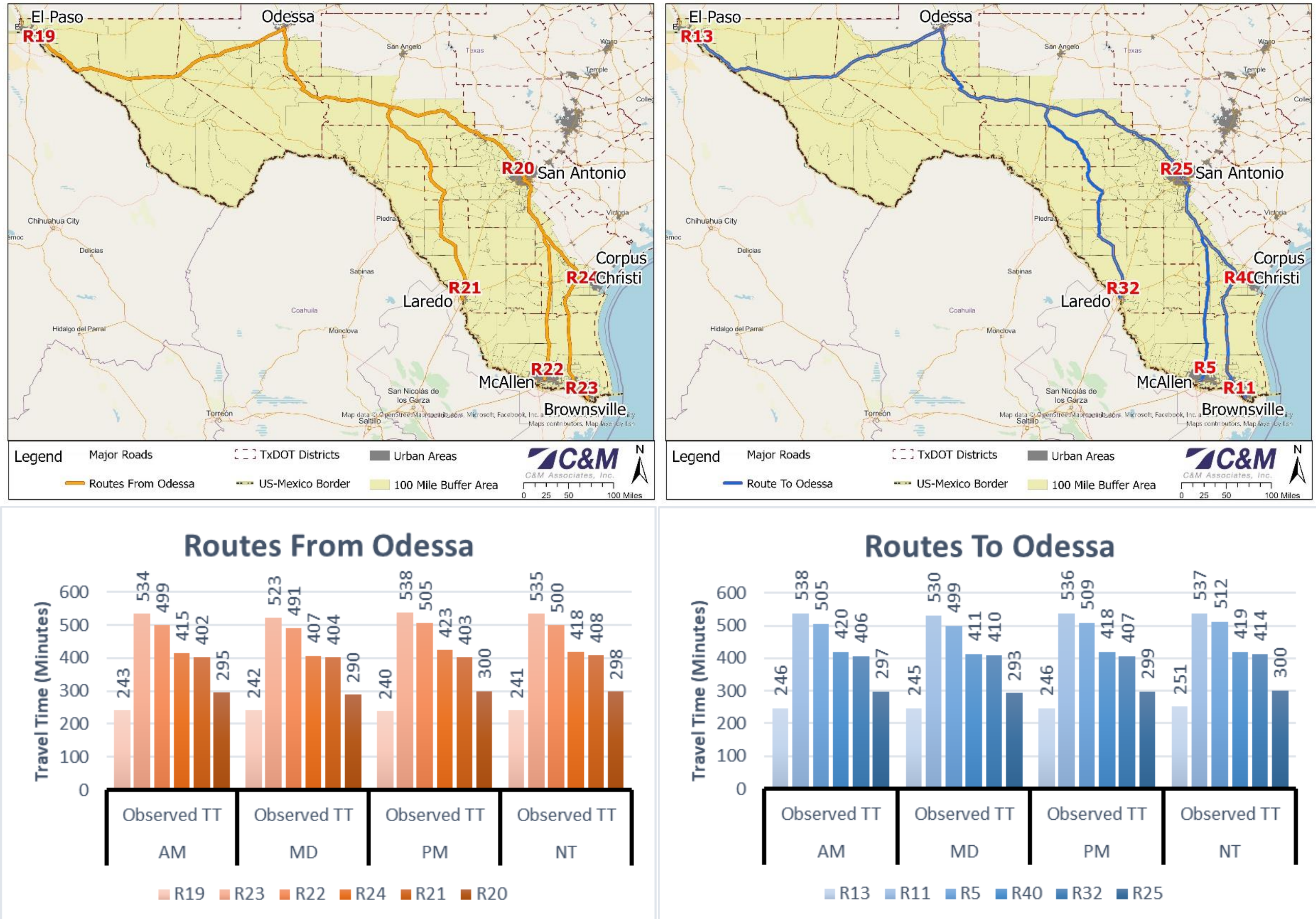


Figure 2-36. Routes to and from Odessa and Observed Travel Times by TOD

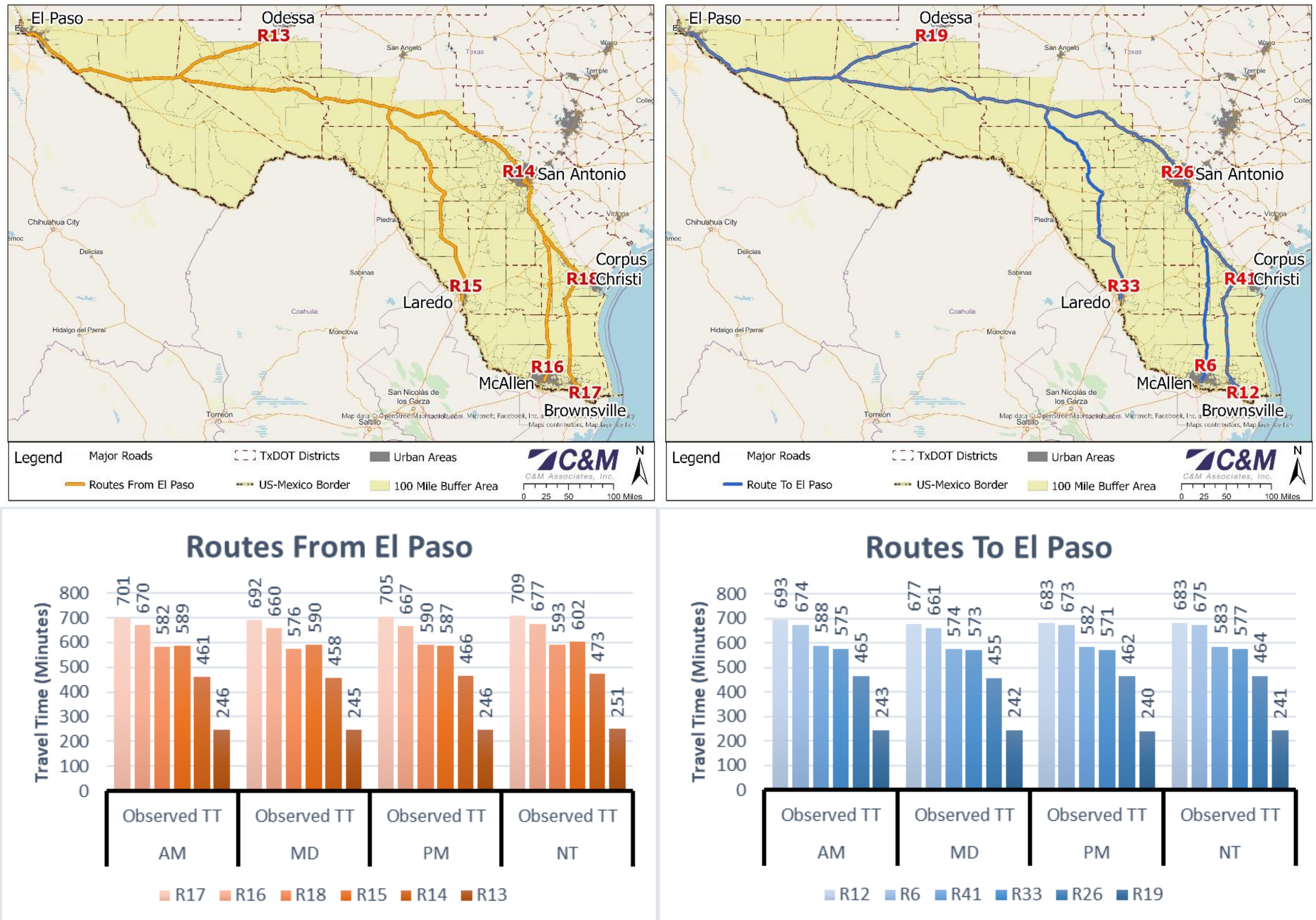


Figure 2-37. Routes to and from El Paso and Observed Travel Times by TOD

[1] Texas Department of Transportation (n.d.). *Traffic Count (TCDS).* Retrieved February 12, 2024, from http://txdot.ms2soft.com/tcds/tsearch.asp?loc=Txdot&mod=

[2] Texas Department of Transportation (2024, March 14). *TxDOT AADT Annuals*. https://gis-txdot.opendata.arcgis.com/datasets/txdot-aadt-annuals/explore

[3] Bureau of Transportation Statistics (n.d.). *Border crossing data.* Retrieved May 3, 2024, from https://data.bts.gov/stories/s/jswi-2e7b

[4] U.S. Customs and Border Protection (n.d.). *Border Crossing/Entry Data.* Retrieved June 13, 2024, from https://data.bts.gov/stories/s/jswi-2e7b

[5] Replica (n.d.). *Traffic datasets.* Retrieved December 18, 2023, from https://www.replicahq.com/

[6] INRIX (n.d.). *Traffic data*. Retrieved December 18, 2023, from https://inrix.com/

[7] Google (n.d.). *Google Cloud Distance Matrix API.* Retrieved April 4, 2024, from https://console.cloud.google.com/apis/library/distance-matrix-backend.googleapis.com

Chapter 3: Existing Conditions & Needs Assessment

In this chapter, C&M presents its efforts related to the analysis of existing conditions and the current needs assessment, with a focus on TDM updates, to reflect the most up-to-date conditions. The chapter describes the process of updating the socioeconomic data for the TDM inputs by providing a review of historical and forecasted socioeconomic data for the State of Texas. C&M evaluated the most recent socioeconomic data within the study area for the purposes of travel demand modeling, with a focus on the counties that lie along the U.S.–Mexico border. Moreover, the Texas SAM model update efforts are also presented, including passenger and freight models, base network updates, and the calibration process and evaluation.

3.1 Socioeconomic Data

The primary purpose of this updated socioeconomic review is to evaluate the socioeconomic model inputs to C&M's TDM and ensure C&M's results reflect the latest outlook of the study area. The analysis includes the socioeconomic data from the regional TDMs along the border area which includes the El Paso, Laredo, and LRGV TDMs. C&M further reviewed socioeconomic data from both public and private sources, targeting consolidated findings to serve as references and assessments for the travel demand modeling procedures and T&R forecasting.

Sources for the historical data analysis and base year estimates include the following,

- LRGV, Laredo, and El Paso regional TDMs
- Texas SAM
- U.S. Decennial Censuses[1]
- Population Estimates Census[2]
- U.S. Census Bureau, American Community Survey (ACS)[3]
- Texas Demographic Center (0.5 and 1.0 Migration Scenarios) (TDC)[4]
- Woods & Poole Economics, Inc. (W&P)[5]
- Texas Water Development Board (TWDB)[6]
- U.S. Bureau of Economic Analysis (BEA)[7]
- U.S. Bureau of Labor Statistics (BLS)[8]
- Texas Labor Market Information (TexasLMI)[9]
- Moody's Analytics (Moody's)[10]
- U.S. Census Bureau's County Business Patterns (Census CBP)[11]
- Annual Survey of Public Employment and Payroll (ASPEP)[12]
- Integrated Postsecondary Education Data System (IPEDS)[13]

C&M consulted historical data from the ACS, including both 1-year (2019) and 5-year estimates. Typically, data from the ACS 1-year estimates are used for historical socioeconomic trend analysis. However, these estimates are only available for geographical areas with a population over 65,000, which represents 7 out of the 48 counties in the study area, and 55 out of 254 counties within the whole of Texas. Furthermore, the ACS estimate samples are collected throughout a five-year period without targeting any specific day, month, or year, but instead focus on the precision of small areas by working with larger samples and smaller margins of error.

C&M also reviewed the U.S. Census Bureau Population and Housing Unit Estimates. The U.S. Census Bureau publishes population estimates for various regions annually, updating the entire time series from April 1, 2020, to July 1 of the current year, referred to as the "vintage year." These estimates, which include all residents, are produced using a cohort-component method, starting with the last decennial census and adjusting for births, deaths, and net migration.

C&M reviewed W&P's State Profile dataset for counties in Texas, which includes historical data from 1970 to 2017, and annual projections up to 2050. The variables included are population by age and race, employment by industry, earnings of employees by industry, gross domestic product (GDP), personal income by source, number of households by income bracket, and retail sales by business type.

C&M also reviewed TWDB. TWDB prepared draft population and municipal water demand projections for 2020-2070 for all municipal water user groups using trends based on the 2017 State Water Plan (SWP), with new 2010 population estimates reflecting utility-based boundaries. Various data sources, including the TWDB Water Use Survey and 2010 Census data, were used to estimate the 2010 baseline population, adjusting for limitations such as transient populations and mismatched service areas. These estimates were reconciled with county totals from the 2017 SWP. Regional and county-level projections from the 2017 SWP were carried over for the 2021 Regional Water Plans to maintain consistency. However, comparing this projection with others reflects that the TWBD projection considers much higher values.

C&M further reviewed BEA mid-year population estimates. BEA produced intercensal annual county population statistics for 2010 to 2019 that are tied to the Census Bureau decennial counts for 2010 and 2020. BEA developed intercensal population statistics because this data was not published when the Census released county population data for 2020 through 2022, which are based on the 2020 decennial counts. BEA used the Census Bureau Das Gupta method, modified to account for an extra leap year day, to produce the intercensal population figures that will be used until the Census releases its official intercensal population data. In the case of employment data, the statistics are based primarily on data from the BLS and the Internal Revenue Service (IRS); BEA uses additional source data and adjustments to produce employment statistics that align with other BEA statistics.

C&M also reviewed BLS's Local Area Unemployment Statistics (LAUS). The LAUS program estimates the civilian labor force, employment, unemployment, and unemployment rates using non-survey methodologies. State estimates are based on Current Population Survey (CPS) data, Current Employment Statistics (CES) payroll employment, and unemployment insurance claims, adjusted to match national CPS figures. County data is developed using the Handbook method, combining adjusted establishment data with synthetic employment components and UI-based unemployment estimates.

C&M reviewed TexasLMI, which includes data from the Quarterly Census of Employment and Wages (QCEW) through the first quarter of 2023, and CES through August 2023. The Texas Workforce Commission (TWC) uses employment projections released in 2022, covering 2020 to 2030, with new projections for 2022 to 2032 expected in the fall of 2024. County business patterns were also reviewed by C&M. The data collected at the county level involves gathering information primarily from administrative records, the Economic Census conducted every five years, annual surveys of multi-unit companies, and unique Employer Identification Numbers. Industry classification follows the North American Industry Classification System (NAICS).

For education employment data, C&M considered ASPEP and IPEDS. ASPEP collects comprehensive data on state and local government employment and payrolls across the United States, excluding federal agencies. It targets civilian employees in 50 state governments, including counties, municipalities, townships, special districts, and school districts. Data collection involves centralized payroll records for state agencies and online instruments for local entities, with special arrangements for school systems. The survey details employment by function (e.g., education, public safety, transportation) and computes full-time equivalent employment based on historical data. IPEDS is a system of 12 interrelated survey components conducted annually that gathers data from every college, university, and technical and vocational institution that participates in the federal student financial aid programs. The data collections occur in fall, winter, and spring.

Lastly, C&M also reviewed TDC's 2022 population estimates and Vintage 2022. County population estimates are produced using a combination of methods, including ratio-correlation, component-method II, and the housing-unit method, along with data sources, including births, deaths, school enrollments, and housing stock changes. These estimates are cross-checked for consistency, and adjustments are made if discrepancies arise. The final estimates are aligned with the state's total population figures from the U.S. Census Bureau. TDC Vintage 2022 projections consist of the projections of the resident population of the state by age and sex, and the total resident population of all counties in the state for each year from 2020 through 2060, with the 2020 population equal to the 2020 Census count for the State of Texas and all counties in Texas. Both the state and the county projections are available in two migration scenarios. The projections were completed using a cohort-component projection technique. As the name implies, the basic characteristics of this technique are the use of separate cohorts—persons with one or more common characteristics—and the separate projections of each of the major components of population change—fertility, mortality, and net migration—for each of the cohorts. These component projections for each cohort are then combined in the familiar demographic bookkeeping equation.

Beyond this, C&M also reviewed socioeconomic data at the TAZ level from the LRGV, Laredo, El Paso regional TDMs and Texas SAM. However, to understand the historical trend, C&M focused on the U.S. Censuses and BLS.

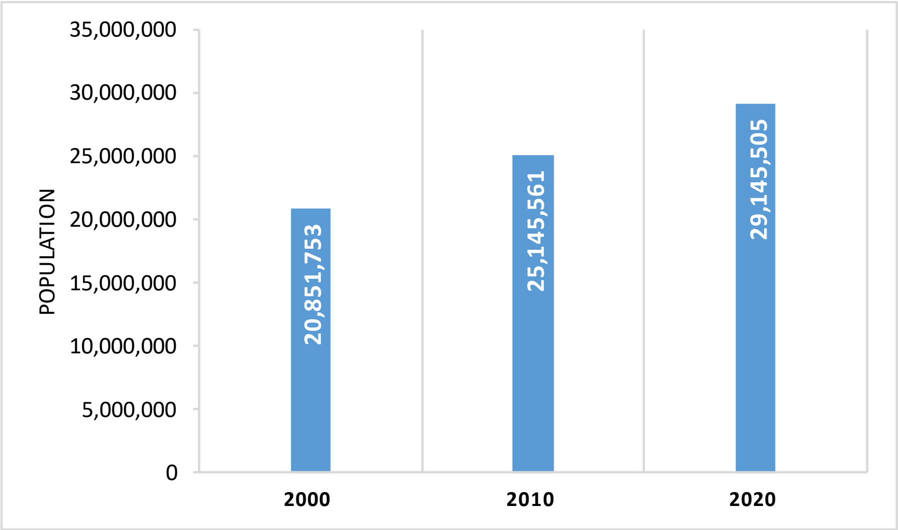
3.1.1 Historical Trends

3.1.1.1 Population Trends

Population is a key factor for transportation modeling and network simulation. C&M evaluated the county- and TAZ-level population data for the study area as gathered from local, state, and federal data sources. In accordance with the established guidelines and the scope of the present study, 2022 was established as the model base year.

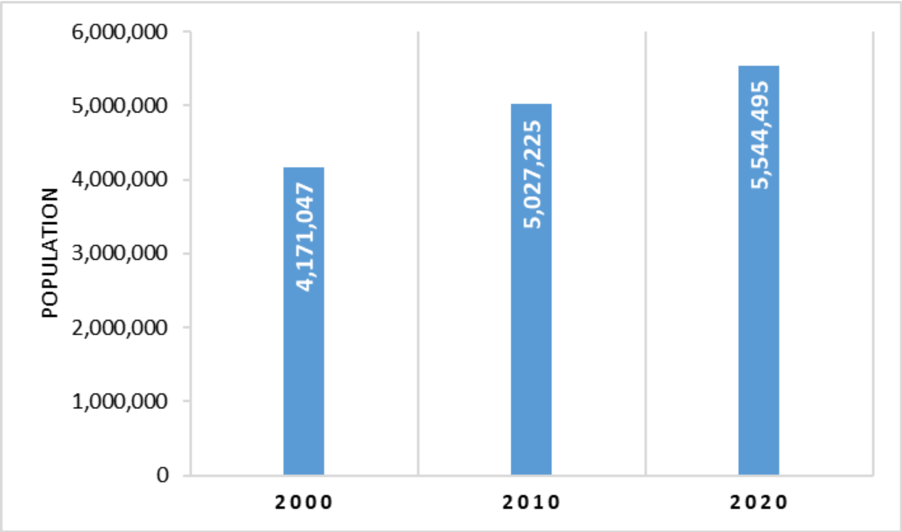
As shown in Figure 3-1 and Figure 3-2, Texas added 4.29 million to its population from 2000 to 2010, which translates to 1.89% growth. Over the next decade, the population increased by about 4 million, a growth rate of 1.49%. The Census data shows that population growth from 2010 to 2020 slowed from the previous decade.

In Figure 3-2, the 100-mile buffer has a total of 48 counties with a total population of 4.17 million in 2000; that increased to 5.03 million in 2010, which translates to an 856,000 increase and 1.88% growth. In the next decade, another 517,000 residents were added, resulting in only 0.98% growth. When compared to the whole of Texas, this 100-mile buffer zone had a similar growth rate from 2000 to 2010; however, in the subsequent decade, the growth rate lagged behind the whole of Texas by 0.5%.



Source: U.S. Decennial Censuses

Figure 3-1. Historical Population Trends of Texas



Source: U.S. Decennial Censuses

Figure 3-2. Historical Population Trends of 100-Mile Buffer Zone

It is important to note that almost 90% of the population was confined within only nine counties in the year 2022. These counties are Bexar (36.24%), Hidalgo (15.71%), El Paso (15.61%), Cameron (7.59%), Nueces (6.37%), Webb (4.82%), San Patricio (1.24%), Starr (1.19%), and Maverick (1.04%). The remainder of the counties possess less than 1% of the total population, as can be seen in Figure 3-3.

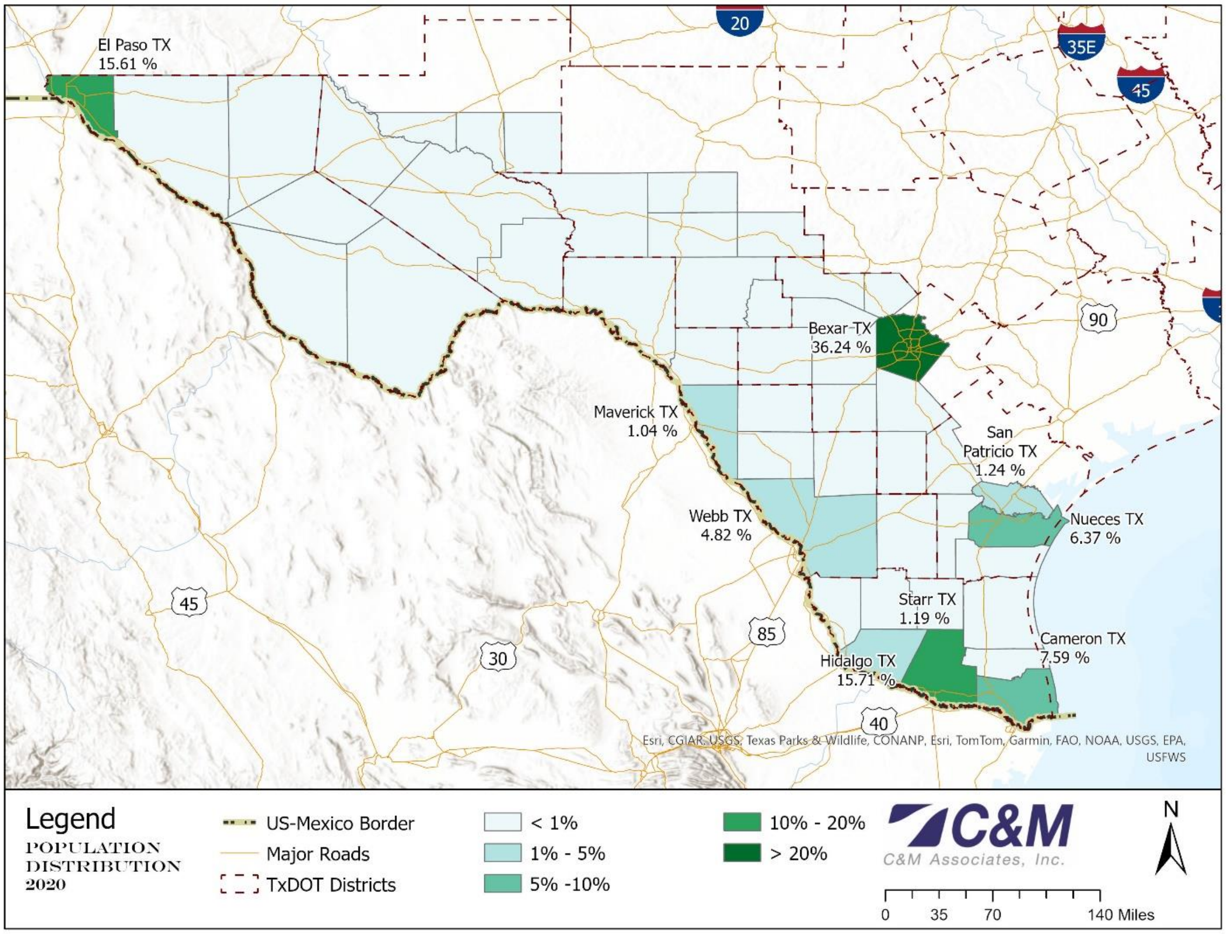


Figure 3-3. 2020 Population Distribution within 100 Miles of the U.S.–Mexico Border

Table 3-1 further narrows down the population trend to the top nine counties, as can be seen in Figure 3-3. As mentioned previously, in the 2010s, growth slowed down; this can be seen in all the major counties except San Patricio. Bexar, Nueces, El Paso, Maverick, and Starr Counties experienced a relatively smaller decline in their growth rates, whereas Hidalgo, Cameron, and Webb Counties witnessed a significant reduction. San Patricio is the only county that experienced a population decrease in the 2000s, and then the population increased until 2020.

Table 3-1. Historical Population Trends and Growth Rates of Major Counties within the Study Area

County	Population			CAGR	
	2000	2010	2020	2010	2020
Bexar County, Texas	1,392,931	1,714,773	2,009,324	2.1%	1.6%
Hidalgo County, Texas	569,463	774,769	870,781	3.1%	1.2%
El Paso County, Texas	679,622	800,647	865,657	1.7%	0.8%
Cameron County, Texas	335,227	406,220	421,017	1.9%	0.4%
Nueces County, Texas	313,645	340,223	353,178	0.8%	0.4%
Webb County, Texas	193,117	250,304	267,114	2.6%	0.7%
San Patricio County, Texas	67,138	64,804	68,755	-0.4%	0.6%
Starr County, Texas	53,597	60,968	65,920	1.3%	0.8%
Maverick County, Texas	47,297	54,258	57,887	1.4%	0.6%
Total	3,652,037	4,466,966	4,979,633	2.0%	1.1%

Figure 3-4 illustrates the overall compound annual growth rate (CAGR) of the population within 100 miles of the U.S.–Mexico border. The data indicates that counties adjacent to those with the highest population shares (as seen in Figure 3-1) are experiencing population growth. This trend suggests that population growth is concentrated near major urban centers. In contrast, counties located farther from these urban areas are experiencing negative CAGRs, highlighting a demographic shift from rural to urban regions.

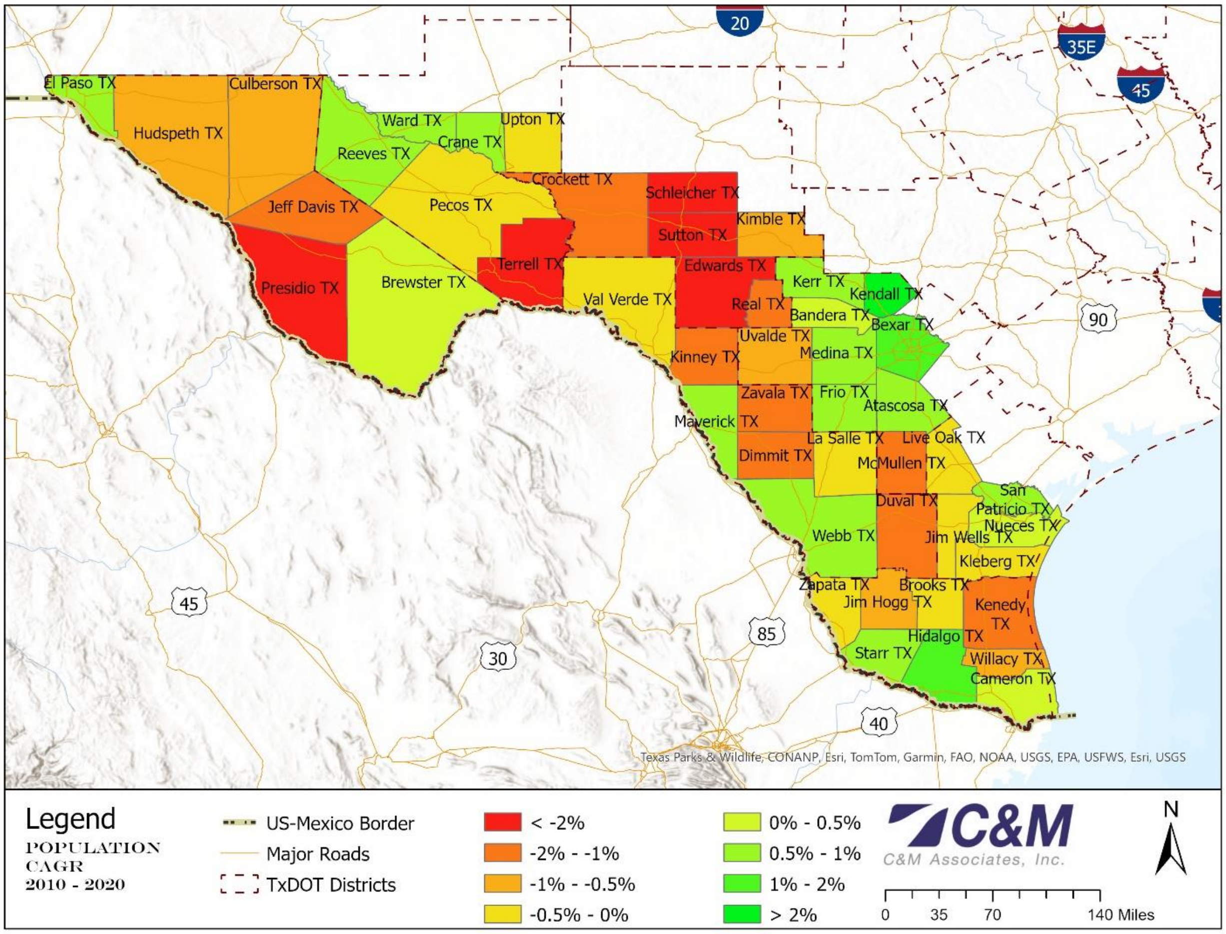


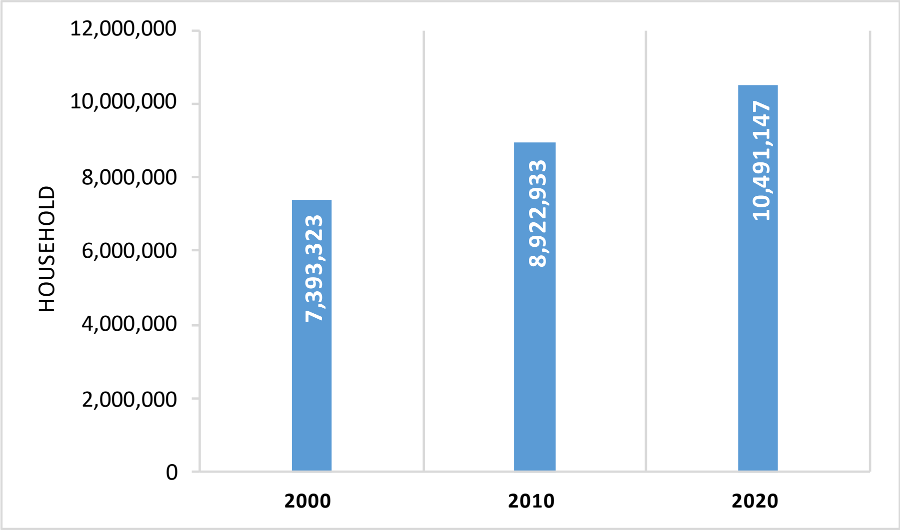
Figure 3-4. Population CAGRs within 100 Miles of the U.S.–Mexico Border, 2010-2020

3.1.1.2 Number of Households

The number of households by TAZ is an important input to the trip generation modeling procedures of the TDM. The following section presents the historical trends for the number of households in the study area.

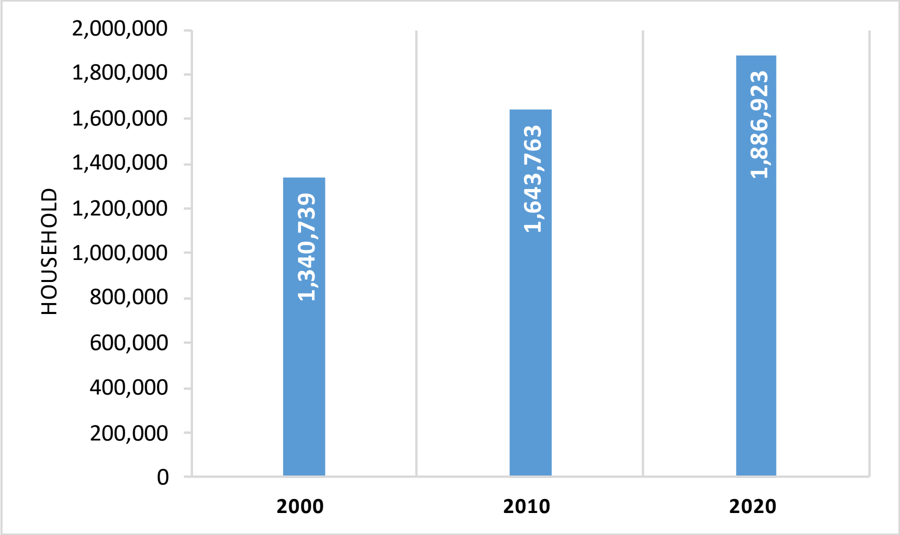
As shown in Figure 3-5, Texas added 1.53 million households from 2000 to 2010, which translates to a 1.90% growth. Over the next decade, households increased by about 1.57 million, a growth rate of 1.63%. The data indicates that even though the number of household increments in the second decade was higher than the first, the rate of growth was almost 0.3% less.

As seen in Figure 3-6, in the 100-mile buffer zone from the U.S.–Mexico border, the number of households increased from 1.34 million in 2000, to 1.64 million in 2010, reflecting a 303,000 increase and a growth rate of 2.06%. In the following decade, another 243,000 households were added, resulting in a 1.39% growth. When compared to the whole of Texas, the 100-mile buffer zone had a faster rate of growth in the 2000s, but in the following decade, the growth rate slowed down by 0.24%. It is important to note that almost 90% of the households are confined within only nine counties in the year 2020. These counties are Bexar (38.52%), El Paso (15.71%), Hidalgo (13.70%), Cameron (7.02%), Nueces (6.93%), Webb (4.15%), San Patricio (1.31%), Kerr (1.17%), and Starr (1.05%). The remainder of the counties possess less than 1% of the total households, as can be seen in Figure 3-7.



Source: U.S. Decennial Censuses

Figure 3-5. Historical Household Trends of Texas



Source: U.S. Decennial Censuses

Figure 3-6. Historical Household Trends in the 100-Mile Buffer Zone

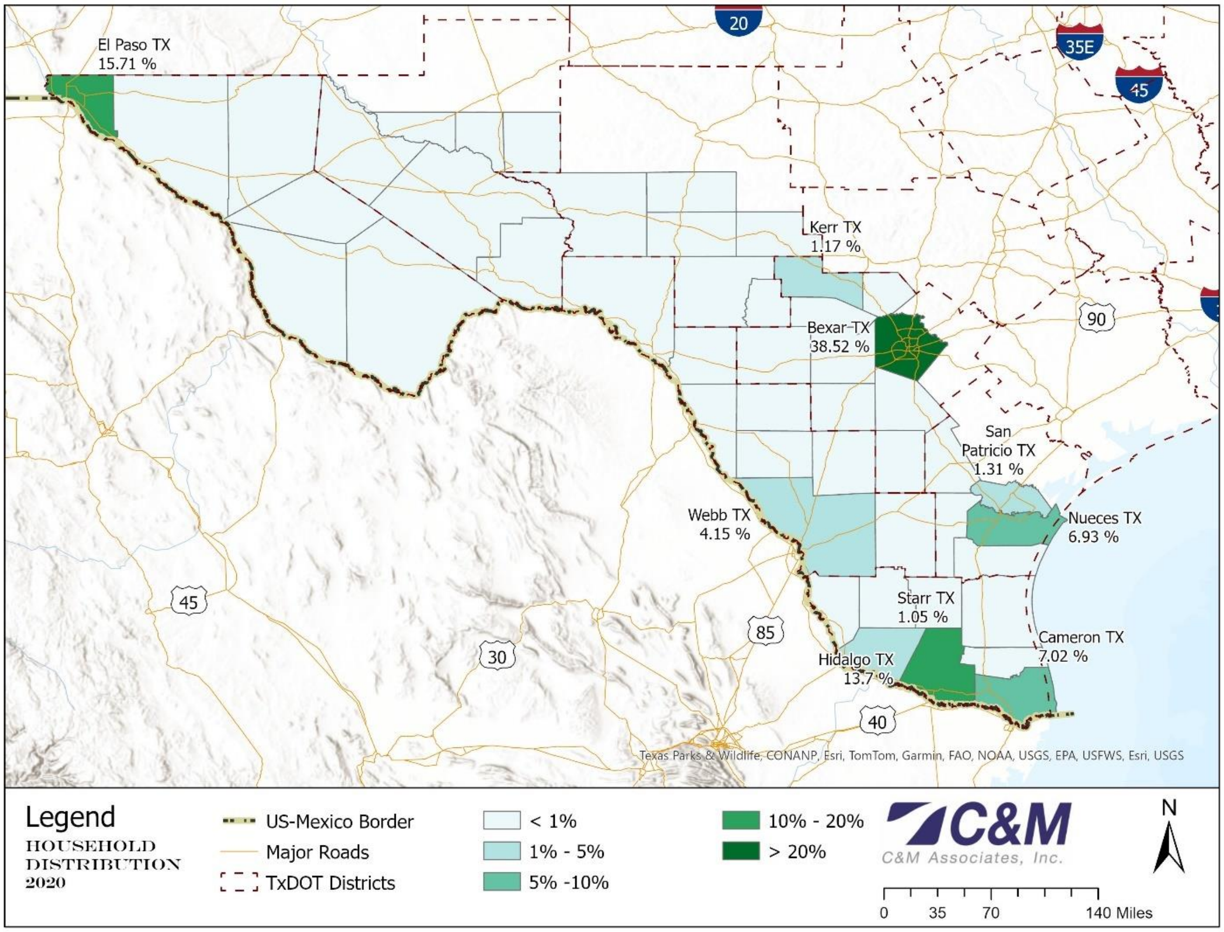


Figure 3-7. 2020 Household Distribution within 100 Miles of the U.S.–Mexico Border

Table 3-2 further narrows down the household trend to the top nine counties, as seen in Figure 3-7. Like the whole of Texas, this zone saw a slowdown in the growth rate of all major counties except for San Patricio County. Bexar, El Paso, Nueces, Kerr, and Starr Counties experienced a relatively smaller decline in their growth rates, whereas Hidalgo, Cameron, and Webb Counties witnessed a significant reduction. Like the trend with population growth, San Patricio is the only county that saw a household decrease in the 2000s, and then an increase until 2020.

Table 3-2. Historical Household Trends and Growth Rates of Major Counties in the Study Area

County	Household			CAGR	
	2000	2010	2020	2010	2020
Bexar County, Texas	488,942	608,931	726,886	2.2%	1.8%
El Paso County, Texas	210,022	256,557	296,400	2.0%	1.5%
Hidalgo County, Texas	156,824	216,471	258,542	3.3%	1.8%
Cameron County, Texas	97,267	119,631	132,507	2.1%	1.0%
Nueces County, Texas	110,365	124,587	130,687	1.2%	0.5%
Webb County, Texas	50,740	67,106	78,282	2.8%	1.6%
San Patricio County, Texas	22,093	22,637	24,796	0.2%	0.9%
Kerr County, Texas	17,813	20,550	22,060	1.4%	0.7%
Starr County, Texas	14,410	17,001	19,868	1.7%	1.6%
Total	1,168,476	1,453,471	1,690,028	2.2%	1.5%

Figure 3-8 illustrates the overall household CAGRs within 100 miles of the U.S.–Mexico border. The data indicates that counties adjacent to those with the highest population shares (as seen in Figure 3-1) and highest household shares are experiencing household growth. This trend suggests that household growth is concentrated near major urban centers. In contrast, counties located farther from these urban areas are experiencing negative CAGRs, highlighting a demographic shift from rural to urban regions and falling in line with the population CAGR growth pattern.

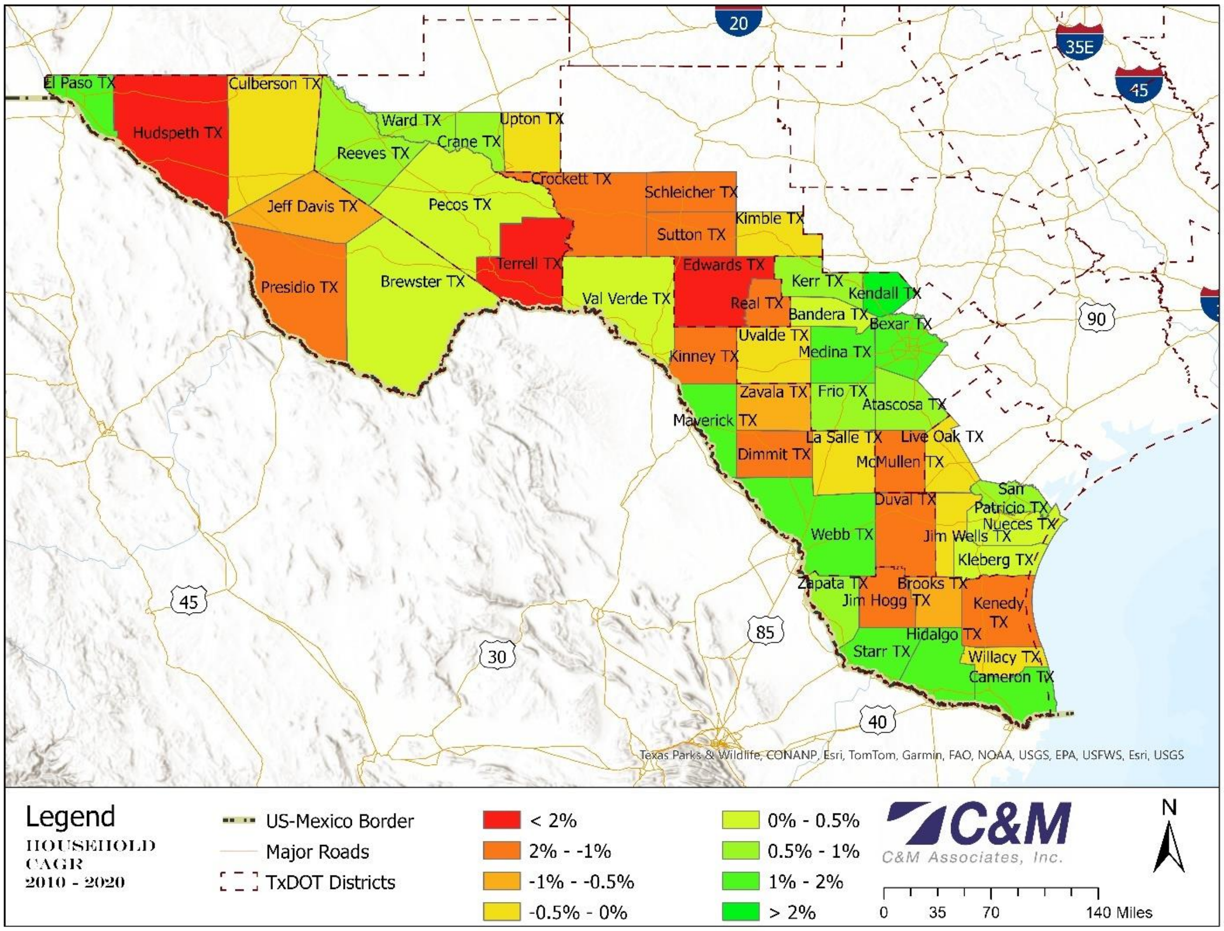


Figure 3-8. Household CAGRs within 100 Miles of the U.S.–Mexico Border, 2010-2020

3.1.1.3 Employment Numbers

From a transportation-planning perspective, workplace-based employment data from Texas provides a useful picture of trip destinations for both work and shopping trips. To develop a picture for future border-area traffic, C&M studied and evaluated the study area's current job market and employment history.

As shown in Table 3-3, Texas added 2.84 million jobs from 2010 to 2022, translating to a 1.9% growth rate. The employment growth rate fluctuated during this period. Notable years include 2012 and 2014, both with a 2.6% CAGR, and a significant increase in 2021 with a 4.8% CAGR, following a decline of 4.2% in 2020 due to the economic impacts of the COVID-19 pandemic.

In the 100-mile buffer zone from the U.S.–Mexico border, the number of jobs increased by 371,000, which translates to 1.4% growth. The employment growth rate in this region has followed a similar pattern of fluctuation to that of the entire State of Texas. However, the growth rate in this area has consistently remained 0.5% below the state average. It is important to note that almost 90% of the jobs were confined within only seven counties in the year 2022. These counties are Bexar (38.23%), El Paso (14.76%), Hidalgo (14.47%), Cameron (6.99%), Nueces (6.51%), Webb (4.70%), and San Patricio (1.15%). The remainder of the counties possess less than 1% of the total households, as can be seen in Figure 3-9

Table 3-3. Historical Employment Trends and Growth Rates of Texas and the 100-Mile Buffer Zone

Year	Texas	
	Employment (1000)	CAGR
2010	11,255	
2011	11,499	2.2%
2012	11,795	2.6%
2013	12,022	1.9%
2014	12,333	2.6%
2015	12,503	1.4%
2016	12,729	1.8%
2017	12,888	1.3%
2018	13,179	2.3%
2019	13,435	1.9%
2020	12,872	####
2021	13,487	4.8%
2022	14,094	4.5%

Year	100-Mile Buffer from U.S.-MEX Border	
	Employment (1000)	CAGR
2010	2,028	
2011	2,066	1.8%
2012	2,110	2.2%
2013	2,141	1.5%
2014	2,183	1.9%
2015	2,201	0.8%
2016	2,242	1.9%
2017	2,263	0.9%
2018	2,305	1.9%
2019	2,334	1.3%
2020	2,220	-4.9%
2021	2,313	4.2%
2022	2,399	3.7%

Source: U.S. Bureau of Labor Statistics (BLS)

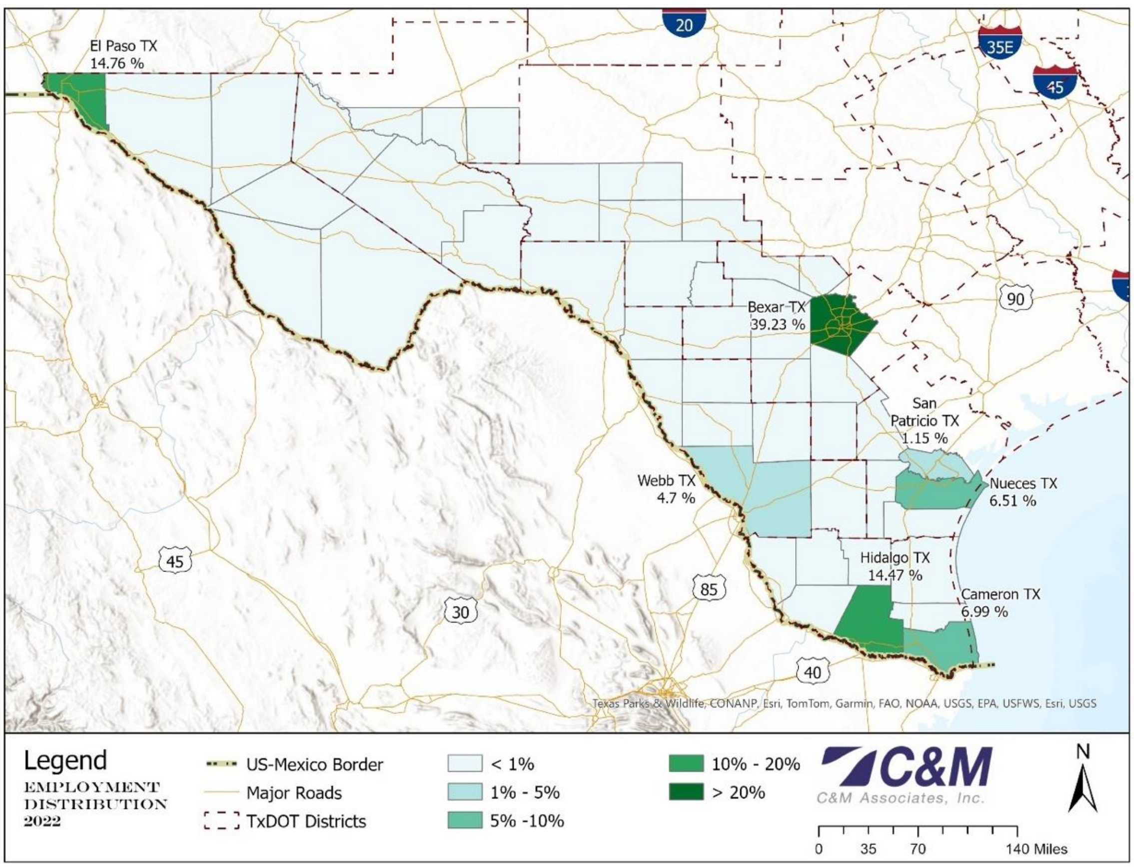


Figure 3-9. 2022 Employment Distribution within 100 Miles of the U.S.–Mexico Border

Table 3-4 further narrows down the employment trend to the top seven counties as seen in Figure 3-9. Like the State of Texas and the 100-mile buffer zone, the major counties followed a similar pattern of slow growth rates until 2019, followed by a major drop in 2020 due to the COVID-19 pandemic. In the following two years, the employment growth rate surged by nearly 5%, restoring employment numbers to, or exceeding, pre-pandemic levels.

Most counties' employment increased steadily until 2019, but at various rates. Bexar County, for example, saw constant growth, peaking at 906,406 in 2019, before dropping significantly in 2020 due to the pandemic, followed by a strong rebound in the following two years. El Paso and Hidalgo Counties followed a similar trend, with growth rates peaking in 2019, declining in 2020, and then recovering. Cameron County's growth rate was relatively modest, with noticeable dips and returns. Nueces and Webb Counties had variations, including significant decreases in 2020, and subsequent recoveries. San Patricio County saw the highest unpredictability, with initial reductions, a significant fall in 2020, and subsequent recovery. Despite the pandemic-induced disruptions in 2020, all counties showed strong recovery trends in 2021 and 2022.

Table 3-4. Historical Employment Trends and Growth Rates of Major Cities in the Study Area

County	Employment												
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Bexar County, TX	754,040	767,720	785,636	802,913	824,137	845,395	871,855	884,586	897,864	906,406	861,055	900,953	941,275
		1.8%	2.3%	2.2%	2.6%	2.6%	3.1%	1.5%	1.5%	1.0%	-5.0%	4.6%	4.5%
El Paso County, TX	309,927	312,917	317,204	318,975	321,731	323,955	332,601	335,163	340,580	345,847	331,382	343,774	354,166
		1.0%	1.4%	0.6%	0.9%	0.7%	2.7%	0.8%	1.6%	1.5%	-4.2%	3.7%	3.0%
Hidalgo County, TX	281,155	287,651	292,711	296,229	302,287	304,695	310,858	314,913	322,241	327,268	317,207	334,443	347,089
		2.3%	1.8%	1.2%	2.0%	0.8%	2.0%	1.3%	2.3%	1.6%	-3.1%	5.4%	3.8%
Cameron County, TX	144,310	146,311	148,873	150,060	152,175	151,483	154,169	153,499	154,504	156,197	152,951	161,984	167,764
		1.4%	1.8%	0.8%	1.4%	-0.5%	1.8%	-0.4%	0.7%	1.1%	-2.1%	5.9%	3.6%
Nueces County, TX	149,458	150,752	155,750	157,617	159,297	157,629	158,355	157,654	158,800	158,842	149,531	152,585	156,295
		0.9%	3.3%	1.2%	1.1%	-1.0%	0.5%	-0.4%	0.7%	0.0%	-5.9%	2.0%	2.4%
Webb County, TX	96,457	99,571	101,867	103,340	105,313	106,503	108,314	109,410	111,043	113,174	105,964	109,107	112,669
		3.2%	2.3%	1.4%	1.9%	1.1%	1.7%	1.0%	1.5%	1.9%	-6.4%	3.0%	3.3%
San Patricio County, TX	27,270	27,210	28,073	28,390	28,708	28,264	28,335	27,997	27,959	27,913	26,353	26,846	27,513
		-0.2%	3.2%	1.1%	1.1%	-1.5%	0.3%	-1.2%	-0.1%	-0.2%	-5.6%	1.9%	2.5%

Figure 3-10 illustrates the overall household CAGRs within 100 miles of the U.S.–Mexico border from 2010 to 2022. The data indicates that counties adjacent to those with the highest population shares (as seen in Figure 3-1) and the highest employment shares are experiencing employment growth, including Bexar, Webb, Cameron, and El Paso. It is notable that several more counties have seen more employment growth than population growth. For instance, counties between Bexar and Webb along I-35, and counties between El Paso and Ward along I-10, exhibited negative population growth, but saw positive employment growth. Another noticeable trend is that there are distinct east-west bands where counties have seen decreases in employment numbers, particularly in the far western (e.g., Presidio, Brewster, Terrel, Sutton, etc.) and far eastern (e.g., Kenedy, Jim Wells, Hogg, etc.) parts of the study area over the last 12 years. The overall trend suggests that employment growth is concentrated near major urban centers and along major interstates within the 100-mile zone along the U.S.–Mexico border.

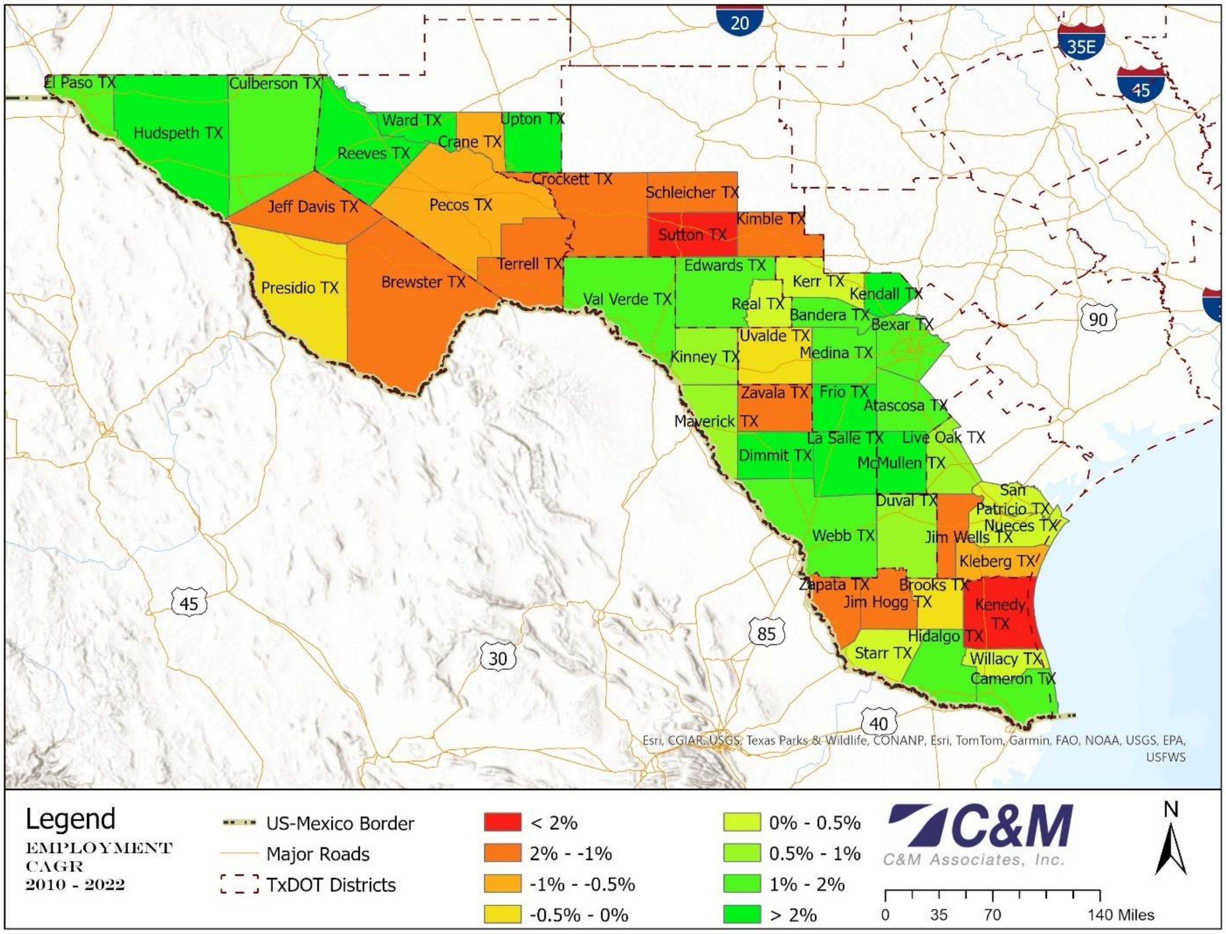


Figure 3-10. Employment CAGRs within 100 miles of the U.S.–Mexico Border, 2010-2022

3.1.2 Base-Year Estimates

In transportation demand modeling, the estimation of socioeconomic data for the base year is critical since it provides the foundation for forecasting future transportation requirements and trends. This data, which includes population, employment numbers, income levels, and other demographic variables, has a direct impact on the estimation of travel demand patterns. Accurately capturing the base year's socioeconomic situation enables accurate predictions about how transportation systems will need to adapt to suit changes in demography, economic conditions, and lifestyle preferences.

3.1.2.1 Population Estimates

C&M conducted a comprehensive review of various sources of population data for the State of Texas, including W&P; the LRGV, Laredo, and El Paso Regional TDMs, U.S. Census population estimates, TDC (1.0 Migration Scenario), and the Decennial Census, among others. However, given the recency and presumed accuracy of the 2022 estimates from TDC, these figures were adopted as the control totals at the county level for the base-year estimations in C&M's TDM for the Border Master Plan.

For the detailed estimation of population data at the TAZ level, the following steps were implemented. It is important to understand the process and modifications that were performed to arrive at the base-year socioeconomic output results.

C&M utilized the proportional population share of each TAZ within a county to redistribute the control total values. For the population share calculation, socioeconomic data from LRGV, Laredo, and El Paso regional TDMs were used for Cameron, Hidalgo, Webb, and El Paso Counties; for the remainder of the county data, Texas SAM was utilized. Since the regional MPOs' socioeconomic data models did not provide estimates for 2022, interpolation methods were employed to derive population figures for that year.

However, it is also important to note that all the regional models were prepared using much more detailed TAZs which encompass much smaller regions than the TAZs of Texas SAM. To overcome this inconsistency, spatial analysis was performed to aggregate the socioeconomic data of the regional TAZs to Texas SAM TAZs, as can be seen in Figure 3-11.

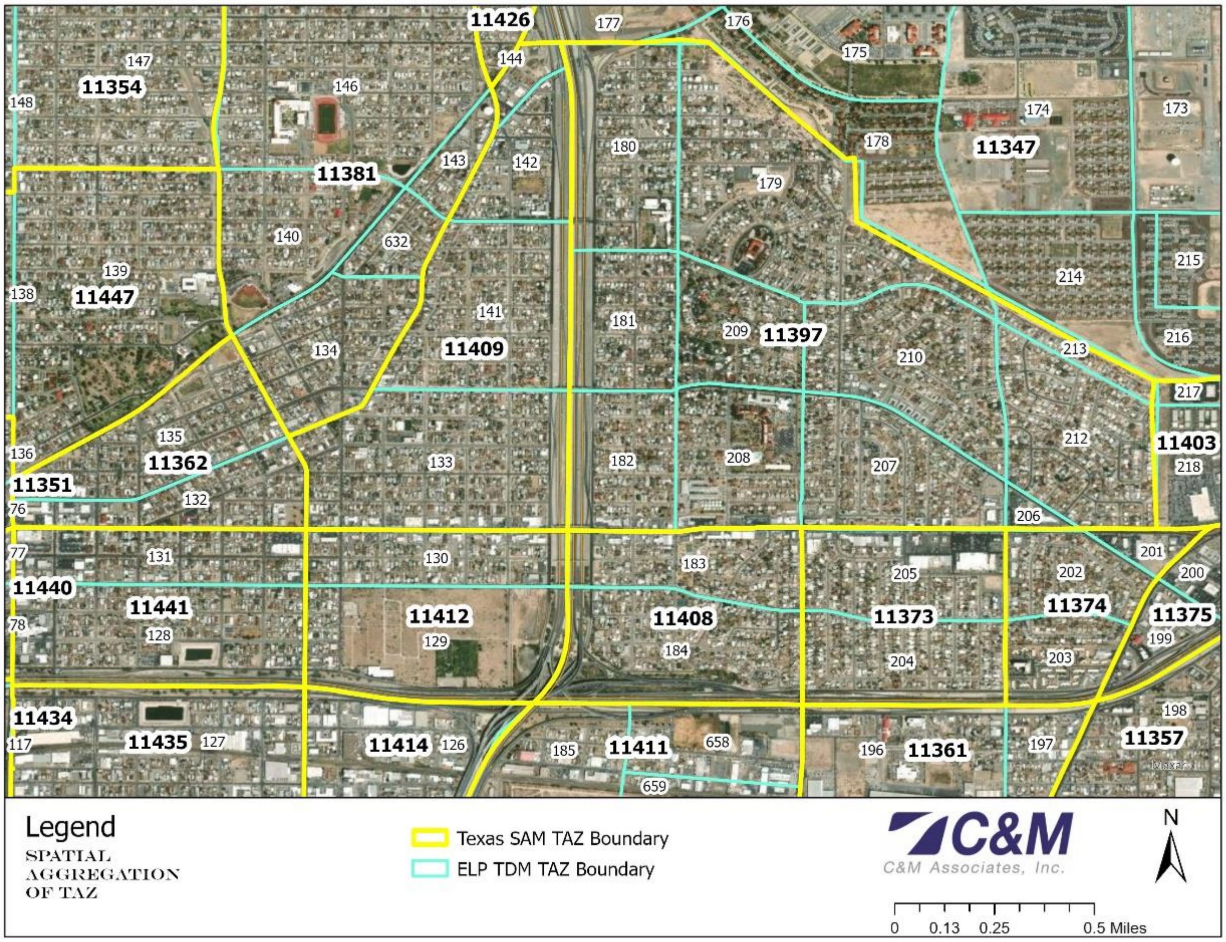


Figure 3-11. El Paso TDM TAZ Aggregated to Texas SAM TAZ

While performing this step, C&M came across issues where some regional TAZs had been shared by two Texas SAM TAZs. Scenarios like this were addressed manually by checking the Google imagery and adjusting the values of the final Texas SAM TAZs accordingly. Another issue arose wherein some of the TAZs from the MPO model had inconsistent data when compared to Google imagery. Examples of this include situations where an MPO model showed zero population when aggregated to the Texas SAM, but Google imagery shows the presence of residents within that TAZ. Such cases may have arisen because the El Paso model may not have considered future developments in that area. In these scenarios, C&M checked the values of Texas SAM 2022 socioeconomic data, and after cross-checking the numbers with Google imagery, the latest block group-level Census data was utilized instead of the MPO values, as shown in Figure 3-12. In the case of the Laredo MPO model, it was found that the interpolated 2022 socioeconomic data was highly inconsistent with the Google imagery. To overcome this, block-level data was collected from the Census (Figure 3-13), and then aggregated at the Texas SAM TAZ level by using spatial analysis.

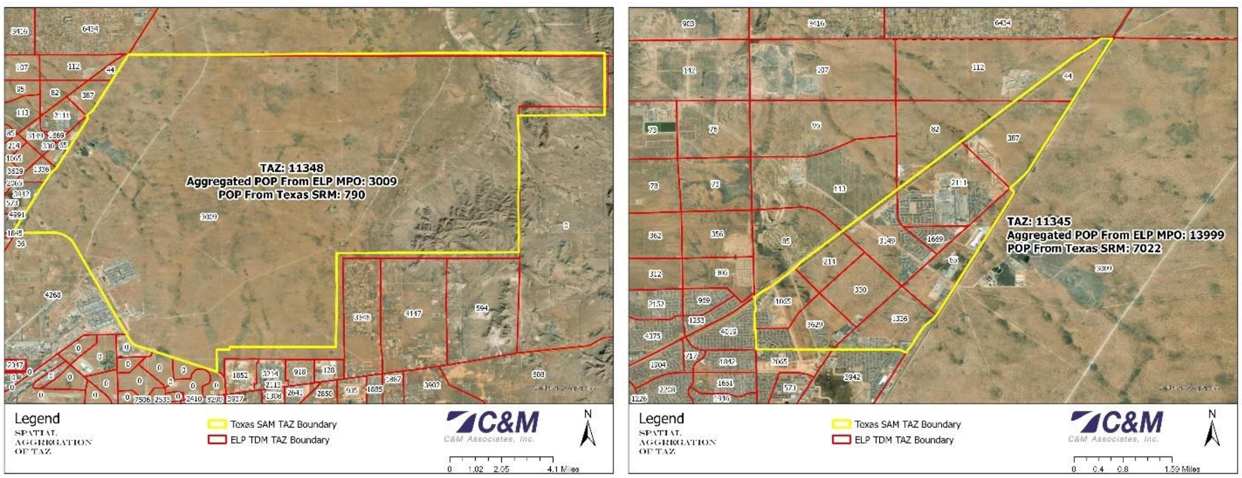


Figure 3-12. Correction Made after Aggregation to Texas SAM

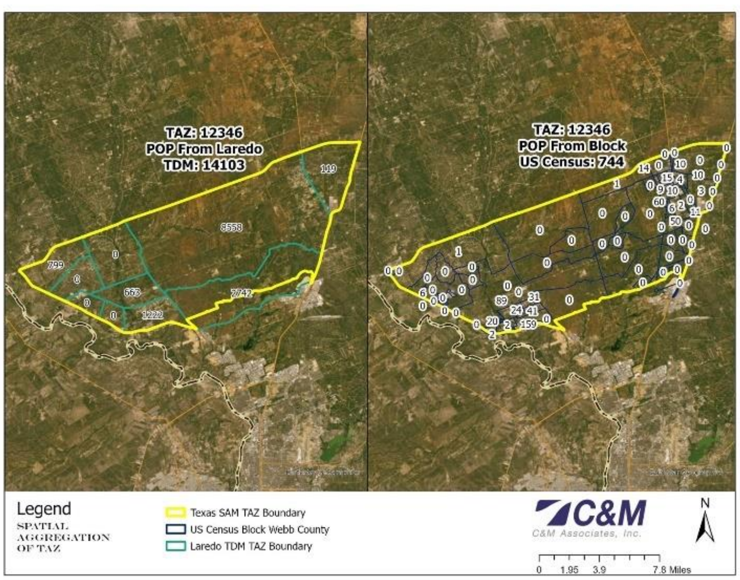


Figure 3-13. Use of Decennial Census for Webb County

For the group quarter population, the 2020 Census was used as a control total. For the detailed estimation of group quarter population data at the TAZ level, the same methodology was used as in the case of population estimation.

Figure 3-14 illustrates the 2022 population estimates prepared by C&M for the study at the TAZ level. It can be seen in the map that most of the TAZs near major cities like San Antonio, El Paso, Corpus Christi, Hidalgo, and Cameron have populations over 10,000. Additionally, TAZs within Maverick, Webb, and Starr Counties exhibit high population ranges between 2,000 and 10,000. This aligns with the population distribution of the 2020 Census. While some TAZs far from major cities also display high populations, it is important to note that these TAZs cover a much larger area. The majority of TAZs, however, have relatively small populations, with fewer than 1,000 residents.

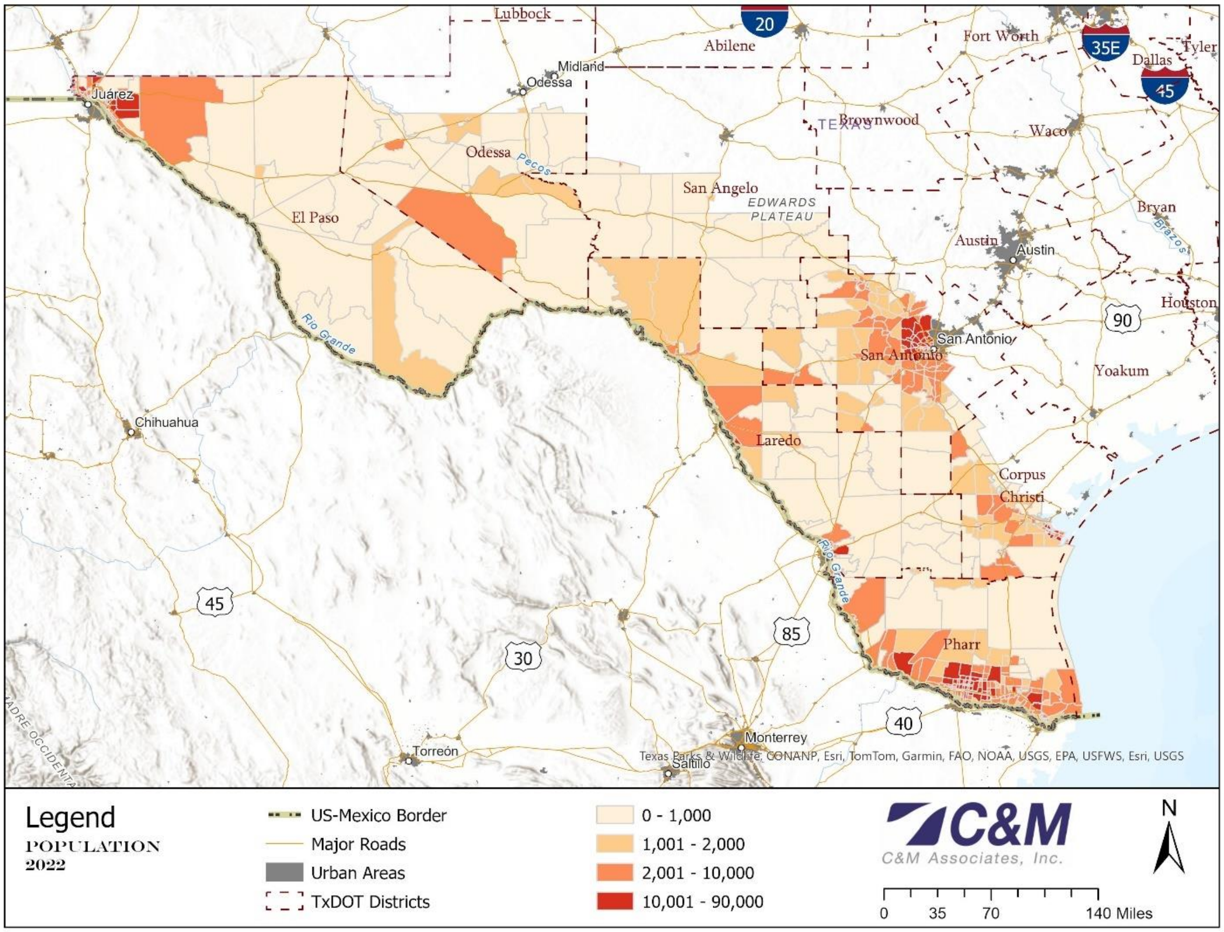


Figure 3-14. 2022 Population Estimates

3.1.2.2 Household Estimates

For the estimation of household data, C&M utilized the previous comprehensive review of W&P; the LRGV, Laredo, and El Paso Regional TDMs; and the ACS. However, to ensure consistency with the population data derived from TDC, C&M computed the household size from the W&P data and then applied to the 2022 control total population from TDC (1.0 Migration Scenario) to compute the total number of households as control totals for 2022. This method assures that the household estimates are consistent with the demographic forecasts. Lastly, C&M utilized the proportional household share of each TAZ within a county to redistribute the control total values. For the household share calculation, the socioeconomic data from the LRGV, Laredo, and El Paso regional TDMs were used for Cameron, Hidalgo, Webb, and El Paso Counties; for the remainer of the counties' data, Texas SAM was utilized. Since the regional MPOs' socioeconomic data models did not provide estimates for 2022, interpolation methods were employed to derive the population figures for that year.

Figure 3-15 illustrates the 2022 household estimates prepared by C&M for the study at the TAZ level. Like the 2022 population estimates, most of the TAZs near major cities like San Antonio, El Paso, Corpus Christi, Hidalgo, and Cameron have over 3,000 households. Additionally, TAZs within Kerr, Webb, and Starr Counties exhibit high household ranges between 1,000 and 3,000. This aligns with the household distribution of the 2020 Census. Like the pattern seen in population distribution, some TAZs far from major cities also display high household numbers; however, it is important to note that these TAZs cover a much larger area. The majority of TAZs, however, have a relatively small number of households—fewer than 500.

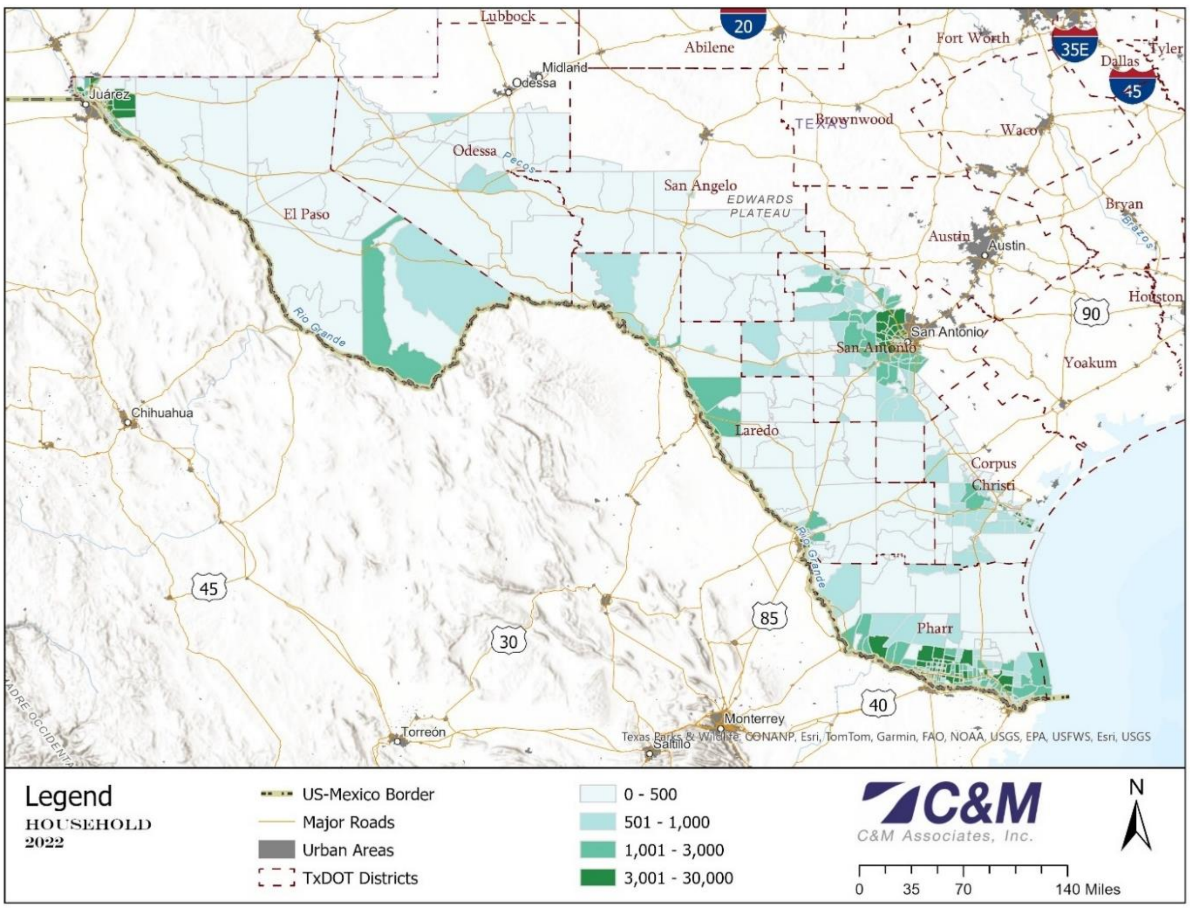


Figure 3-15. 2022 Household Estimates

3.1.2.3 Employment Estimates

C&M used data from BLS to estimate employment rates. However, many industry-specific job categories, such as farming, basic industries, retail, and education, showed shortcomings in the BLS datasets. As a result, C&M used the most reliable alternative data sources available to forecast 2022 employment statistics for these industries as control totals. The employment data from these sources were then aggregated to achieve the overall employment indicators. Table 3-5 summarizes the data sources used in the development of employment by industry for the TDM. For the employment share calculation at the TAZ level, 2022 socioeconomic data from Texas SAM was utilized. These shares were implemented to control total values to redistribute the county-level values to the TAZ level.

Table 3-5. Employment by Industry and their Sources

Employment by Industry	Source
Farm	BEA
Oil and Gas	BLS
Basic	Census CBP
Retail	Census CBP
Service	BLS
Accommodation	BLS
Education 1	APES
Education 2	IPEDS

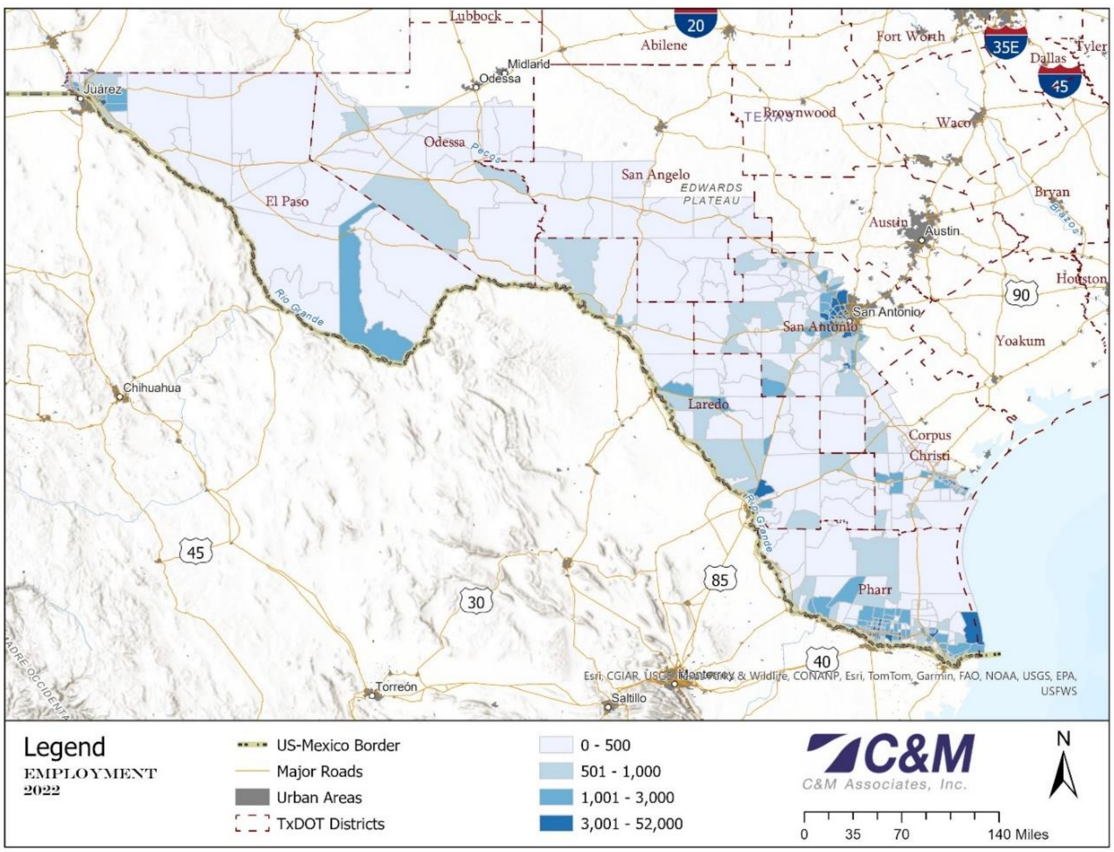


Figure 3-16. 2022 Employment Estimates

Figure 3-16 illustrates the 2022 employment estimates prepared by C&M for the study at the TAZ level. Following the same pattern of distribution as 2022 population estimates, most of the TAZs near major cities like San Antonio, El Paso, Hidalgo, and Cameron have more than 3,000 employments. Additionally, TAZs within Nueces and Webb Counties exhibit high employment ranges between 1,000 and 3,000. This aligns with the 2022 employment distribution from BLS. Like the pattern seen in population distribution, some TAZs far from major cities also display high employment numbers; however, as mentioned previously, these TAZs cover a much larger area. The majority of TAZs, however, have a relatively small number of employments—fewer than 500.

For the development of the freight model, C&M utilized the U.S. Census Bureau's County Business Patterns (Census CBP) data. This dataset enabled the extraction of employment figures categorized by both three-digit and two-digit NAICS codes for key sectors such as Mining, Quarrying, and Oil and Gas Extraction (NAICS-21), Manufacturing (NAICS-31-33), Wholesale Trade (NAICS-42), and Transportation and Warehousing (NAICS-48-49). However, discrepancies were observed in the data for several counties.

In instances where significant inconsistencies were identified between the Census CBP data and Texas SAM data, the proportionate shares from Texas SAM were employed to allocate two-digit NAICS employment figures across the respective subgroups within those counties. Where the data aligned consistently, the original Census CBP data was retained for use in the model.

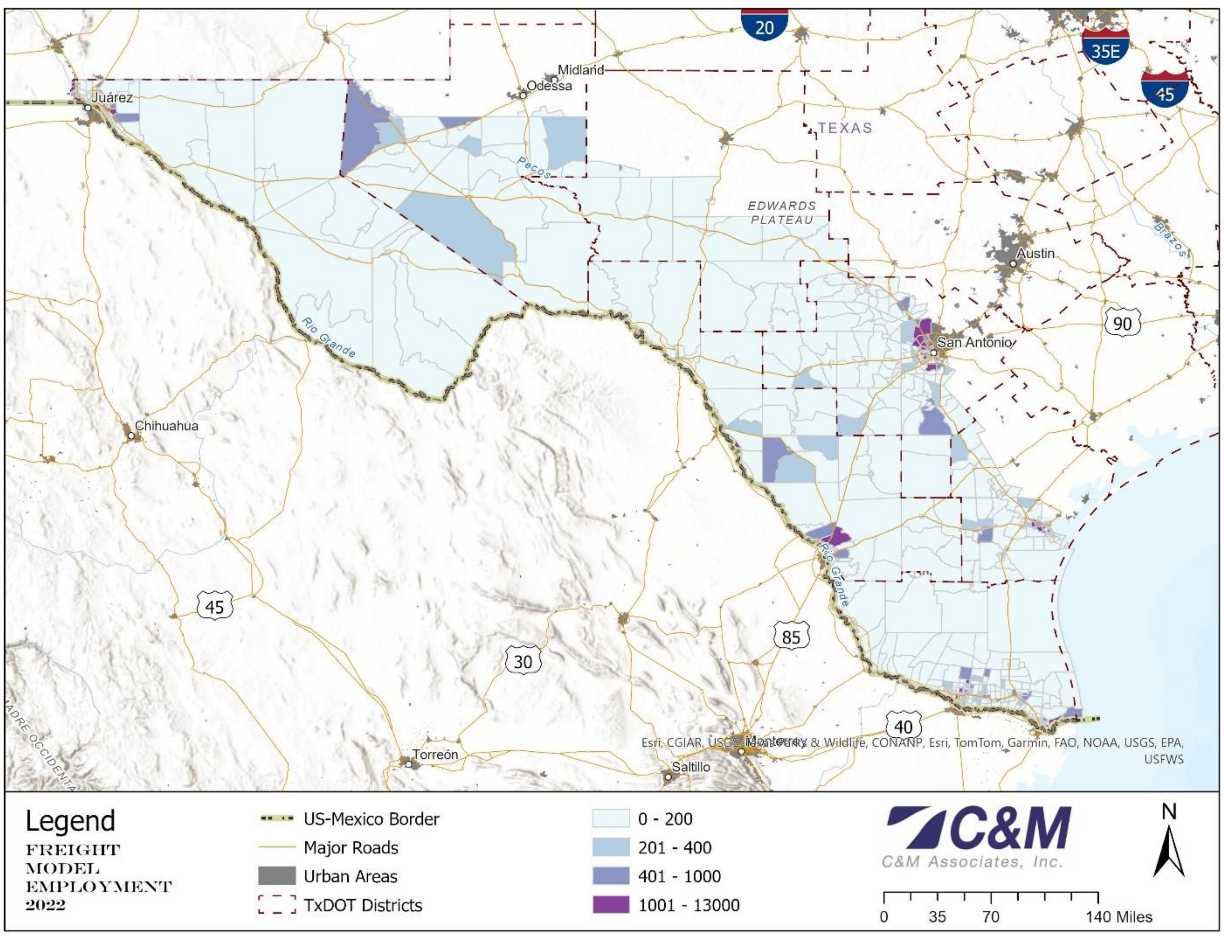


Figure 3-17. 2022 Freight Employment Estimates

It is also noteworthy that the Census CBP dataset was based on 2021 figures. To address this, employment growth rates derived from W&P data for 2021 and 2022 were used to project the 2022 employment control total, thereby ensuring that the data remained current and relevant for the model's application. Lastly, C&M utilized the proportional household share of each TAZ within a county to redistribute the control total values. In the case that the regional models did not follow similar segregation of employment types as found in the Texas SAM, only the Texas SAM was utilized for the calculations.

Figure 3-17 illustrates the 2022 freight employment estimates prepared by C&M for the study at the TAZ level. It is important to note that freight movements are driven by industry demand and household consumption. Most TAZs near major cities like San Antonio, El Paso, and Laredo have more than 1,000 employments. There are also employments in the range of 400 to 1,000 near other major locations (Nueces, Hidalgo, and Cameron Counties). These locations are the major centers for demand and consumption. The majority of TAZs, however, have a relatively small number of employments—fewer than 200.

3.2 Texas SAM Model Update

To achieve the project objectives, C&M adopted the SAM-V4 as the main transportation modeling tool for Texas, with elements to describe border behavior between Mexico and Texas and the study area, which is an integration of the El Paso, Odessa, Laredo, and Pharr districts.

C&M revised, evaluated, updated, and replicated the SAM-V4 inputs with a focus on 2022 observed data for the base year. This section explains each four-step model (passenger model and freight model) in detail, and how C&M adopted and updated SAM-V4 to improve the model for the base year.

C&M included the following major updates:

- Reviewed and updated master geography network.
- Developed and improved the socioeconomic database with real 2022 data included in the demographic inputs.
- Reviewed and updated the external station data.
- Planned and reviewed future projects within the network.

3.2.1 Overview of the Texas SAM-V4

The Texas SAM developed by TxDOT and Alliance Transportation Group is a comprehensive transportation modeling tool for evaluating intercity transportation projects throughout Texas. The SAM-V4 was completed in 2017, which established 2015 as the base year, and 2020 to 2050 as future forecasted years.

SAM-V4 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-V4 includes a passenger model and freight model that follow a traditional four-step structure.

3.2.1.1 Model Area

Figure 3-18 shows the model area for the Texas SAM-V4. The model includes:

- 254 Texas counties.
- 49 U.S. zones representing states and the District of Columbia (without Texas);
- 32 Mexican states; and
- 13 Canadian provinces.

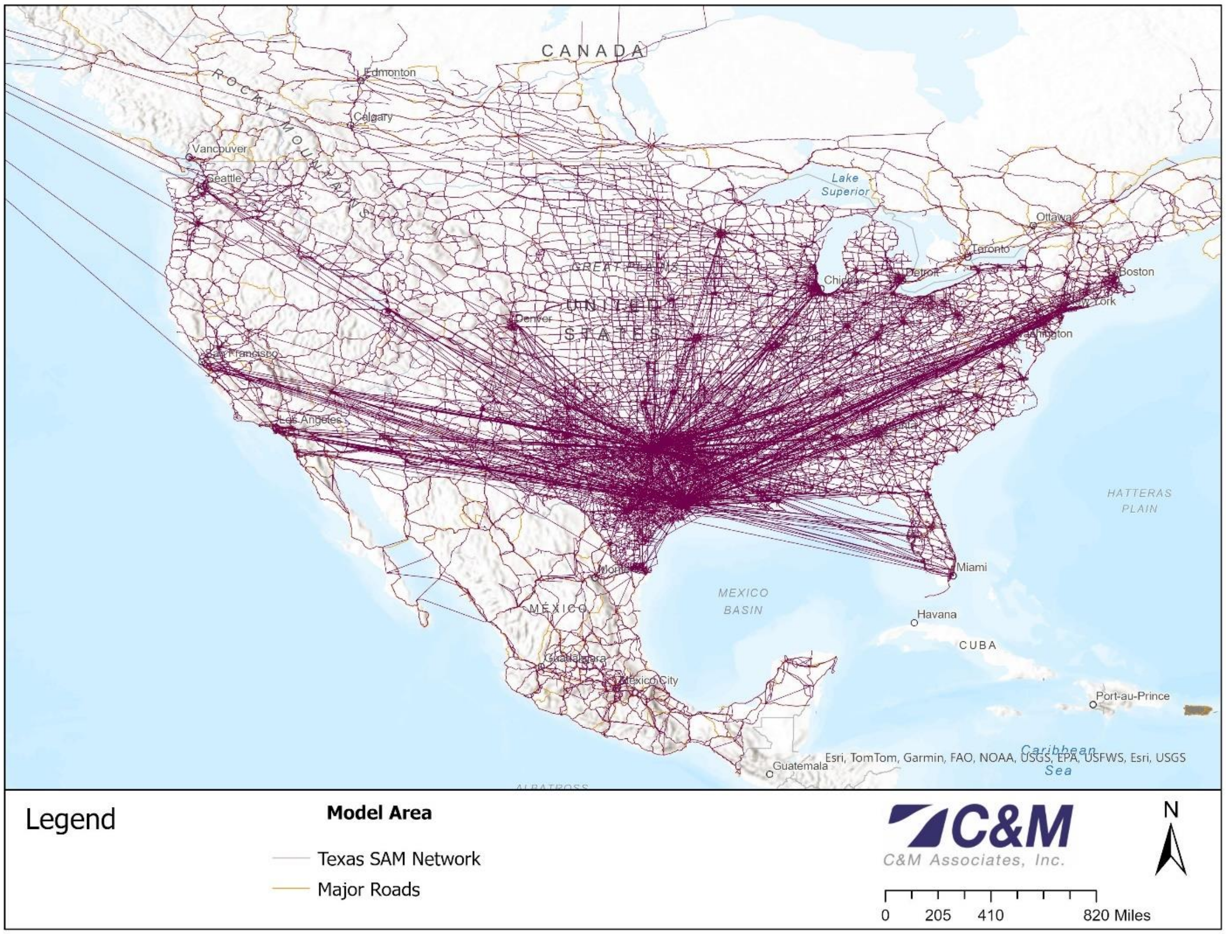


Figure 3-18. Texas SAM-V4 Model Area

3.2.1.2 Model Years and Time-of-Day Periods

The SAM-V4 model used 2015 as its base year, extending its projections across a series of 5- and 10-year model years (specifically 2020, 2025, 2035, 2045, and 2050 as future model years).

Within the temporal framework of this model, distinct TOD periods are considered: AM, MD, PM, and NT (see Table 3-6).

Table 3-6. TOD Periods

Period	Time	Hours
Morning (AM)	06:00 – 7:59	2
Midday (MD)	8:00 – 13:59	6
Afternoon (PM)	14:00 – 17:59	4
Nighttime (NT)	17:59 – 05:59	12

3.2.2 Passenger Model

This section explains the development of the four-step passenger model that is included in the SAM-V4. Trip generation, trip distribution, mode choice, and traffic assignment processes are described below.

3.2.2.1 Trip Generation

The SAM-V4 trip generation model defined and classified trips as short-distance, long-distance, and non-freight truck trips and used the following trip purposes.

Short-Distance Trips

- Home-Based Work (HBW): Trips between the traveler's home and workplace for the purpose of working or work-related activities. These are trips made by Texas residents with a trip distance less than 50 miles.
- Home-Based Other (HBO): Trips between the traveler's home and any other location not defined above. These are trips made by Texas residents with a trip distance less than 50 miles.
- Home-Based K-12 School (HBS): Trips between the traveler's home and a K-12 school to attend school. These are trips made by Texas residents with a trip distance less than 50 miles.
- Non-Home-Based Other (NHBO): Trips between two locations, neither of which are the traveler's home location. These are trips made by Texas residents with a trip distance less than 50 miles that are not carried by commercial services or cargo vehicles.
- Non-Home-Based Visitor (NHBV): Trips made by non-Texas residents while they are in Texas, but the trips are not directly to/from outside Texas.

Long-Distance Trips

- Infrequent Long-Distance Business (ILDB): Trips between the traveler's home and workplace for the purpose of working or work-related activities. Trip distance is greater than 50 miles and less than 400 miles.
- Infrequent Long-Distance Other (ILDO): Trips between the traveler's home and any other location not defined above. Trip distance is greater than 50 miles and less than 400 miles.
- Infrequent Long-Long-Distance Business (ILLDB): Trips between the traveler's home and workplace for the purpose of working or work-related activities. The trip distance is 400 miles or greater.
- Infrequent Long-Long-Distance Other (ILLDO): Trips between the traveler's home and any other location not defined above. The trip distance is 400 miles or greater.

Non-Freight Truck Trips

- Non-Freight Light Truck (LT): Trips made by passenger vehicles and light-duty trucks (classes 2 and 3) for commercial uses.
- Non-Freight Medium Truck (MT): Trips made by trucks with classifications 5 through 7.
- Non-Freight Heavy Truck (HT): Trips made by multi-unit trucks with at least three axles and classifications 8 through 13.

3.2.2.2 Household Size and Income Variables

The selected income group categories are presented in Table 3-7. Income group categories were based on the TxDOT household travel surveys and the 2017 National Household Travel Survey (NHTS). To apply the household size and income cross-classification models, household size and income information were required for each TAZ. Furthermore, two sub-models (household size sub-model and household income sub-model) were developed to stratify zonal households into each cross-classification cell.

Table 3-7. Income Group Categories

Income Group	Income Range (in 2015 Dollars)
1	Less than $25,000
2	$25,00–$49,999
3	$50,000–$99,999
4	$100,000 and above

3.2.2.3 Location Size Variables

The SAM-V4 included categories based on the location of each TAZ for weekday short- and long-distance trip production. Table 3-8 shows the SAM-V4's location categories.

Table 3-8. SAM-V4's Location Categories

Area Type	Description
1. Metropolitan Area 1	Metropolitan area with population < 250,000
2. Metropolitan Area 2	Metropolitan area with population > 250,000 and < 1,000,000
3. Metropolitan Area 3	Metropolitan area with population ≥ 1,000,000
4. Non-Metropolitan Area	Non-metropolitan area

3.2.2.4 Employment Variables

Employment is highly correlated with a location's activity level and is commonly used to estimate zonal attraction. Based on that, the purpose of including these variables is to more accurately predict travel behavior. Texas SAM-V4 used the following employment variables for its passenger model, which were based on the NAICS code.

Table 3-9. Employment Variables

Employment Type	NAICS	Definition
Basic	22	Utilities
	23	Construction
	31-33	Manufacturing
	42	Wholesale Trade
	48-49	Transportation and Warehousing
	5111	Newspaper, Periodical, Book, and Directory Publishers
	5112	Software Publishers
	512	Motion Picture and Sound Recording Industries
	5151	Radio and Television Broadcasting
	5152	Cable and Other Subscription Programming
	5174	Satellite Telecommunications
Service	5171	Wired Telecommunications Carriers
	5172	Wireless Telecommunications Carriers (except Satellite)
	5179	Other Telecommunications
	518	Data Processing, Hosting, and Related Services
	519	Other Information Services
	52	Finance and Insurance
	53	Real Estate and Rental and Leasing
	54	Professional, Scientific, and Technical Services
	55	Management of Companies and Enterprises
	56	Administrative and Support and Waste Management and Remediation Services
	6114	Business Schools and Computer and Management Training
	6115	Technical and Trade Schools
	6116	Other Schools and Instruction
	6117	Educational Support Services
	62	Health Care and Social Assistance
	81	Other Services (except Public Administration)
	92	Public Administration
Retail	44-45	Retail Trade
	491	Postal Service
	51213	Motion Picture and Video Exhibition
	71	Arts, Entertainment, and Recreation
	722	Food Services and Drinking Places
Accommodation	721	Accommodation
Education 1	6111	Elementary and Secondary Schools
Education 2	6112	Junior Colleges
	6113	Colleges, Universities, and Professional Schools
Farm	11	Agriculture, Forestry, Fishing and Hunting
Oil and Gas	21	Mining, Quarrying, and Oil and Gas Extraction

3.2.2.5 Trip Production Rates

Trip production rates define the number of trips generated or "produced" by each household. In the case of home-based trips, both the number of generated trips and trip-end locations are defined by trip production rates. SAM-V4 used trip rates based on the 2017 NHTS to maintain consistency.

Therefore, the cross-classified trip rates used within SAM-V4 by trip purpose are shown in Table 3-10 through Table 3-13.

Table 3-10. Weekday Production Rates for Metropolitan Area 1

Income Group	Household Size	HBW	HBO	HBS	NHB	ILDB	ILDO	ILLB	ILLO
$0-$25K	1	0.26	1.35	0.00	1.00	0.01	0.01	0.00	0.00
	2	0.87	3.16	0.09	1.60	0.02	0.02	0.00	0.00
	3	1.25	4.99	0.75	1.88	0.02	0.05	0.00	0.00
	4	1.34	7.14	1.80	3.02	0.03	0.43	0.00	0.01
$25K-$50K	1	0.67	1.80	0.00	1.31	0.01	0.04	0.00	0.00
	2	1.19	3.47	0.09	2.02	0.02	0.06	0.00	0.01
	3	1.92	5.08	1.16	4.01	0.05	0.06	0.00	0.01
	4	2.16	7.73	3.54	4.13	0.10	0.12	0.00	0.01
$50K-$100K	1	1.12	1.64	0.00	1.66	0.05	0.05	0.00	0.00
	2	1.48	2.96	0.06	4.01	0.08	0.17	0.00	0.01
	3	2.58	4.62	2.12	4.23	0.09	0.27	0.01	0.01
	4	2.65	7.65	2.90	5.61	0.20	0.29	0.01	0.01
$100k+	1	1.51	1.64	0.00	1.67	0.11	0.15	0.00	0.01
	2	1.80	2.99	0.05	3.22	0.12	0.28	0.01	0.02
	3	2.93	4.31	2.12	4.45	0.13	0.32	0.01	0.03
	4	2.94	9.41	2.90	7.55	0.29	0.39	0.02	0.03

Table 3-11. Weekday Production Rates for Metropolitan Area 2

Income Group	Household Size	HBW	HBO	HBS	NHB	ILDB	ILDO	ILLB	ILLO
$0-$25K	1	0.43	1.98	0.00	1.45	0.00	0.01	0.00	0.00
	2	0.88	4.34	0.24	1.60	0.00	0.02	0.00	0.00
	3	1.28	4.49	0.68	1.88	0.00	0.03	0.00	0.00
	4	2.09	6.42	3.52	3.63	0.01	0.03	0.00	0.01
$25K-$50K	1	0.58	1.76	0.00	1.70	0.01	0.04	0.00	0.00
	2	1.27	3.90	0.09	2.02	0.01	0.05	0.00	0.01
	3	1.79	4.41	0.91	2.42	0.01	0.09	0.00	0.01
	4	2.54	8.38	2.94	4.34	0.02	0.15	0.00	0.01
$50K-$100K	1	0.88	1.73	0.00	1.19	0.03	0.05	0.00	0.00
	2	1.32	3.07	0.03	2.48	0.04	0.07	0.00	0.01
	3	2.08	5.29	0.52	2.82	0.07	0.12	0.01	0.01
	4	2.30	7.44	2.72	4.71	0.11	0.22	0.01	0.01
$100k+	1	1.17	1.71	0.00	1.55	0.03	0.05	0.00	0.01
	2	1.80	3.19	0.03	2.42	0.07	0.11	0.01	0.02
	3	1.92	6.22	0.81	4.45	0.08	0.16	0.01	0.03
	4	2.76	7.55	3.19	5.46	0.17	0.19	0.02	0.03

Table 3-12. Weekday Production Rates for Metropolitan Area 3

Income Group	Household Size	HBW	HBO	HBS	NHB	ILDB	ILDO	ILLB	ILLO
$0-$25K	1	0.32	1.57	0.00	1.00	0.00	0.01	0.00	0.00
	2	0.85	2.76	0.29	1.60	0.01	0.02	0.00	0.00
	3	1.52	4.06	1.26	2.84	0.02	0.03	0.00	0.00
	4	1.77	6.17	2.96	3.23	0.03	0.05	0.00	0.01
$25K-$50K	1	0.64	1.58	0.00	1.36	0.01	0.02	0.00	0.00
	2	1.21	3.09	0.16	2.01	0.03	0.05	0.00	0.01
	3	1.69	4.73	1.17	3.15	0.03	0.06	0.00	0.01
	4	1.91	6.30	3.12	3.89	0.04	0.08	0.00	0.01
$50K-$100K	1	0.86	1.65	0.00	1.63	0.02	0.04	0.00	0.00
	2	1.36	3.11	0.12	2.20	0.04	0.07	0.00	0.01
	3	1.83	4.77	1.13	3.12	0.05	0.08	0.01	0.01
	4	2.34	6.84	3.03	4.25	0.08	0.15	0.01	0.01
$100k+	1	0.92	1.53	0.00	1.41	0.03	0.04	0.00	0.01
	2	1.58	3.00	0.03	2.30	0.04	0.10	0.01	0.02
	3	2.06	4.08	1.13	3.08	0.07	0.12	0.01	0.03
	4	2.10	7.48	3.38	4.39	0.08	0.15	0.02	0.03

Table 3-13. Weekday Production Rates for Metropolitan Area 4

Income Group	Household Size	HBW	HBO	HBS	NHB	ILDB	ILDO	ILLB	ILLO
$0-$25K	1	0.22	1.95	0.00	1.47	0.00	0.02	0.00	0.00
	2	0.70	2.81	0.15	1.90	0.01	0.04	0.00	0.00
	3	1.56	3.93	0.86	2.65	0.02	0.07	0.00	0.00
	4	1.80	5.14	3.62	4.37	0.03	0.13	0.00	0.01
$25K-$50K	1	0.93	1.95	0.00	1.60	0.01	0.09	0.00	0.00
	2	1.11	2.81	0.02	2.86	0.12	0.16	0.00	0.01
	3	1.66	4.53	1.40	3.42	0.16	0.21	0.00	0.01
	4	2.03	5.21	3.76	4.43	0.32	0.24	0.00	0.01
$50K-$100K	1	0.82	1.95	0.00	1.71	0.04	0.15	0.00	0.00
	2	1.06	2.83	0.03	2.90	0.16	0.38	0.00	0.01
	3	2.40	4.62	1.40	3.56	0.29	0.45	0.01	0.01

3.2.2.6 Trip Attraction Rates

Trip attraction rates define the number of trips generated or "attracted" to locations outside of the home. For home-based trips, trip attractions represent the non-home end of each trip. SAM-V4 adopts a destination choice model which does not require attraction rates as input. However, HBS, NHBV, and non-freight truck trip purposes are distributed using a gravity model which does require the development of attraction rates and are shown in Table 3-14 though Table 3-16.

Table 3-14. HBS Attraction Rates

Variable	Person Trip Rate
K-12 Employment	21

Table 3-15. Non-Freight Truck Trip Generation Rates

Variables	LT	MT	HT
Household	0.0110	0.0002	0.0000
Basic Employment	0.0010	0.0194	0.0445
Retail Employment	0.0020	0.0276	0.0356
Service Employment	0.0010	0.0010	0.0105
K-12 Employment (Education 1)	0.0000	0.0100	0.0000
College & University Employment (Education 2)	0.0000	0.0100	0.0000
Accommodation Employment	0.0000	0.0000	0.0050
Farm Employment	0.4000	0.3000	0.3000
Number of Oil and Gas Wells	0.0000	2.0000	4.0000

Table 3-16. NHBV Trip Generation Rates

Variable	Weekday
Retail	0.0712
Accommodation	6.0000
Number of National Park Visitors	0.006

3.2.2.7 Trips To and From External Locations

The SAM-V4 model applied an external trip model, which is an integral part of the overall demand model and accounts for trips with at least one end outside of Texas. The model included the following:

- Internal-to-external trips (IE) with production ending inside Texas.
- External-to-internal (EI) trips with production outside Texas.
- External-to-external (EE) trips with trips that pass through Texas.

SAM-V4 included 154 external locations, among which 31 are along the Texas-Mexico border, which are shown in Figure 3-19 and detailed in Table 3-17.

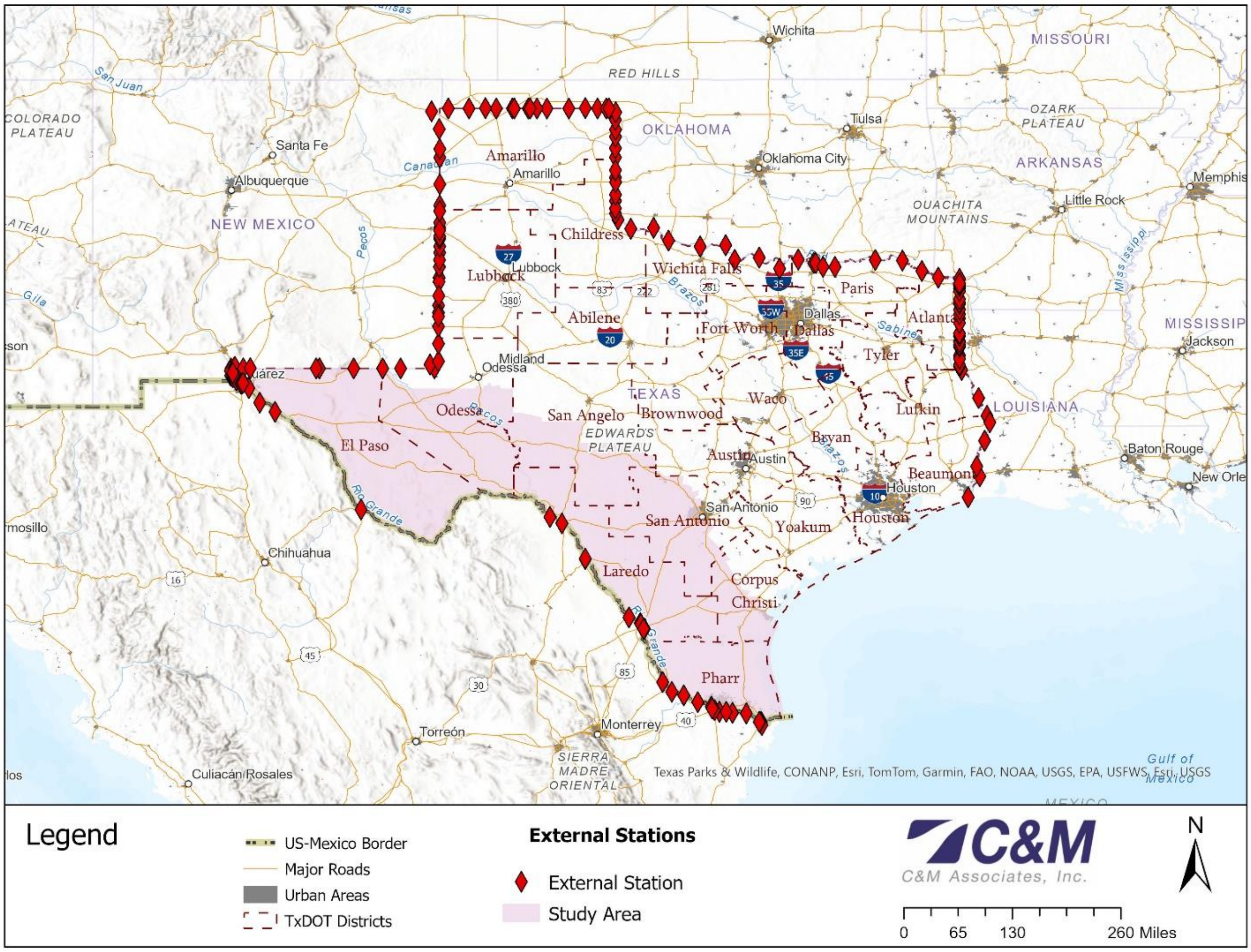


Figure 3-19. SAM-V4 External Locations

Table 3-17. 2015 Daily Volumes at SAM-V4's External Location by Vehicle Type

No.	Station ID	Station Name	Passenger Trips	Truck Trips	Total Trips
1	4401	Port of Brownsville (Proposed)	N/A	N/A	0
2	4402	Gateway International Bridge	6,800	N/A	6,800
3	4403	Brownsville & Matamoros (B&M) Bridge	8,200	N/A	8,200
4	4404	Veterans International Bridge	6,800	1,000	7,800
5	4405	Free Trade Bridge	2,200	200	2,400
6	4406	Weslaco-Progreso International Bridge	2,600	200	2,800
7	4407	Donna International Bridge	3,200	N/A	3,200
8	4408	Pharr-Reynosa International Bridge	6,200	3,000	9,200
9	4409	McAllen-Hidalgo International Bridge	12,800	N/A	12,800
10	4410	Anzalduas International Bridge	6,000	N/A	6,000
11	4411	Mission International Bridge (Proposed)	N/A	N/A	0
12	4412	Los Ebanos Ferry	200	N/A	200
13	4413	Camargo Bridge	2,000	200	2,200
14	4414	Roma-Ciudad Miguel Aleman International Bridge	3,600	40	3,640
15	4415	Lake Falcon Dam International Crossing	400	N/A	400
16	4416	Juarez-Lincoln International Bridge	22,200	N/A	22,200
17	4417	Gateway to the Americas Bridge	5,200	N/A	5,200
18	4418	World Trade Bridge	N/A	9,000	9,000
19	4419	Colombia Solidarity Bridge	1,200	2,000	3,200
20	4420	Camino Real International Bridge	8,000	800	8,800
21	4421	Eagle Pass International Bridge	6,200	N/A	6,200
22	4422	Del Rio International Bridge	7,800	400	8,200
23	4423	Lake Amistad Dam Crossing	200	N/A	200
24	4424	Presidio-Ojinaga International Bridge	3,600	40	3,640
25	4425	Fort Hancock-El Porvenir Bridge	400	N/A	400
26	4426	Tornillo-Guadalupe International Bridge	1,200	N/A	1,200
27	4427	Ysleta Bridge	23,600	1,600	25,200
28	4428	Bridge of the Americas	21,200	2,600	23,800
29	4429	Good Neighbor Bridge	5,600	N/A	5,600
30	4430	Paso del Norte Bridge	5,600	N/A	5,600
31	4432	Laredo V International Bridge (Proposed)	N/A	N/A	0
32	4501	I-10	30,505	6,495	37,000
33	4502	SH 20	10,986	274	11,260
34	4503	FM 3255	6,435	555	6,990
35	4504	US 54 and BUS 54A	10,496	904	11,400
36	4505	FM 1437	24	6	30
37	4506	FM 1576	32	8	40
38	4507	US 82	982	248	1,230
39	4508	US 285	3,165	735	3,900

No.	Station ID	Station Name	Passenger Trips	Truck Trips	Total Trips
40	4509	US 62	1,980	460	2,440
41	4510	US 380	1,086	274	1,360
42	4511	RM 652	2,337	543	2,880
43	4512	US 60 and US 70	9,342	2,698	12,040
44	4513	FM 1058	109	21	130
45	4514	I-40	7,477	5,323	12,800
46	4515	Frying Pan Ranch Road	120	N/A	120
47	4516	SH 18	2,297	533	2,830
48	4517	SH 102	222	58	280
49	4518	SL 14	14,282	288	14,570
50	4519	Combined externals in Texarkana	13,724	276	14,000
51	4520	US 87	2,864	746	3,610
52	4521	Combined externals in Texarkana	33,329	671	34,000
53	4522	Combined externals in Texarkana	9,705	195	9,900
54	4523	US 287	825	1,725	2,550
55	4524	SH 245	9,798	2,842	12,640
56	4525	SH 136	237	243	480
57	4526	US 83	1,914	706	2,620
58	4527	US 54	2,232	2,288	4,520
59	4528	SH 23	906	334	1,240
60	4529	Combined externals in Texarkana	543	157	700
61	4530	FM 251	320	130	450
62	4531	FM 249	1,009	411	1,420
63	4532	SH 15	281	149	430
64	4533	US 60	998	532	1,530
65	4534	SH 33	684	76	760
66	4535	I-40	5,746	6,054	11,800
67	4536	SH 152	1,799	401	2,200
68	4537	SH 203	114	26	140
69	4538	US 62	577	233	810
70	4539	US 70	1,031	169	1,200
71	4540	CR 249	1,421	579	2,000
72	4541	I-44	9,515	1,555	11,070
73	4542	FM 125	599	121	720
74	4543	US 81	908	422	1,330
75	4544	SH 49	916	184	1,100
76	4545	FM 1999	341	69	410
77	4546	I-35	34,520	9,480	44,000
78	4547	Mt. Zion Road	360	40	400
79	4548	US 80	1,650	1,030	2,680

No.	Station ID	Station Name	Passenger Trips	Truck Trips	Total Trips
80	4549	US 377	2,320	280	2,600
81	4550	SH 78	813	257	1,070
82	4551	US 69	33,159	4,001	37,160
83	4552	US 271	8,995	1,145	10,140
84	4553	FM 451	653	407	1,060
85	4554	US 79	3,878	2,122	6,000
86	4555	FM 123	752	108	860
87	4556	FM 2517	568	82	650
88	4557	FM 3359	315	45	360
89	4558	SH 8	3,016	1,004	4,020
90	4559	US 59	11,065	3,515	14,580
91	4560	I-30	34,575	21,965	56,540
92	4561	US 67	11,505	3,655	15,160
93	4562	FM 31	1,171	169	1,340
94	4563	Stratford Lake Road	500	N/A	500
95	4564	FM 692	617	133	750
96	4565	I-20	23,470	14,650	38,120
97	4566	NM 273	3,150	350	3,500
98	4567	SH 77	1,607	323	1,930
99	4568	US 84	8,469	1,221	9,690
100	4569	SH 184	7,650	850	8,500
101	4570	SH 178	4,050	450	4,500
102	4571	SH 21	2,016	434	2,450
103	4572	FM 259 and FM 260	5,193	447	5,640
104	4573	SH 63	897	193	1,090
105	4574	FM 1905	5,524	476	6,000
106	4575	US 190	1,751	639	2,390
107	4576	SH 12	2,076	254	2,330
108	4577	I-10	29,890	13,460	43,350
109	4578	SH 82	3,312	288	3,600
110	4579	FM 2586	54	6	60
111	4580	US 385	373	97	470
112	4581	FM2677	54	6	60
113	4582	FM 1290	333	37	370
114	4583	FM 1262	180	20	200
115	4584	SH 207	306	34	340
116	4585	FM 1261	171	19	190
117	4586	RM 2248	135	15	150
118	4587	FM 2741	54	6	60
119	4588	FM 1454	117	13	130

No.	Station ID	Station Name	Passenger Trips	Truck Trips	Total Trips
120	4589	FM 3004	222	118	340
121	4590	RM 2758	90	10	100
122	4591	FM 2124	405	45	450
123	4592	CR 30	108	12	120
124	4593	FM 1439	18	2	20
125	4594	FM 338	144	16	160
126	4595	FM 680	36	4	40
127	4596	SH 6	414	46	460
128	4597	US 283	1,129	361	1,490
129	4598	SH 79	853	397	1,250
130	4599	FM 677	198	92	290
131	4600	SH 91	2,017	243	2,260
132	4601	FM 120	798	252	1,050
133	4602	SH 37	2,298	632	2,930
134	4603	US 259	2,369	651	3,020
135	4604	SH 128	1,710	370	2,080
136	4605	SH 176	2,137	463	2,600
137	4606	US 62	5,795	1,255	7,050
138	4607	FM 1757	439	31	470
139	4608	SH 83	2,127	153	2,280
140	4609	FM 1585	88	22	110
141	4610	SH 125	96	24	120
142	4611	SH 114	117	43	160
143	4612	FM 54	40	10	50
144	4613	FM 298	8	2	10
145	4614	FM 746	56	14	70
146	4615	FM 1760	769	281	1,050
147	4616	FM 3125	176	64	240
148	4617	CR 12	3,725	1,075	4,800
149	4618	FM 2290	652	78	730
150	4619	FM 2013	87	23	110
151	4620	US 54	1,326	194	1,520
152	4621	RM 3296	35	5	40
153	4622	Sunland Park Drive	9,900	1,100	11,000
154	4633	La Union Street	900	100	1,000

3.2.2.8 Trip Distribution

The trip distribution process of SAM-V4 is carried out by destination choice models for short-distance trips (HBW, HBO, NHB) and long-distance purposes (ILDB, ILDO, ILLB and ILLO); and by gravity models for HBS, NHBV, and non-freight truck trips. Both models were based on 2017 NHTS data and the TXDOT household travel survey data.

Destination Choice Models

Table 3-18 to Table 3-20 show the resulting destination choice terms for each impedance and size variable and by location and trip purpose.

Table 3-18. HBW Destination Choice Parameters

Variables	Metropolitan Area 1	Metropolitan Area 2	Metropolitan Area 3	Non-Metropolitan Area
Impedance Variable				
Time	-0.09	-0.10	-0.22	-0.17
Airport Flag	0.13	0.12	0.63	0.00
Hospital Flag	0.02	0.02	0.02	0.01
Military Base Flag	-0.01	-0.02	-0.02	-0.01
Oil and Gas Well Flag	0.10	0.10	0.00	0.20
Size Variables				
Basic Employment	3.01	6.44	2.34	1.23
Retail Employment	1.94	1.83	2.64	0.67
Service Employment	1.00	1.00	1.00	1.00
K-12 Employment (Education 1)	1.22	1.27	1.45	1.70
College and University Employment (Education 2)	1.95	2.73	0.91	0.16
Accommodation Employment	16.56	4.72	4.72	10.15
Oil and Gas Employment	1.61	10.71	1.15	1.61
Farm Employment	8.83	2.85	16.91	2.91
Number of Oil and Gas Wells	1.10	1.10	0.00	1.10

Table 3-19. HBO Destination Choice Parameters

Variables	Metropolitan Area 1	Metropolitan Area 2	Metropolitan Area 3	Non-Metropolitan Area
Impedance Variable				
Time	-0.15	-0.16	-0.24	-0.17
Airport Flag	0.95	0.44	0.67	0.51
Hospital Flag	0.25	0.16	0.14	0.37
Military Base Flag	-0.02	-0.02	-0.03	-0.02
Oil and Gas Well Flag	0.02	0.02	0.00	0.10
Size Variables				
Household	1.51	1.12	1.94	1.19
Basic Employment	0.30	0.24	0.24	0.30
Retail Employment	3.85	11.36	21.78	7.24
Service Employment	1.00	1.00	1.00	1.00
College and University Employment (Education 2)	3.12	3.09	3.16	3.19
Accommodation Employment	17.73	2.10	1.20	19.90
Oil and Gas Employment	2.77	7.34	0.33	2.77
Farm Employment	6.62	4.14	0.01	1.41

Table 3-20. NHB Destination Choice Parameters

Variables	Metropolitan Area 1	Metropolitan Area 2	Metropolitan Area 3	Non-Metropolitan Area
Impedance Variable				
Time	-0.11	-0.12	-0.21	-0.17
Airport Flag	0.41	0.25	0.08	0.24
Hospital Flag	0.12	0.18	0.04	0.04
Military Base Flag	-0.01	-0.01	-0.03	-0.01
Oil and Gas Well Flag	0.02	0.02	0.00	0.10
Size Variables				
Household	2.75	6.33	7.12	2.80
Basic Employment	0.44	2.42	1.64	0.72
Retail Employment	7.51	12.32	24.91	8.98
Service Employment	1.00	1.00	1.00	1.00
K-12 Employment (Education 1)	2.16	3.32	8.75	2.84
College and University Employment (Education 2)	2.23	5.21	0.84	2.23
Accommodation Employment	6.44	7.22	7.85	5.30
Oil and Gas Employment	2.01	0.39	0.19	2.91
Farm Employment	3.62	11.75	0.45	5.46

Gravity Models

For HBS, NHBV, and non-freight truck trip distribution, a gamma function-based singly constrained gravity model formulation is used. The gamma function is:

$$f(x_{ij}) = a x_{ij}^{-b} \cdot exp \cdot (-cx)$$

Where:

- *a*, *b*, and *c* are parameters to be calibrated during model validation, and
- *x* is the impedance.

Table 3-21 show the friction factors terms for HBS, NHBV, and non-freight truck trips.

Table 3-21. Friction Factor Parameters

Purpose	Location	a	b	c
HBS	1	100	0.5	0.3
	2	100	0.5	0.3
	3	100	0.5	0.3
	4	100	0.5	0.3
NHBV	All	100	0.01	0.175
LT	All	100	0.6	0.0961
MT	All	100	0.3	0.0723
HT	All	100	0.01	0.0474

3.2.2.9 Mode Choice

SAM-V4 applies different approaches to estimate the mode-choice step in the travel demand process. In mode choice, SAM-V4 split the trips into short- and long-distance-trips to avoid unnecessary skims calculations and speed up the mode-choice process.

Short-Distance Trips

Short-distance trips, as previously mentioned, include HBW, HBO, HBS, NHB, and NHBV trips, and their mode-share factors were based on the 2017 NHTS and are shown in Table 3-22.

Table 3-22. Mode Share Factors for Weekdays

Income Level	Trip Purpose	No Transit Available Area				Bus Available Area				Urban Rail Available Area			
		Drive Alone	Share Ride 2	Share Ride 3+	Other	Drive Alone	Share Ride 2	Share Ride 3+	Other	Drive Alone	Share Ride 2	Share Ride 3+	Other
$0-$25K	HBW	0.79	0.16	0.05	-	0.7	0.16	0.05	0.1	0.66	0.16	0.05	0.13
	HBO	0.46	0.29	0.25	-	0.34	0.29	0.25	0.11	0.31	0.29	0.25	0.15
	NHB	0.46	0.3	0.24	-	0.36	0.3	0.24	0.1	0.33	0.3	0.24	0.13
	HBS	0.12	0.23	0.36	0.29	0.12	0.23	0.36	0.29	0.12	0.23	0.36	0.29
$25K-$50K	HBW	0.83	0.12	0.06	-	0.76	0.12	0.06	0.07	0.72	0.12	0.06	0.1
	HBO	0.45	0.31	0.24	-	0.4	0.31	0.24	0.05	0.38	0.31	0.24	0.07
	NHB	0.49	0.28	0.23	-	0.42	0.28	0.23	0.08	0.39	0.28	0.23	0.1
	HBS	0.14	0.32	0.34	0.21	0.14	0.32	0.34	0.21	0.14	0.32	0.34	0.21
$50K-$100K	HBW	0.86	0.11	0.03	-	0.83	0.11	0.03	0.03	0.81	0.11	0.03	0.05
	HBO	0.48	0.32	0.21	-	0.45	0.32	0.21	0.03	0.43	0.32	0.21	0.04
	NHB	0.54	0.27	0.19	-	0.49	0.27	0.19	0.05	0.48	0.27	0.19	0.06
	HBS	0.12	0.32	0.36	0.2	0.12	0.32	0.36	0.2	0.12	0.32	0.36	0.2
$100k+	HBW	0.89	0.09	0.01	-	0.85	0.09	0.01	0.04	0.83	0.09	0.01	0.06
	HBO	0.44	0.3	0.26	-	0.43	0.3	0.26	0.01	0.42	0.3	0.26	0.02
	NHB	0.53	0.26	0.21	-	0.49	0.26	0.21	0.04	0.45	0.26	0.21	0.07
	HBS	0.16	0.31	0.39	0.14	0.16	0.31	0.39	0.14	0.16	0.31	0.39	0.14
All	NHBV	0.35	0.29	0.36	-	0.33	0.29	0.36	0.02	0.3	0.29	0.36	0.05

Long-Distance Trips

The SAM-V4's long-distance mode choice applies a nested model structure. The logit choice model is based on random utility theory in which the probability of choosing an alternative is a function of the utilities associated with the alternatives. SAM-V4 long-distance mode choice module includes Drive Alone, Shared Ride 2 (SR2), Shared Ride 3 and more (SR3+), Intercity Rail/Amtrak Rail (ICR), High Speed Rail (HSR), and Air as transportations modes and has four levels of nesting logit structure, as shown in Figure 3-20.

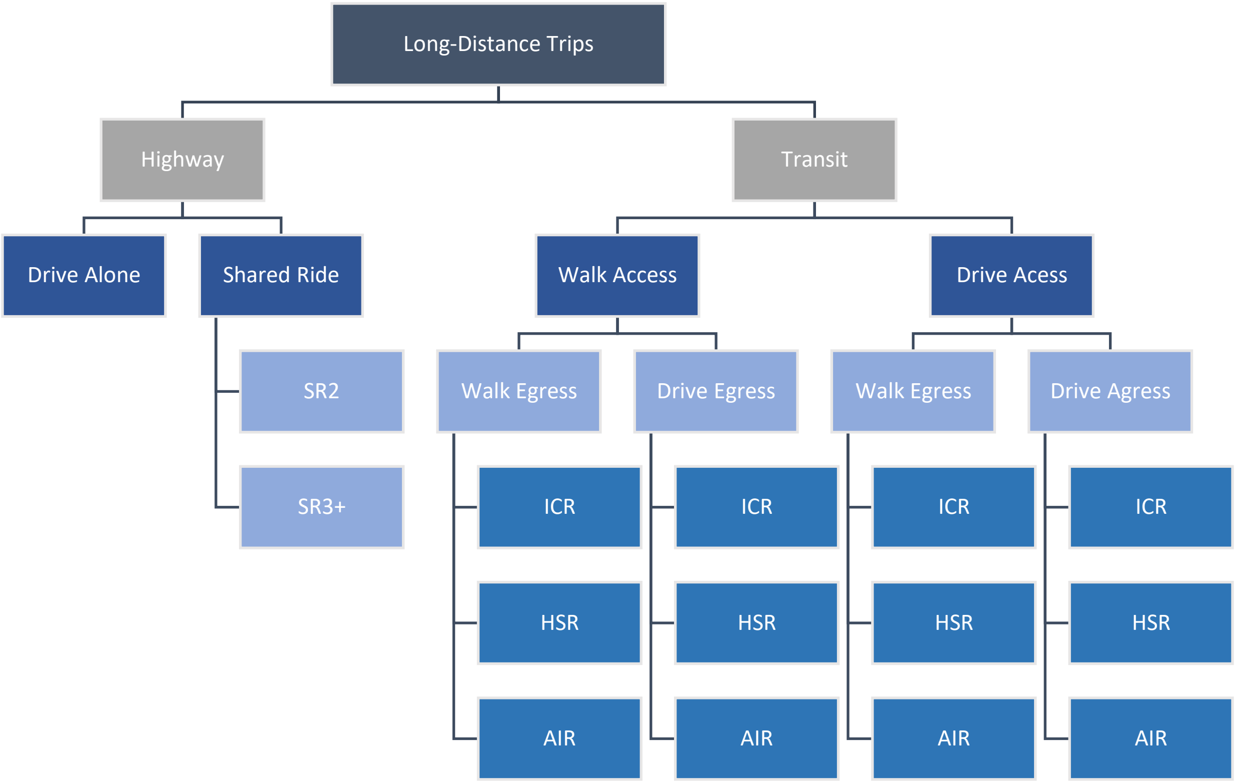


Figure 3-20. SAM-V4's Long-Distance Mode Choice Structure

3.2.2.10 Traffic Assignment

For each of the four time periods, traffic assignments are carried out. For the highway assignment, a Multi-Modal Multi-Class Assignment routine is used in SAM-V4 for passenger vehicles and trucks (both non-freight and freight trucks). SAM-V4 employs the capability of incorporating value-of-time, operating cost, and tolls into a generalized cost function.

Furthermore, according to SAM-V4, each mode or class is allowed to have a different volume delay function (VDF) parameter, toll cost, and value of time (VOT) to reflect different congestion impacts and route choice behaviors. A flexible toll cost function is included in SAM-V4 by varying toll costs by vehicle class and by peak and off-peak time periods.

3.2.3 Freight Model

SAM-V4 developed a four-step model (trip generation, trip distribution, mode choice, and traffic assignment) for freight truck trips, which is combined with passenger trips for the final assignment process. SAM-V4 used Transearch data for freight trip estimation using annual tons by 15 commodity groups for truck, carload train, intermodal rail, water, and air modes, and for each production and attraction zone. The commodity groups are listed in Table 3-23.

Table 3-23. SAM-V4 Commodity Groups

Commodity Number	Commodity Name
1	Agriculture
2	Metallic Ores and Coal Mining
3	Crude Petroleum or Natural Gas
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 and Misc. Mixed

3.2.3.1 Freight Generation

The freight generation step in the freight model is used to generate the quantities of commodities at each end of the freight movement. SAM-V4 freight trip generation used annual tons as the unit of measurement for zonal productions and attractions. The estimation of freight trip productions and attractions was realized through statistical regression between freight tonnage by commodity group and zonal socioeconomic inputs. The TAZ-level production and attraction rates are used for disaggregating county-level tonnages to the TAZ level to prepare the truck trip assignment.

As shown in the Passenger Model, the employment variables were useful to predict travel behavior. Furthermore, SAM-V4 used employment variables that are highly related to freight activities. This employment variables were based on the NAICS codes and are listed in Table 3-24.

Table 3-24. SAM-V4 Employment Variables for the Freight Model

NAICS Code	NAICS Name
11	Agriculture, Forestry, Fishing, and Hunting
21	Mining
211	Oil and Gas Extraction
212	Mining (except Oil and Gas)
213	Support Activities for Mining
31	Consumer Product Manufacturing
311	Food Manufacturing
312	Beverage and Tobacco Product Manufacturing
313	Textile Mills
314	Textile Product Mills
315	Apparel Manufacturing
316	Leather and Allied Product Manufacturing
32	Non-Durable Products Manufacturing
321	Wood Product Manufacturing
322	Paper Manufacturing
323	Printing and Related Support Activities
324	Petroleum and Coal Products Manufacturing
325	Chemical Manufacturing
326	Plastics and Rubber Products Manufacturing
327	Non-Metallic Mineral Product Manufacturing
33	Durable Products Manufacturing
331	Primary Metal Manufacturing
332	Fabricated Metal Product Manufacturing
333	Machinery Manufacturing
334	Computer and Electronic Product Manufacturing
335	Electrical Equipment, Appliance, and Component Manufacturing
336	Transportation Equipment Manufacturing
337	Furniture and Related Product Manufacturing
339	Miscellaneous Manufacturing
42	Wholesale Trade
48-49	Transportation and Warehousing

Trip production and attraction rates used for freight estimation trips are described below.

Texas Production Rates

Production equations were estimated for 13 out of 15 commodity groups defined for the SAM-V4 freight model. Regression equations were not estimated for CG2 (metallic ores and coal mining) and CG3 (crude petroleum or natural gas) since production of commodities in these two groups are highly related to mine or oil and gas extraction locations in specific Texas counties, but the NAICS employment categories do not provide enough details to reflect these specific locations. The productions equation for CG1 (agriculture) had a very poor statistical relationship with covered employment in any industrial sector; therefore, the county productions from the Transearch were also for CG1. Table 3-25 presents the final production rates applied in the freight model from CG4 to CG15.

Table 3-25. Freight Production Rates

Commodity Group No.	Commodity Group Name	Variable	Coefficient
4	Non-Metallic Minerals	NAICS 212	20610.94
		NAICS 327	2469.12
5	Food	NAICS 311	272.54
		NAICS 312	1380.62
6	Consumer Manufacturing	NAICS 31	6.53
7	Non-Durable Manufacturing	NAICS 32	30.73
8	Lumber	NAICS 321	346.92
9	Durable Manufacturing	NAICS 33	111.15
10	Paper	NAICS 322	323.19
11	Chemicals	NAICS 325	2404.36
12	Petroleum	NAICS 324	7543.95
13	Clay, Concrete, Glass	NAICS 327	3382.85
14	Primary Metal	NAICS 331	264.31
		NAICS 332	44.21
15	Secondary and Misc. Mixed	NAICS 42	136.77
		NAICS 48-49	245.31

Texas Attraction Rates

Table 3-26 presents the final production rates applied in the freight model. The attraction equations were developed through the estimation of linear regressions of the 2015 Transearch data and population and employment on a county basis. SAM-V3 freight attraction equations were used for the initial selection of appropriate employment and population variables.

Is important to mention that the attraction equations were estimated for 13 out of 15 commodity groups defined for the SAM-V4 freight model. Regression equations were not estimated for CG2 (metallic ores and coal mining) and CG3 (crude petroleum or natural gas) since the attraction of commodities in these two groups are highly related to power plants and refineries in Texas.

Table 3-26. Freight Attraction Rates

Commodity Group No.	Commodity Group	Variable	Coefficient
1	Agriculture	Population	1.85
4	Non-Metallic Minerals	Population	9.30
		NAICS 42	146.61
5	Food	Population	1.62
		NAICS 42	22.47
6	Consumer Manufacturing	NAICS 42	3.05
7	Non-Durable Manufacturing	Population	0.08
		NAICS 42	11.83
8	Lumber	Population	0.21
		NAICS 42	26.02
9	Durable Manufacturing	Population	0.83
		NAICS 42	56.74
10	Paper	Population	0.16
		NAICS 42	7.76
11	Chemicals	NAICS 325	5604.50
12	Petroleum	Population	6.08
		NAICS 324	2030.85
13	Clay, Concrete, Glass	Population	1.19
		NAICS 42	128.59
14	Primary Metal	Population	0.21
		NAICS 42	22.23
15	Secondary and Misc. Mixed	NAICS 42	197.64

3.2.3.2 Freight Distribution

The gravity model is a fundamental tool used in transportation to estimate the interaction between different zones. In SAM-V4, the gravity model was used in the freight distribution step to estimate the flows of goods between the freight model regions. In this case, the gravity model for freight models assumes movement between a zone pair is a function of the magnitude of the total productions and attractions in two zones and the travel impedance between the zones.

The SAM-V4 freight model adopted a gravity distribution model in which the friction factor was a negative exponential of the impedance between a zone pair. The equation is expressed below.

$$T_{ij} = K'_i * K"_j * P_i * A_j * exp * (-\beta * C_{ij})$$

Where:

T_{ij} = Freight tonnage movement between zone i and zone j;

K'_i *and* K''_j = the adjustment factors for zone i and zone j, respectively;

P_i = the productions in zone i;

A_j = the attraction in zone *j;*

exp ( ) = the exponential function;

C_{ij} = the impedance between zone *i* and zone *j; and*

β = the coefficient applied to impedance in the exponential function.

Friction Factors

The friction factors to be used in the SAM-V4 freight distribution are calculated as a negative exponential function of the impedance between an origin zone and destination zone for each commodity group. Since freight trucks traveling on the highway have the greatest share of freight movements highway distance was used as impedance for the SAM-V4 freight distribution.[14]

The friction faction function is shown below.

$$FF_{cij} = exp * (-1 \div ATL_c * d_{ij})$$

Where:

FF_{cij} = friction factor for OD pair *ij* and commodity group *c*,

ATL_c = average travel length for commodity group *c*, and

d_{ij} = highway distance for OD pair *ij*.

Table 3-27 show the values for average travel length that were used in the equation.

Table 3-27. Weighted Average Trip Length by Commodity Group

Commodity Group No.	Name	Average Trip Length (Miles)
1	Agriculture	519
2	Metallic Ores and Coal Mining	895
3	Crude Petroleum or Natural Gas	1184
4	Non-Metallic Minerals	213
5	Food	685
6	Consumer Manufacturing	1069
7	Non-Durable Manufacturing	710
8	Lumber	721
9	Durable Manufacturing	730
10	Paper	759
11	Chemicals	605
12	Petroleum	301
13	Clay, Concrete, and Glass	228
14	Primary Metal Product	730
15	Secondary and Miscellaneous Mix	479

Table 3-28 shows the final friction factors applied in the SAM-V4 freight distribution process.

Table 3-28. Freight Distribution Friction Factors

Commodity Group No.	Name	Friction Factor
1	Agriculture	0.0029
2	Coal and Metallic Ore Mining	0.0011
3	Crude Petroleum or Natural Gas	0.0006
4	Non-Metallic Minerals	0.0107
5	Food	0.0012
6	Consumer Manufacturing	0.0006
7	Non-Durable Manufacturing	0.0017
8	Lumber	0.0024
9	Durable Manufacturing	0.0007
10	Paper	0.0013
11	Chemicals	0.0041
12	Petroleum	0.0061
13	Clay, Concrete, and Glass	0.0078
14	Primary Metal Product	0.0008
15	Secondary and Miscellaneous Mix	0.0005

3.2.3.3 Freight Mode Choice

SAM-V4 employs sophisticated methodologies to analyze and predict the choice of transportation modes for freight movements. This step has two main purposes: 1) to produce an accurate truck and rail tonnage forecast, and 2) to provide the ability to test various modal policies.

The SAM-V4 freight mode choice model is presented in Figure 3-21.

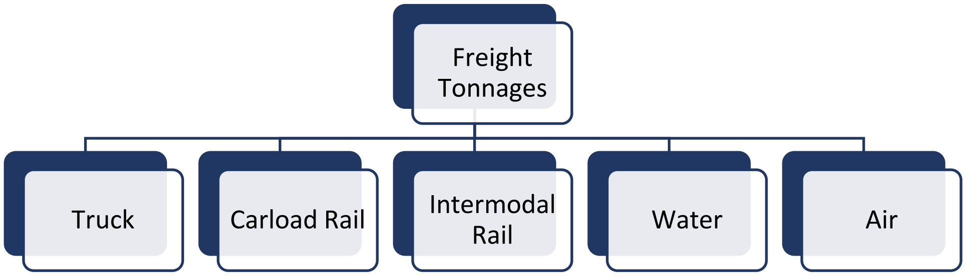


Figure 3-21. Freight Mode Choice Model Structure

Mode Choice Utility Equations

Multinomial logit (MNL) models were developed for SAM-V4 to estimate the effect of shipping cost, travel time, and number of intermodal facilities available to the origin in the mode choice for each commodity group. The dependent variable in the model is the percentage of tons traveling by truck, carload, and intermodal rail (IMX) for each OD pair. The existing flows reported in the Transearch data were used to develop a model. Each ton represented a unit of choice, which is why all modal utilities impedances were specified as cost or time per ton. Using trucks as a base mode and including no constants for the truck mode, the final model coefficients for each commodity group are presented in Table 3-29.

Table 3-29. Freight Mode Choice Model Coefficients

Commodity Group No.	Carload Constant	IMX Constant	Cost Coefficient	Time Coefficient	No. of IMX Coefficient
1	5.4809	-0.4277	-0.0063	0	0.0469
2	4.1237	-3.1	-0.0032	-0.0584	0
3	3.549	0	0	-0.0162	0
4	-0.6799	-8.4338	-0.0061	0	0.0998
5	-3.2788	-2.7486	-0.0058	0	0.0406
6	0	0	-0.0019	-0.042	0.0409
7	-3.7565	-6.5606	-0.0059	0	0.0279
8	-4.0162	-8.0001	-0.0011	-0.0131	0.0461

3.2.3.4 Freight Truck Assignment

The SAM-V4 freight model includes a zonal structure which was based upon aggregated counts outside of Texas and counties within Texas. For this step, freight tonnage at the county level was forecasted on an annual basis and was converted to daily truck trips to be assigned on the network. The conversion was made through the following steps.

Disaggregate County Flows to TAZs

For this step, the matrix expansion was used to disaggregate the Texas county flows to TAZs. TAZ productions and attractions produced in the freight generation were used to disaggregate the county-level truck tonnage flows to TAZs.

Convert Annual to Weekday

SAM-V4 divided the annual freight truck tonnage into 260 days (85%) for weekdays and 105 days (15%) for weekends.

Convert Tonnage to Truck Trips

To convert tonnage to truck trips SAM-V4 used a table of payload factors which are unique to each commodity group, as reported in Table 3-30.

Table 3-30. Truck Payload Factors by Commodity Group

Commodity Group No.	Commodity Group Name	Tons per loaded truck
1	Agriculture	17.57
2	Other Mining	24.82
3	Oil and Gas	22.04
4	Non-Metallic Minerals	24.31
5	Food	22.94
6	Consumer Manufacturing	17.55
7	Non-Durable Manufacturing	12.62
8	Lumber	25.6
9	Durable Manufacturing	15.33
10	Paper	24.17
11	Chemicals	20.32
12	Petroleum	24.23
13	Clay, Concrete, and Glass	15.85
14	Primary Metal product	25.01
15	Secondary and Miscellaneous Mix	21.52

3.2.4 Texas SAM-V4 Base Network Updates

C&M developed and considered parameters for the network to carry out the traffic assignment. This section describes the study area location, area type, and function classes, and the new estimation of external stations.

3.2.4.1 Study Area Network

C&M employed the SAM-V4 road network for the base year 2022. As discussed with the Client, C&M identified the study area, which was delimited with an extension of 100 miles from the Mexico-Texas border and included El Paso, Odessa, Laredo, and Pharr as main districts. C&M's team reviewed the road network for correctness and developed network characteristics, validating the information with public available GIS data and Google Earth.

Figure 3-22 shows the study area extension and the base network links.

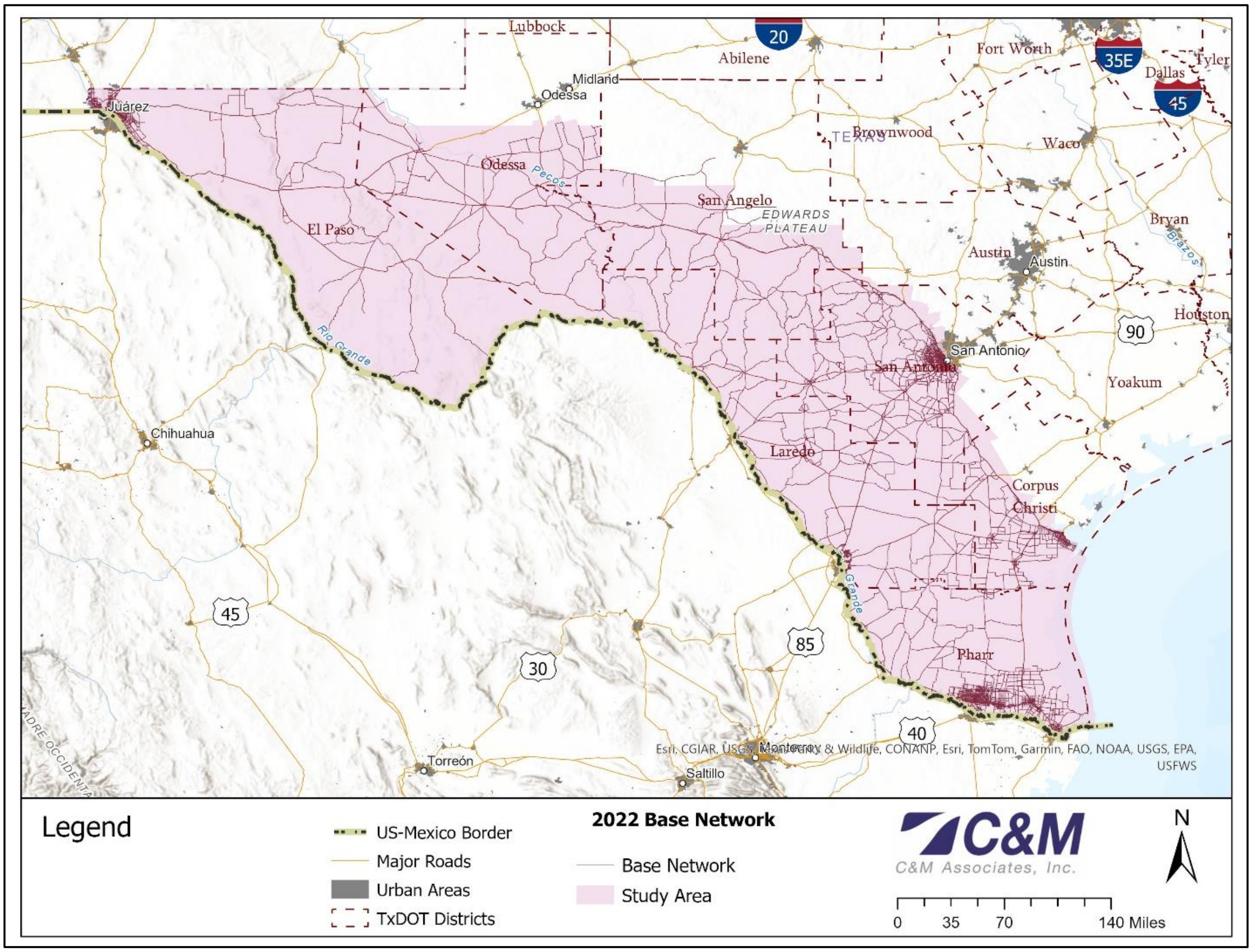


Figure 3-22. 2022 Base Network

3.2.4.2 Area Types and Function Classes

A roadway's functional classification is dependent on its network attributes, such as free-flow speed, parameters for volume delay functions (VDF), and link capacity. The roadway network links comprise functional class classifications based on SAM-V4 characteristics.

The attributes of each link are defined not only by their functional class but also by the area type of the TAZ in which the link is located. The base network included the update of area type definitions, which were based on SAM-V4 definitions and were classified as either rural, suburban, urban, urban central, or central business district (CBD).

The area type classification is calculated as follows.

$$Activity\ Density = PopulationDensity + \beta + EmploymentDensity$$

$$\beta = TotalPopulation/TotalEmployment$$

The rule-based area type density ranges are shown in Table 3-31. The CBD area type was defined manually following the 25 metropolitan areas in Texas.

Table 3-31. Area Type and Density Ranges

Area Type	Activity Density Range
1. CBD	Pre-defined downtown/CBD areas
2. Urban Central	≥ 12 and not pre-defined as area type 1
3. Urban	≥ 6 and < 12
4. Suburban	≥ 1 and < 6
5. Rural	< 1

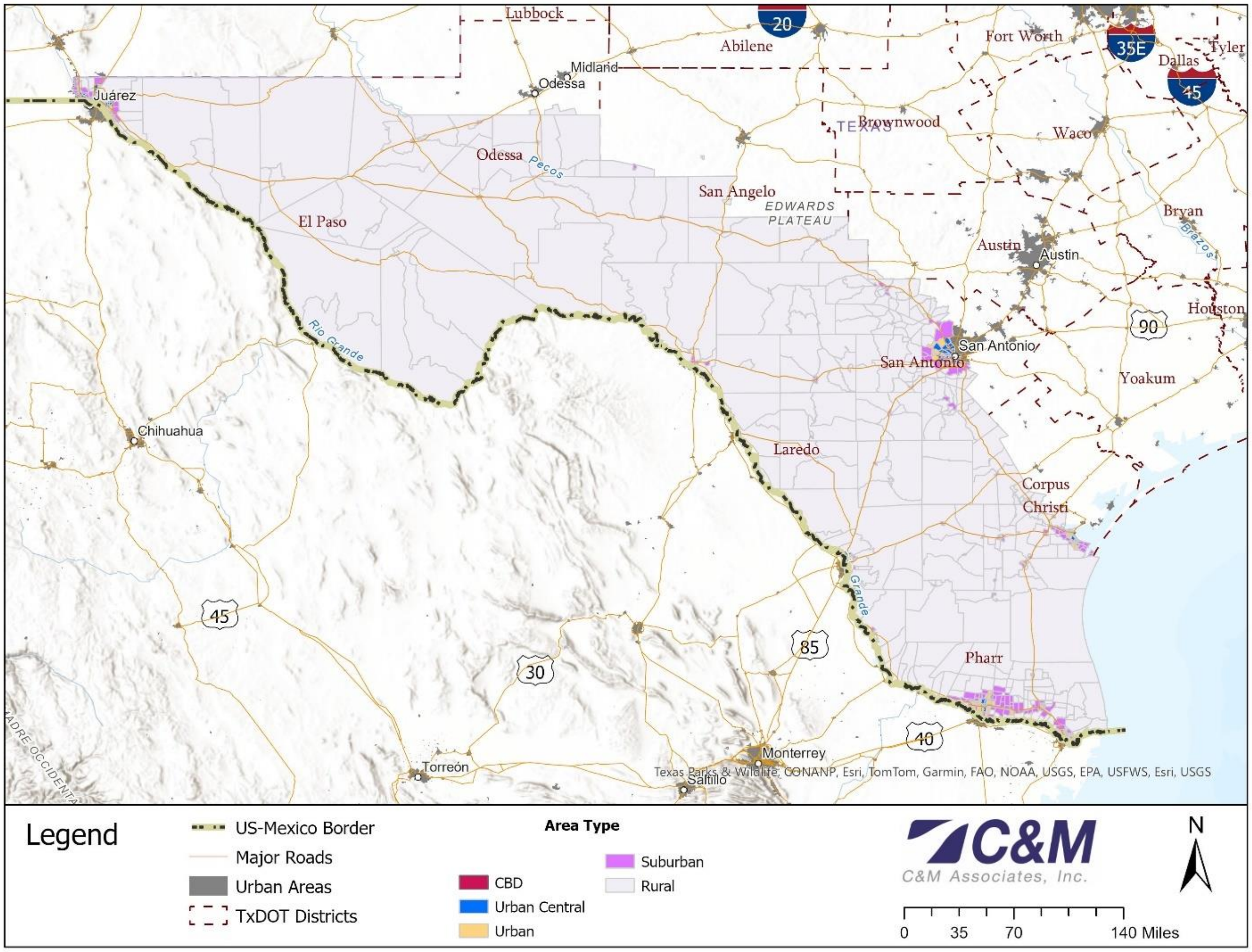


Figure 3-23. Area Type

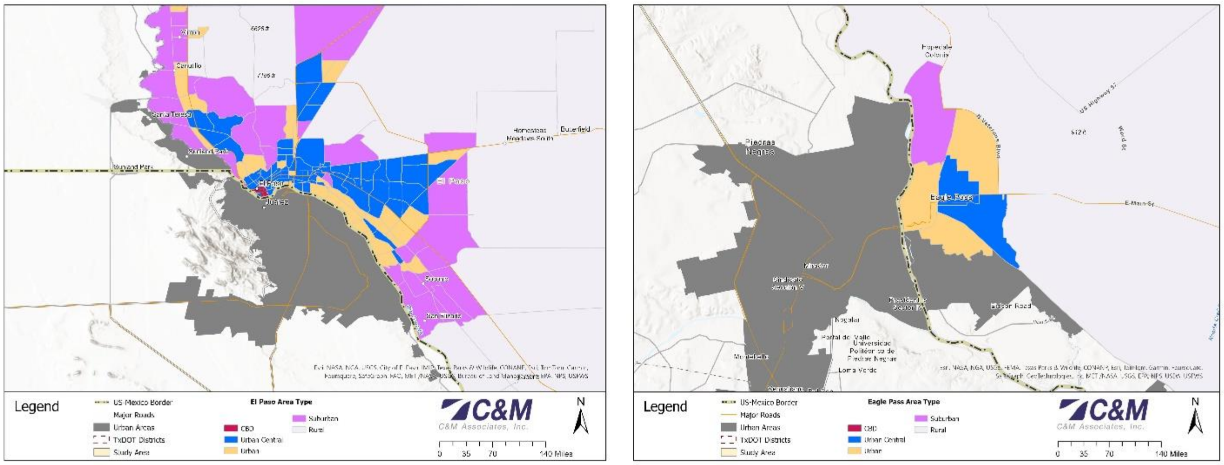


Figure 3-24. El Paso and Eagle Pass Area Types

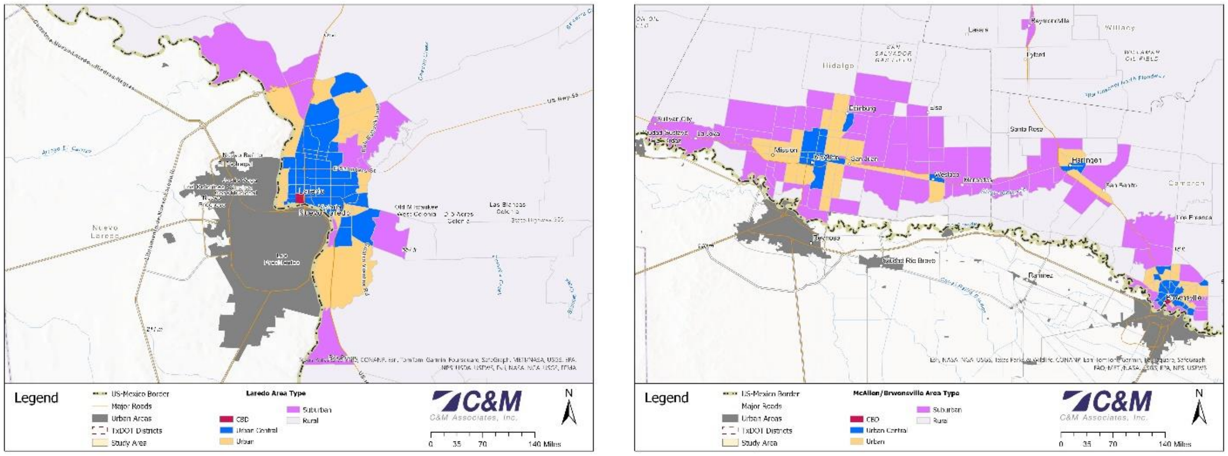


Figure 3-25. Laredo, McAllen, and Brownsville Area Types

The link attributes for the 2022 road network (i.e., free-flow speed and daily capacity per lane) are presented in Table 3-32 thought Table 3-36 by area type, functional classification, and speed. C&M defined functional classes and speeds in such a way that speeds and capacities reflect the study area conditions on the U.S. side. Following the SAM-V4 parameters, the daily capacity and speed were defined in five area types:

- Central Business District (CBD)
- Urban Central
- Urban
- Suburban
- Rural

Table 3-32. Speed and Capacity Lookup Table (Area Type 1, CBD)

Roadway Type	Facility Type Code	Speed ≥ 70	Speed = 65	Speed = 60	Speed = 55	Speed = 50	Speed = 45	Speed ≤ 40
Freeway (includes Interstate, Other Freeway, and Toll Road)	1-8 and 23-26	2,150	2,100	2,060	2,010	2,010	2,010	2,010
Managed Lane (HOV & HOT)	27	1,690	1,690	1,690	1,690	1,690	1,690	1,690
Managed Lane Connector	28	1,500	1,500	1,500	1,500	1,500	1,500	1,500
Expressway	9-10	1,840	1,840	1,760	1,760	1,680	1,600	1,520
Principal Arterial – Divided	11-12	710	710	710	710	710	710	710
Principal Arterial - Undivided	13	670	670	670	670	670	670	670
Minor Arterial - Divided	14-15	650	650	650	650	650	650	650
Minor Arterial - Undivided	16	610	610	610	610	610	610	610
Collector - Divided	17-18	480	480	480	480	480	480	480
Collector - Undivided	19	460	460	460	460	460	460	460
Frontage Road	20	720	720	720	720	720	720	720
Ramp	21-22	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Local Street	40	500	500	500	500	500	500	500

Table 3-33. Speed and Capacity Lookup Table (Area Type 2, Urban Central)

Roadway Type	Facility Type Code	Speed ≥ 70	Speed = 65	Speed = 60	Speed = 55	Speed = 50	Speed = 45	Speed ≤ 40
Freeway (includes Interstate, Other Freeway, and Toll Road)	1-8 and 23-26	2,150	2,100	2,060	2,010	2,010	2,010	2,010
Managed Lane (HOV & HOT)	27	1,690	1,690	1,690	1,690	1,690	1,690	1,690
Managed Lane Connector	28	1,500	1,500	1,500	1,500	1,500	1,500	1,500
Expressway	9-10	1,840	1,840	1,760	1,760	1,680	1,600	1,520
Principal Arterial - Divided	11-12	710	710	710	710	710	710	710
Principal Arterial - Undivided	13	670	670	670	670	670	670	670
Minor Arterial - Divided	14-15	650	650	650	650	650	650	650
Minor Arterial - Undivided	16	610	610	610	610	610	610	610
Collector - Divided	17-18	500	500	500	500	500	500	500
Collector - Undivided	19	470	470	470	470	470	470	470
Frontage Road	20	720	720	720	720	720	720	720
Ramp	21-22	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Local Street	40	500	500	500	500	500	500	500

Table 3-34. Speed and Capacity Lookup Table (Area Type 3, Urban)

Roadway Type	Facility Type Code	Speed ≥ 70	Speed = 65	Speed = 60	Speed = 55	Speed = 50	Speed = 45	Speed ≤ 40
Freeway (includes Interstate, Other Freeway, and Toll Road)	1-8 and 23-26	2,150	2,100	2,060	2,010	2,010	2,010	2,010
Managed Lane (HOV & HOT)	27	1,690	1,690	1,690	1,690	1,690	1,690	1,690
Managed Lane Connector	28	1,500	1,500	1,500	1,500	1,500	1,500	1,500
Expressway	9-10	1,840	1,840	1,760	1,760	1,680	1,600	1,520
Principal Arterial - Divided	11-12	750	750	750	750	750	750	750
Principal Arterial - Undivided	13	710	710	710	710	710	710	710
Minor Arterial - Divided	14-15	680	680	680	680	680	680	680
Minor Arterial - Undivided	16	650	650	650	650	650	650	650
Collector - Divided	17-18	530	530	530	530	530	530	530
Collector - Undivided	19	500	500	500	500	500	500	500
Frontage Road	20	770	770	770	770	770	770	770
Ramp	21-22	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Local Street	40	500	500	500	500	500	500	500

Table 3-35. Speed and Capacity Lookup Table (Area Type 4, Suburban)

Roadway Type	Facility Type Code	Speed ≥ 70	Speed = 65	Speed = 60	Speed = 55	Speed = 50	Speed = 45	Speed ≤ 40
Freeway (includes Interstate, Other Freeway, and Toll Road)	1-8 and 23-26	2,150	2,100	2,060	2,010	2,010	2,010	2,010
Managed Lane (HOV & HOT)	27	1,690	1,690	1,690	1,690	1,690	1,690	1,690
Managed Lane Connector	28	1,500	1,500	1,500	1,500	1,500	1,500	1,500
Expressway	9-10	1,840	1,840	1,760	1,760	1,680	1,600	1,520
Principal Arterial - Divided	11-12	750	750	750	750	750	750	750
Principal Arterial - Undivided	13	710	710	710	710	710	710	710
Minor Arterial - Divided	14-15	680	680	680	680	680	680	680
Minor Arterial - Undivided	16	650	650	650	650	650	650	650
Collector - Divided	17-18	530	530	530	530	530	530	530
Collector - Undivided	19	500	500	500	500	500	500	500
Frontage Road	20	770	770	770	770	770	770	770
Ramp	21-22	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Local Street	40	500	500	500	500	500	500	500

Table 3-36. Speed and Capacity Lookup Table (Area Type 5, Rural)

Roadway Type	Facility Type Code	Speed ≥ 70	Speed= 65	Speed= 60	Speed= 55	Speed= 50	Speed= 45	Speed ≤ 40
Freeway (includes Interstate, Other Freeway, and Toll Road)	1-8 and 23-26	2,010	1,970	1,930	1,890	1,890	1,890	1,890
Managed Lane (HOV & HOT)	27	1,690	1,690	1,690	1,690	1,690	1,690	1,690
Managed Lane Connector	28	1,500	1,500	1,500	1,500	1,500	1,500	1,500
Expressway	9-10	1,840	1,840	1,760	1,760	1,680	1,600	1,520
Principal Arterial - Divided	11-12	1,840	1,840	1,760	1,760	1,680	1,600	1,520
Principal Arterial - Undivided	13	1,840	1,840	1,760	1,760	1,680	1,600	1,520
Minor Arterial - Divided	14-15	1,840	1,840	1,760	1,760	1,680	1,600	1,520
Minor Arterial - Undivided	16	1,840	1,840	1,760	1,760	1,680	1,600	1,520
Collector - Divided	17-18	1,840	1,840	1,760	1,760	1,680	1,600	1,520
Collector - Undivided	19	1,330	1,330	1,330	1,330	1,330	1,330	1,330
Frontage Road	20	1,330	1,330	1,330	1,330	1,330	1,330	1,330
Ramp	21-22	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Local Street	40	500	500	500	500	500	500	500

3.2.4.3 External Stations

C&M developed an estimation to obtain 2022 base year traffic model inputs for EI and EE trips based on MS2Soft's traffic counts, the U.S. Custom and Border Protection's (CBP) border crossings by POE, and SAM-V4's 2022 volume interpolation. Table 3-37 shows the inputs updated in SAM-V4.

Table 3-37. 2022 Traffic Volumes update for External Station

Station ID	External-Internal Trips		External-External Trips	
	EI Passenger	EI Trucks	EE Passenger Production	EE Passenger Attraction
4401	0	0	0	0
4402	7,128	0	36	36
4403	8,613	0	44	44
4404	7,128	0	36	36
4405	2,300	0	0	0
4406	3,069	0	16	16
4407	3,800	0	0	0
4408	5,643	0	29	29
4409	11,583	0	59	59
4410	5,500	0	0	0
4411	0	0	0	0
4412	200	0	0	0
4413	2,000	0	0	0
4414	3,600	0	0	0
4415	400	0	0	0

Station ID	External-Internal Trips		External-External Trips	
	EI Passenger	EI Trucks	EE Passenger Production	EE Passenger Attraction
4416	19,206	0	97	97
4417	4,554	0	24	24
4418	0	0	0	0
4419	1,100	0	0	0
4420	8,600	0	0	0
4421	6,613	0	44	44
4422	8,217	0	42	42
4423	200	0	0	0
4424	3,500	0	0	0
4425	600	0	0	0
4426	1,700	0	0	0
4427	19,107	11	97	97
4428	17,127	19	87	87
4429	4,554	0	23	23
4430	4,554	0	23	23
4432	0	0	0	0
4501	28,961	212	497	497
4502	11,804	8	30	30
4503	6,803	0	19	19
4504	9,766	0	27	27
4505	31	0	0	0
4506	42	0	0	0
4507	1,068	0	0	0
4508	2,160	0	0	0
4509	2,001	0	0	0
4510	1,178	0	1	1
4511	1,262	0	0	0
4512	9,926	0	116	116
4513	116	0	1	1
4514	5,984	0	813	813
4515	131	0	0	0
4516	2,258	0	0	0
4517	224	0	8	8
4518	15,175	3	53	53
4519	14,581	0	51	51
4520	2,902	0	106	106
4521	35,412	7	125	125
4522	10,311	2	36	36
4523	835	0	30	30

Station ID	External-Internal Trips		External-External Trips	
	EI Passenger	EI Trucks	EE Passenger Production	EE Passenger Attraction
4524	10,410	0	36	36
4525	240	0	9	9
4526	1,769	0	156	156
4527	2,262	0	82	82
4528	918	0	33	33
4529	576	0	2	2
4530	339	0	1	1
4531	1,072	0	3	3
4532	284	0	10	10
4533	1,011	0	37	37
4534	693	0	25	25
4535	5,058	0	374	374
4536	1,957	0	0	0
4537	124	0	0	0
4538	627	0	0	0
4539	1,120	0	0	0
4540	1,463	0	28	28
4541	9,830	0	0	0
4542	626	0	12	12
4543	975	0	6	6
4544	958	0	19	19
4545	357	0	7	7
4546	33,097	0	811	811
4547	376	0	7	7
4548	1,738	0	27	27
4549	2,523	0	0	0
4550	884	0	0	0
4551	35,663	0	198	198
4552	9,537	0	122	122
4553	687	0	11	11
4554	4,086	0	65	65
4555	817	0	0	0
4556	618	0	0	0
4557	341	0	0	0
4558	3,079	0	74	74
4559	11,839	0	0	0
4560	32,963	228	185	185
4561	12,224	37	43	43
4562	1,273	0	0	0

Station ID	External-Internal Trips		External-External Trips	
	EI Passenger	EI Trucks	EE Passenger Production	EE Passenger Attraction
4563	523	0	10	10
4564	671	0	0	0
4565	22,259	0	395	395
4566	3,425	11	0	0
4567	1,681	0	33	33
4568	9,210	0	0	0
4569	8,277	27	20	20
4570	4,382	14	11	11
4571	2,191	0	0	0
4572	5,210	13	14	14
4573	974	0	0	0
4574	5,977	15	15	15
4575	1,904	0	0	0
4576	2,257	0	0	0
4577	27,207	0	1,137	1,137
4578	3,602	0	0	0
4579	54	0	2	2
4580	377	0	14	14
4581	54	0	2	2
4582	337	0	12	12
4583	182	0	6	6
4584	310	0	11	11
4585	173	0	6	6
4586	136	0	5	5
4587	54	0	2	2
4588	118	0	4	4
4589	224	0	8	8
4590	91	0	3	3
4591	410	0	15	15
4592	117	0	0	0
4593	19	0	0	0
4594	157	0	0	0
4595	39	0	0	0
4596	450	0	0	0
4597	1,228	0	0	0
4598	917	0	5	5
4599	215	0	0	0
4600	2,192	0	0	0
4601	867	0	0	0

Station ID	External-Internal Trips		External-External Trips	
	EI Passenger	EI Trucks	EE Passenger Production	EE Passenger Attraction
4602	2,436	0	31	31
4603	2,511	0	32	32
4604	1,281	0	0	0
4605	2,154	0	0	0
4606	6,302	0	0	0
4607	477	0	0	0
4608	2,313	0	0	0
4609	95	0	0	0
4610	103	0	0	0
4611	127	0	0	0
4612	43	0	0	0
4613	8	0	1	1
4614	60	0	0	0
4615	833	0	1	1
4616	190	0	0	0
4617	3,957	0	46	46
4618	692	0	8	8
4619	92	0	1	1
4620	1,153	0	144	144
4621	30	0	3	3
4622	10,712	36	26	26
4633	978	3	0	0

3.2.5 Texas SAM-V4 Calibration/Validation

The last step of the travel demand modeling process is the calibration-validation of the model. This can be summarized in three steps: model definition, calibration, and validation. The following section describes the process and results for base year 2022.

3.2.5.1 Volume Delay Functions

Traffic assignment is the final component of the four-step travel demand modeling process, and it determines the selection of route ODs in the transportation network. The selection of routes between ODs in the transportation network is a function of the congested travel time, which depends on the volume and capacity of each road network link. This is done by using a VDF. The Binational TDM's VDF is a Bureau of Public Roads (BPR) function, where the resulting congested speeds by functional classification are a function of the posted free-flow speed, the V/C ratio, and the parameters of the BPR function.

Table 3-38 shows the model's VDF based on SAM-V4 parameters where area types and function classes are used to assign each one.

Table 3-38. SAM-V4 VDF Parameters

Facility Type Name	Facility Type Code	Area Type Code	Alpha	Beta
Freeway/Expressway/Toll	1-10, 22-27	1-5	0.80	5.50
Ramp	21, 22, 28	1-5	0.95	5.50
Principal Arterial (Divided)	11, 12	1-4	1.30	6.00
		5	1.05	5.50
Principal Arterial (Undivided)	13	1-5	1.35	6.00
Minor Arterial (Divided)	14, 15	1-5	1.40	6.00
Minor Arterial (Undivided)	16	1-5	1.45	6.00
Collector (Divided)	17, 18	1-5	1.50	6.00
Collector (Undivided)	19	1-5	1.55	6.00
Frontage Road	20	1-5	1.05	5.50
Centroid Connector	0	1-5	0.15	4.00

3.2.5.2 Time-of-Day Model

C&M used a TOD period capacity factor, which was based on SAM-V4 where the assignment is performed. Table 3-39 shows the percent of trips during each TOD for weekdays.

Table 3-39. Peak Hour to Peak Period Capacity Factors

Time Period	% of Trips
Morning (AM)	18.7
Midday (MD)	29.3
Afternoon (PM)	33.5
Nighttime (NT)	18.6

Table 3-40. Diurnal Distribution Summary

Income	Period	HBW	HBO	HBS	NHB
$0K-$25K	AM	0.2	0.11	0.43	0.15
	MD	0.22	0.38	0.1	0.44
	PM	0.31	0.29	0.44	0.31
	NT	0.28	0.22	0.03	0.1
$25K-$50K	AM	0.2	0.11	0.47	0.14
	MD	0.21	0.36	0.04	0.39
	PM	0.34	0.31	0.45	0.35
	NT	0.25	0.22	0.04	0.13
$50K-$100K	AM	0.26	0.11	0.46	0.14
	MD	0.16	0.32	0.06	0.39
	PM	0.35	0.3	0.44	0.35
	NT	0.23	0.27	0.05	0.12
$100K+	AM	0.26	0.1	0.45	0.12
	MD	0.17	0.29	0.06	0.41
	PM	0.36	0.32	0.45	0.35
	NT	0.2	0.29	0.05	0.12

3.2.5.3 Screenline Comparison

The model was calibrated to base year 2022 using the screenlines shown in Figure 3-26. The screenlines are strategically positioned to accurately represent trips and travel behavior related to main roads located in the El Paso, Odessa, Laredo, and Pharr districts.

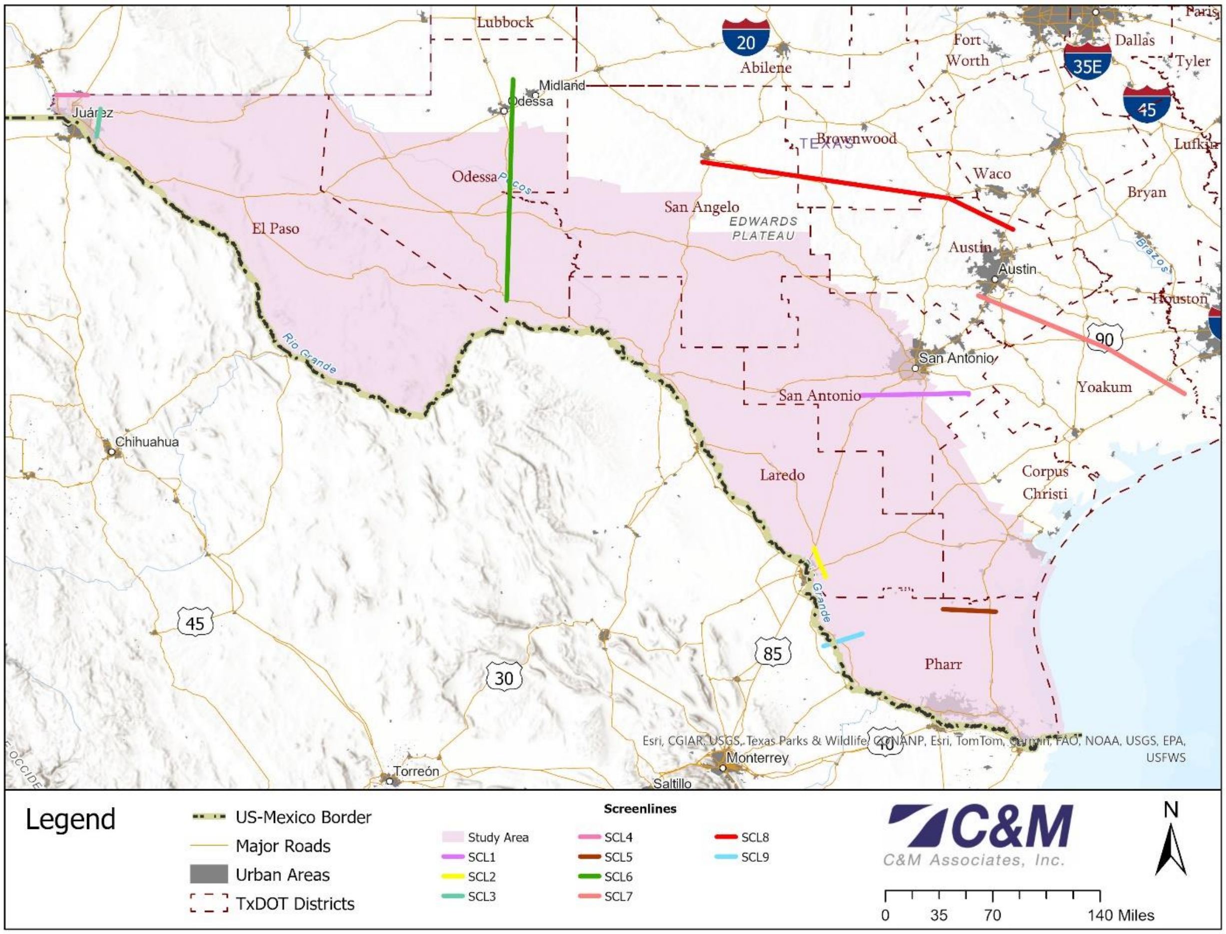


Figure 3-26. Screenlines

Table 3-41 presents the calibrated 2022 screenline model volumes compared to the corresponding observed U.S. traffic volumes. The calibration results indicate that the model replicates existing traffic conditions within an acceptable margin of error.

Table 3-41. 2022 Model Screenline Calibration Results

Screenline ID	Total		
	Observed	Model	Diff. %
1	100,669	91,138	-9.5%
2	52,398	53,239	1.6%
3	60,151	56,970	-5.3%
4	148,430	136,610	-8.0%
5	27,243	27,035	-0.8%
6	62,984	53,927	-14.4%
7	160,799	155,220	-3.5%
8	115,594	105,444	-8.8%
9	3,615	3,406	-5.8%

Figure 3-27 illustrates the calibration results of the 2022 model, in terms of the total observed screenline vehicle volume deviations from model volumes. As shown, the results are well below the NCHRP's recommended deviation thresholds.[15]

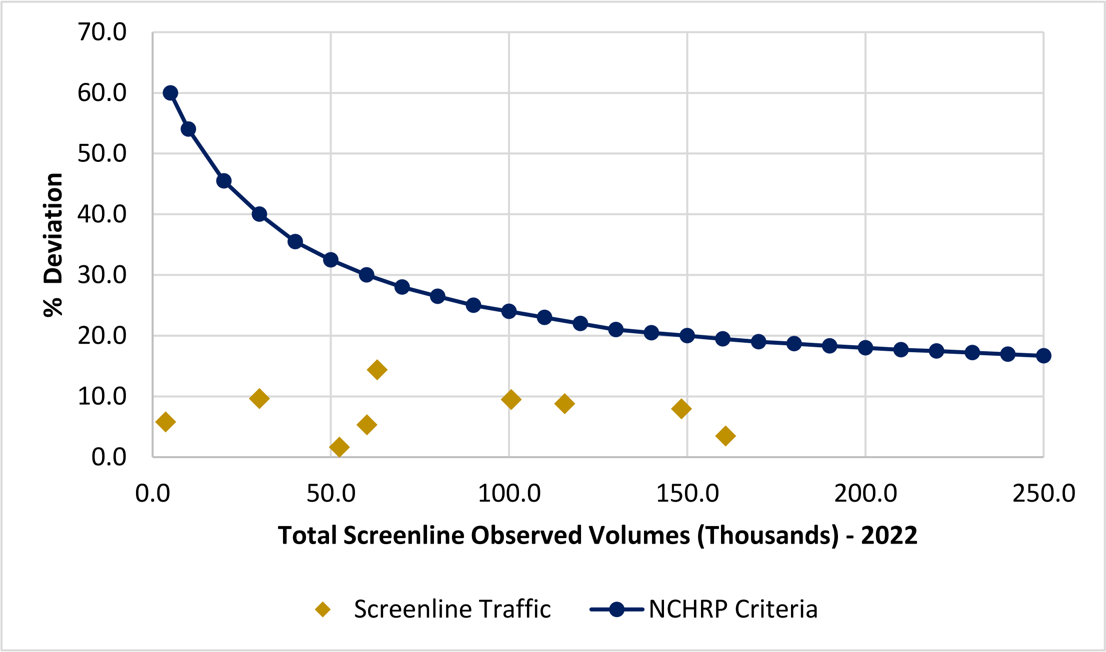


Figure 3-27. Comparison of Total Observed Screenline Volumes to Maximum Desirable Deviation, 2022

Figure 3-28 illustrates the calibration results of the 2022 model, in terms of the passenger vehicles' observed screenline vehicle volume deviations from model volumes. As shown, the results are well below the NCHRP's recommended deviation thresholds.

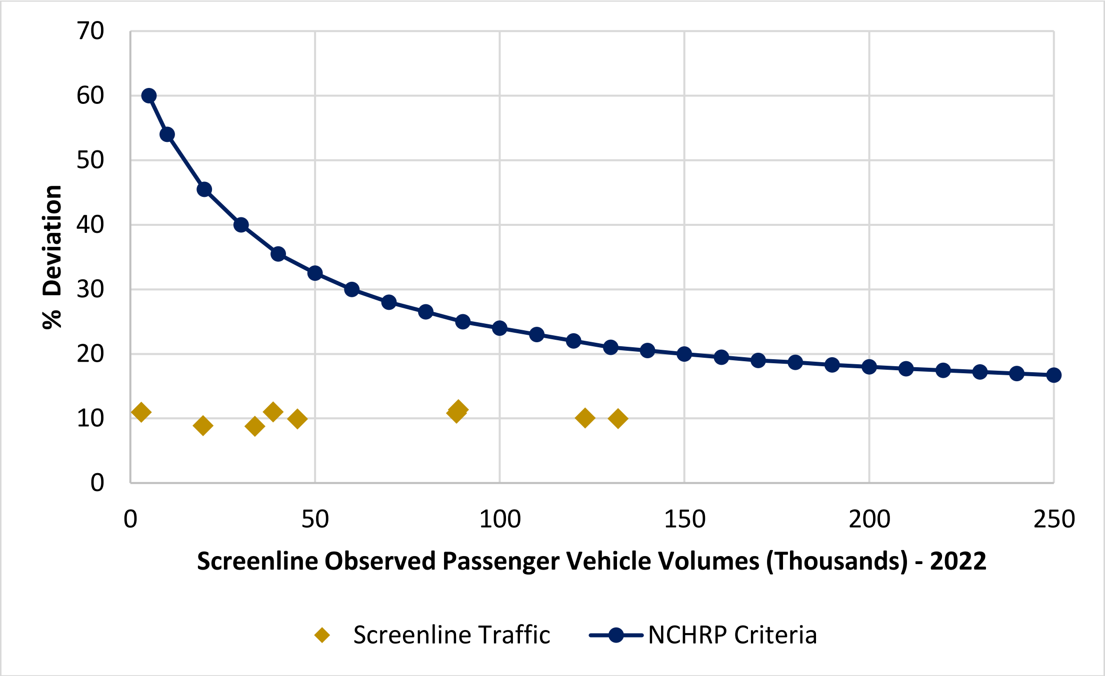


Figure 3-28. Passenger Vehicles' Observed Screenline Volumes vs. Maximum Desirable Deviation, 2022

Figure 3-29 illustrates the calibration results of the 2022 model, in terms of trucks' observed screenline vehicle volume deviations from model volumes. As shown, the results are well below the NCHRP's recommended deviation thresholds.

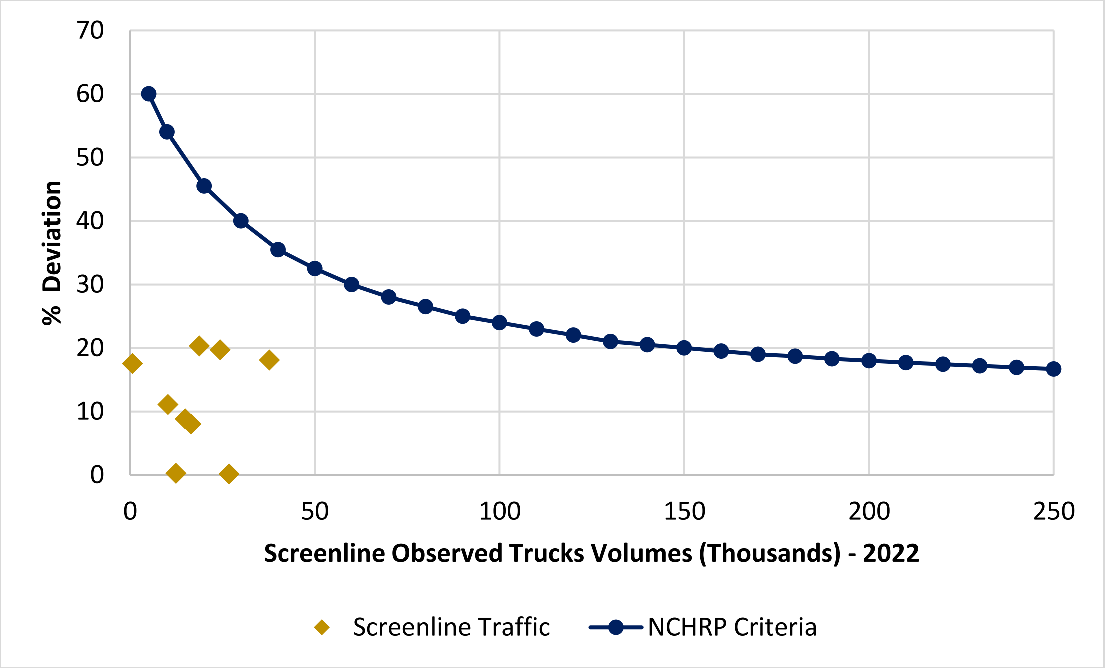


Figure 3-29. Trucks' Observed Screenline Volumes vs. Maximum Desirable Deviation, 2022

3.2.5.4 Travel Time Comparison

To calibrate speeds, C&M compared the travel times from the model with real times, which were extracted from Google Maps. C&M selected the following 42 routes (see Figure 3-30), which are listed below.

1. From McAllen to Brownsville
2. From McAllen to San Antonio
3. From McAllen to Corpus Christi
4. From McAllen to Odessa
5. From McAllen to El Paso
6. From McAllen to Laredo
7. From El Paso to Odessa
8. From El Paso to San Antonio
9. From El Paso to Laredo
10. From El Paso to McAllen
11. From El Paso to Brownsville
12. From El Paso to Corpus Christi
13. From Odessa to El Paso
14. From Odessa to San Antonio
15. From Odessa to Laredo
16. From Odessa to McAllen
17. From Odessa to Brownsville
18. From Odessa to Corpus Christi
19. From San Antonio to Odessa
20. From San Antonio to El Paso
21. From San Antonio to Laredo
22. From San Antonio to Corpus Cristi
23. From San Antonio to McAllen
24. From San Antonio to Brownsville
25. From Laredo to Corpus Christi
26. From Laredo to Odessa
27. From Laredo to El Paso
28. From Laredo to San Antonio
29. From Laredo to Brownsville
30. From Laredo to McAllen
31. From Corpus Christi to McAllen
32. From Corpus Christi to Brownsville
33. From Corpus Christi to San Antonio
34. From Corpus Christi to Odessa
35. From Corpus Christi to El Paso
36. From Corpus Christi to Laredo

37. From Brownsville to Laredo
38. From Brownsville to Odessa
39. From Brownsville to El Paso
40. From Brownsville to San Antonio
41. From Brownsville to Corpus Christi
42. From Brownsville to McAllen

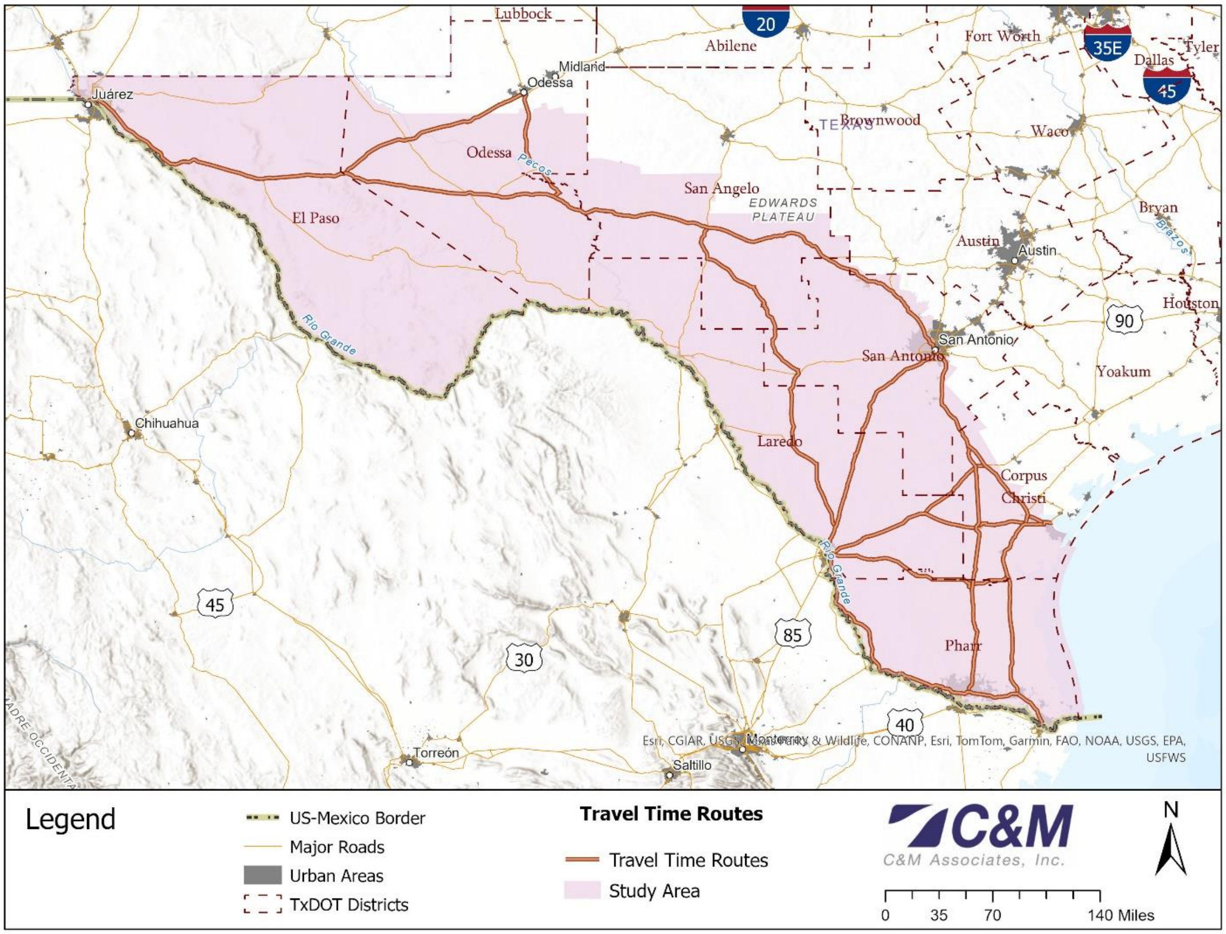
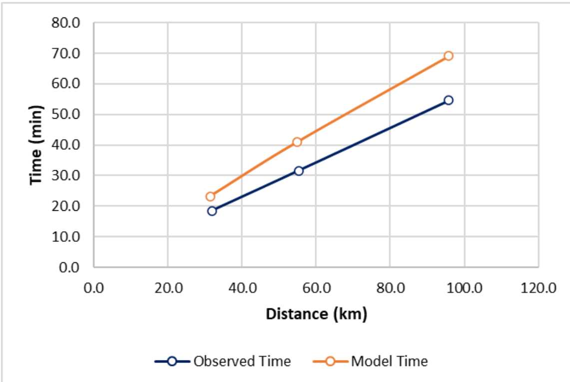


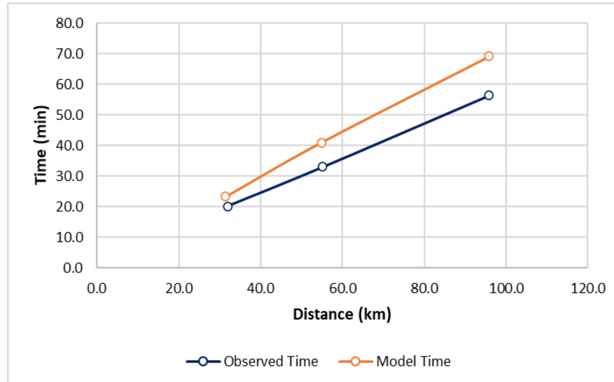
Figure 3-30. Travel Time Routes

For all 42 routes, the observed and modeled travel times by time period were examined and exhibited minimal deviations. The modeled travel times replicate observed travel times across all routes, indicating high accuracy. As a result, C&M could verify that the TDM replicates the existing travel times of the binational study area when traveling within it. Figure 3-31 through Figure 3-44 illustrate the observed and modeled travel times (in minutes during the AM and MD time periods, respectively) for each route and show the most representative direction of travel to border destinations. Analysis for AM and MD time periods are shown here, while the remainder (PM and NT) are shown in the appendices.

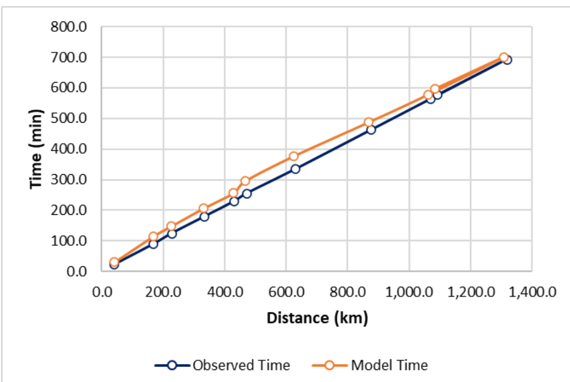
1. From McAllen to Brownsville – AM



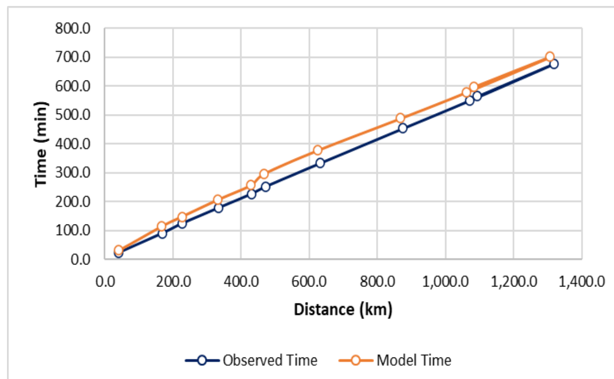
1. From McAllen to Brownsville – MD



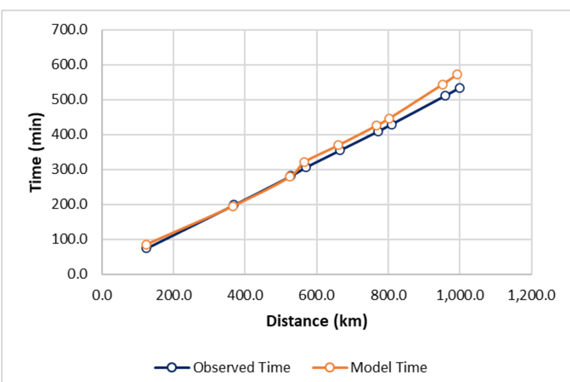
2. From McAllen to San Antonio - AM



2. From McAllen to San Antonio - MD



3. From McAllen to Corpus Christi – AM



3. From McAllen to Corpus Christi – MD

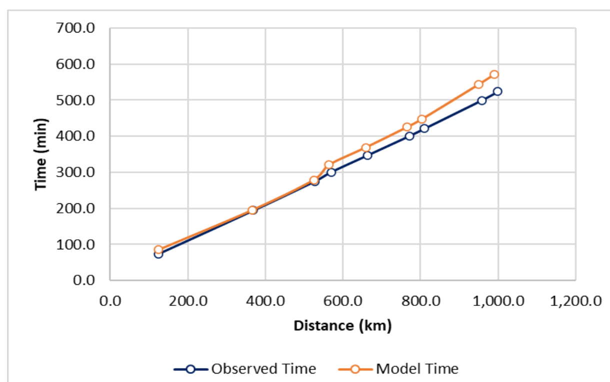
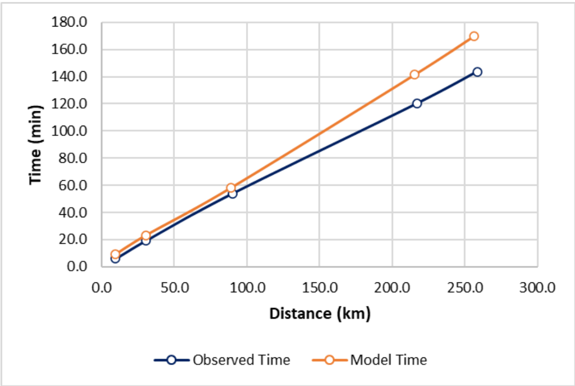
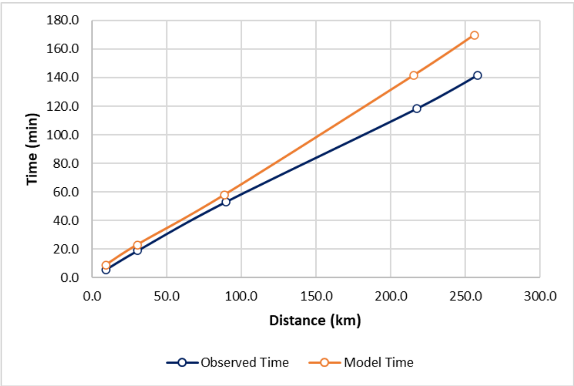


Figure 3-31. Observed and Modeled Travel Time Comparisons

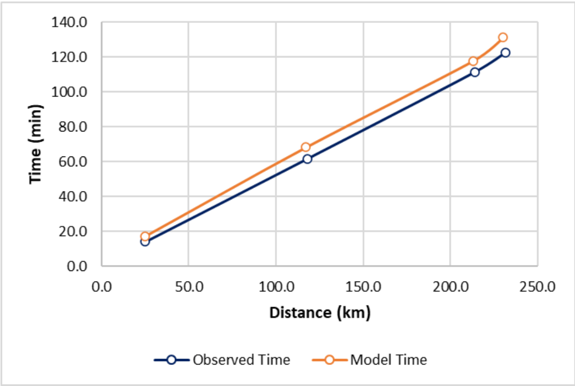
4. From McAllen to Odessa – AM



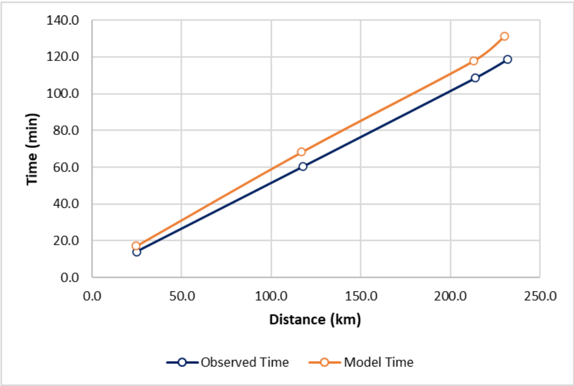
4. From McAllen to Odessa – MD



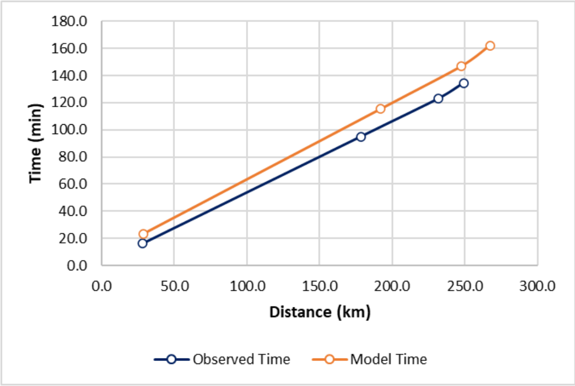
5. From McAllen to El Paso – AM



5. From McAllen to El Paso – MD



6. From McAllen to Laredo – AM



6. From McAllen to Laredo – MD

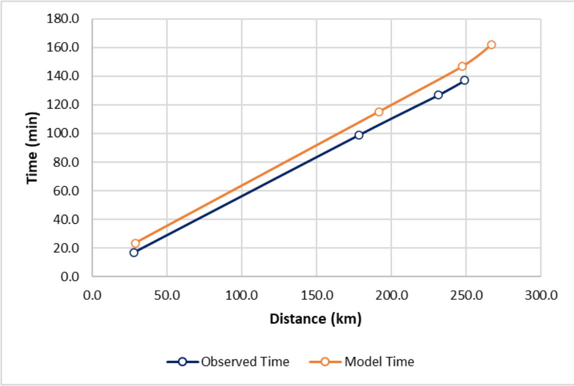
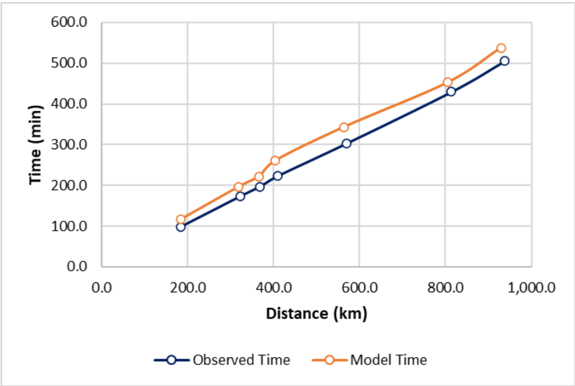
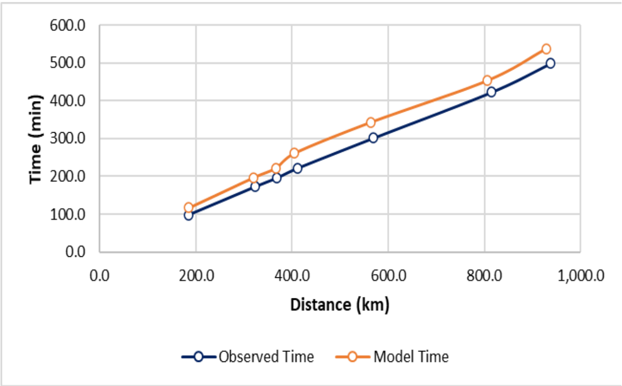


Figure 3-32. Observed and Modeled Travel Time Comparisons

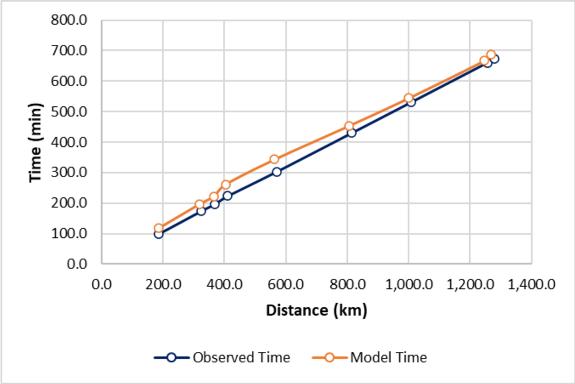
7. From El Paso to Odessa – AM



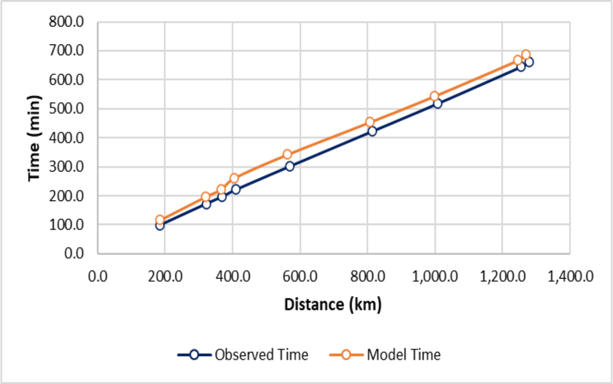
7. From El Paso to Odessa – MD



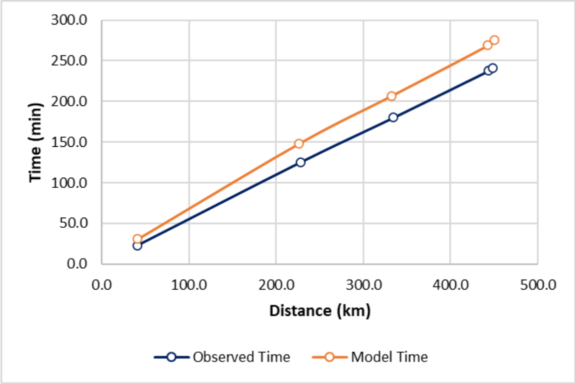
8. From El Paso to San Antonio – AM



8. From El Paso to San Antonio – MD



9. From El Paso to Laredo – AM



9. From El Paso to Laredo – MD

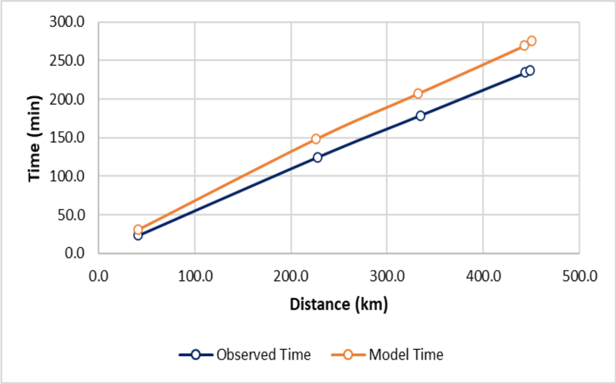
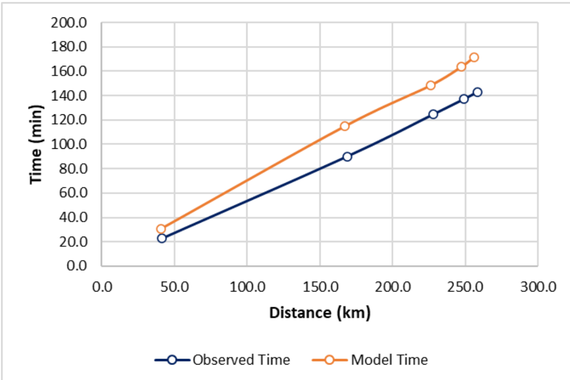
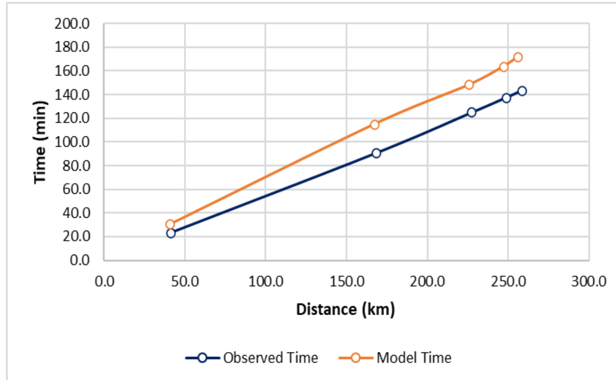


Figure 3-33. Observed and Modeled Travel Time Comparisons

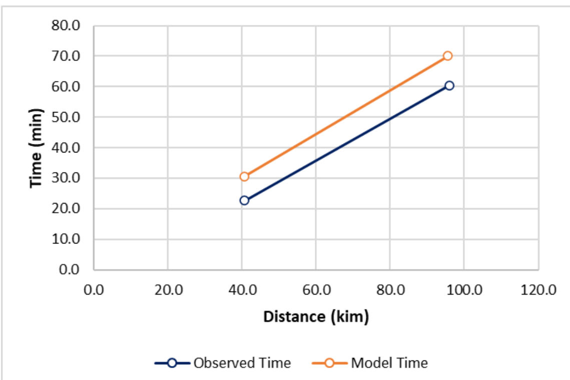
10. From El Paso to McAllen – AM



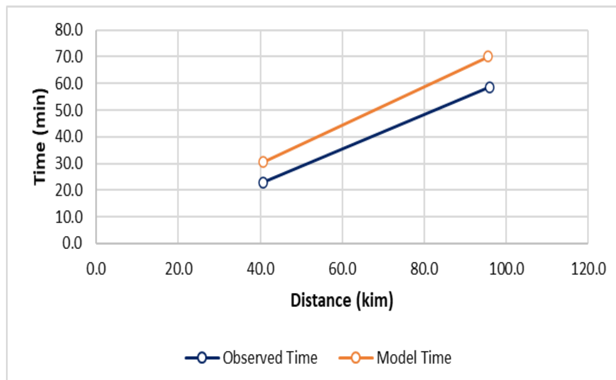
10. From El Paso to McAllen – MD



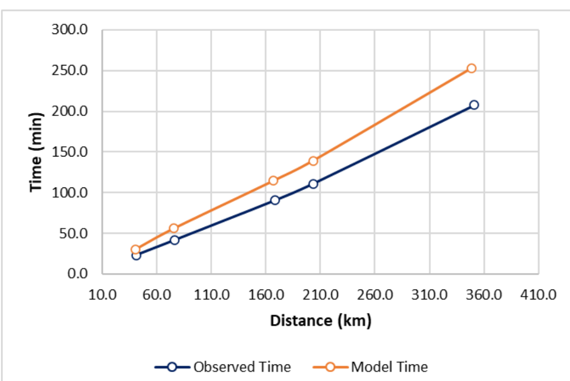
11. From El Paso to Brownsville – AM



11. From El Paso to Brownsville – MD



12. From El Paso to Corpus Christi – AM



12. From El Paso to Corpus Christi – MD

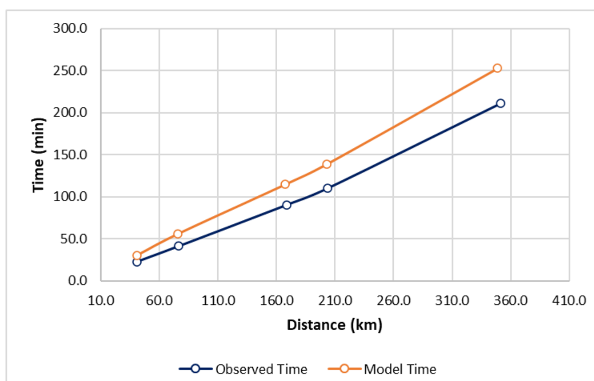
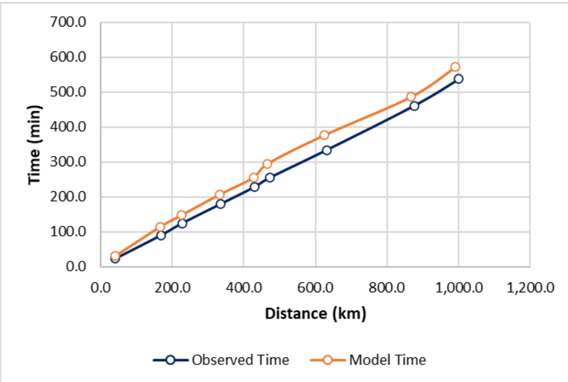
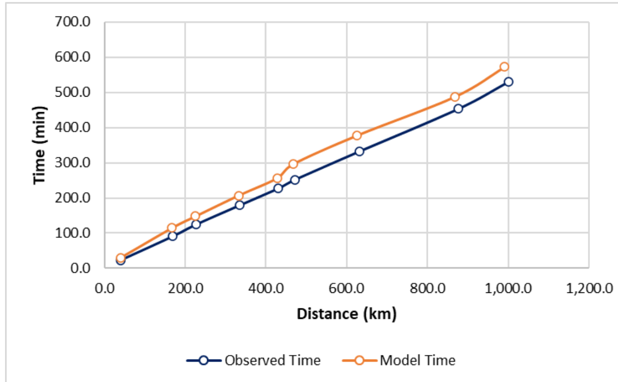


Figure 3-34. Observed and Modeled Travel Time Comparisons

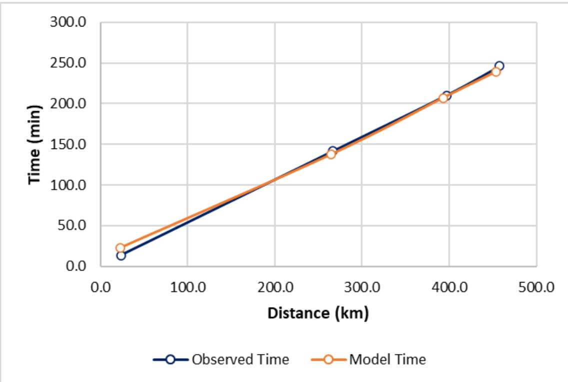
13. From Odessa to El Paso – AM



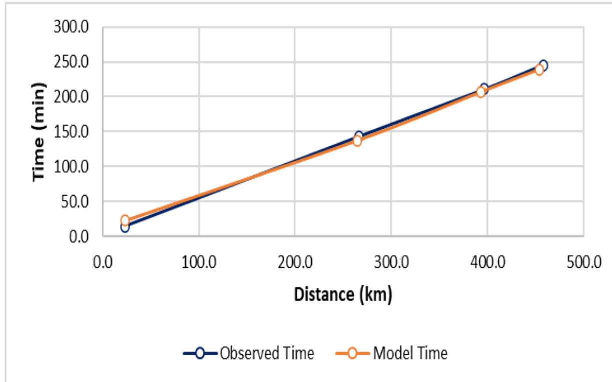
13. From Odessa to El Paso – MD



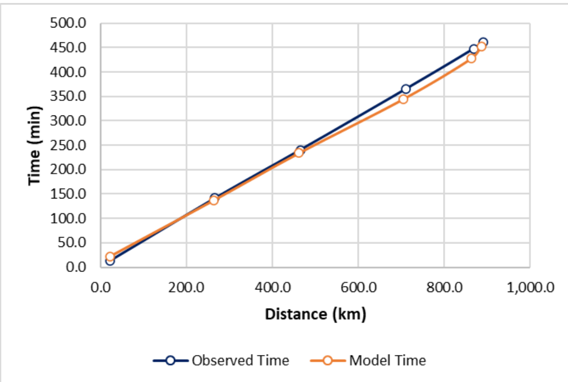
14. From Odessa to San Antonio – AM



14. From Odessa to San Antonio –MD



15. From Odessa to Laredo – AM



15. From Odessa to Laredo – MD

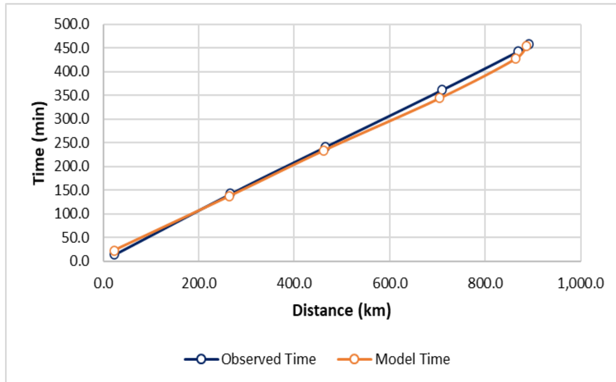
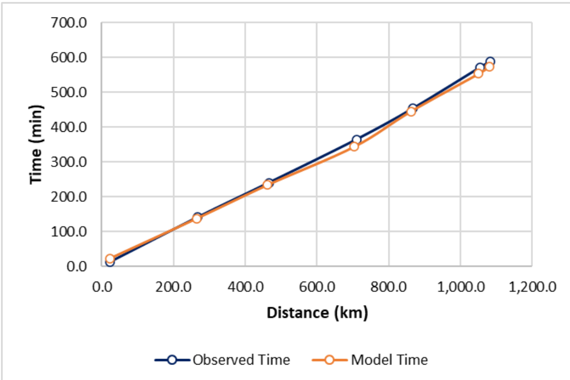
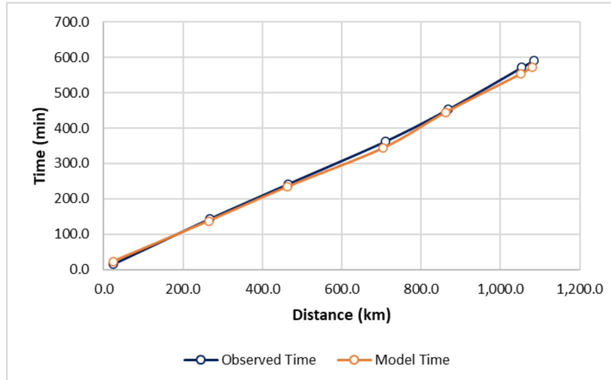


Figure 3-35. Observed and Modeled Travel Time Comparisons

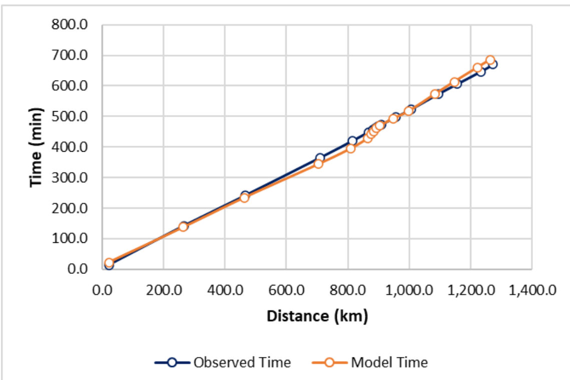
16. From Odessa to McAllen – AM



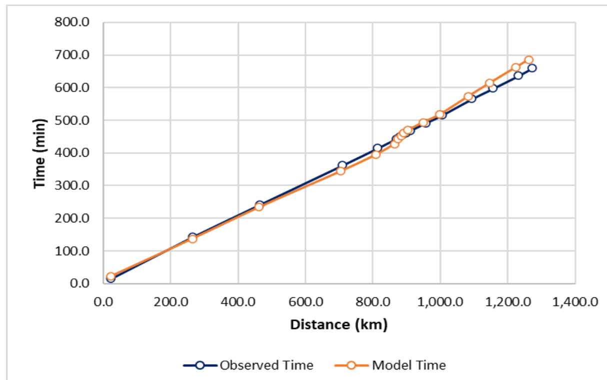
16. From Odessa to McAllen – MD



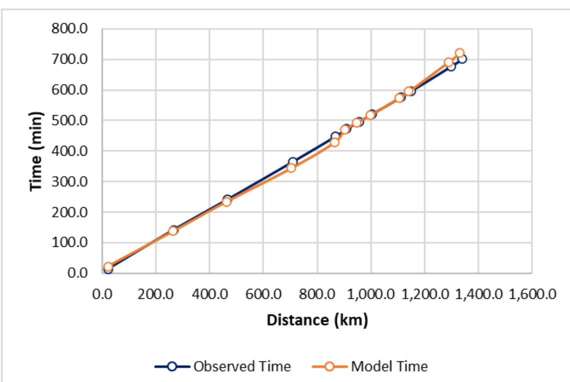
17. From Odessa to Brownsville – AM



17. From Odessa to Brownsville – MD



18. From Odessa to Corpus Christi – AM



18. From Odessa to Corpus Christi – MD

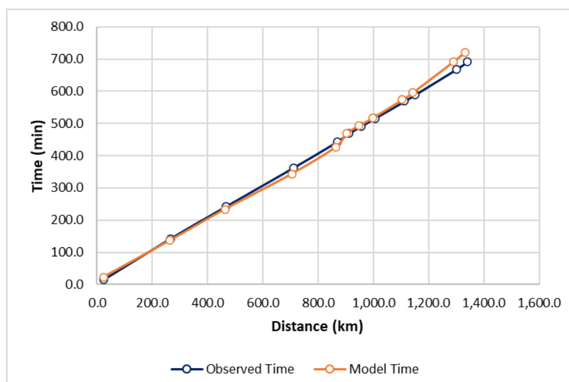
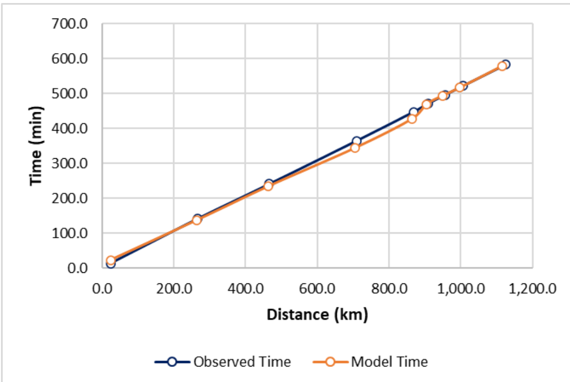
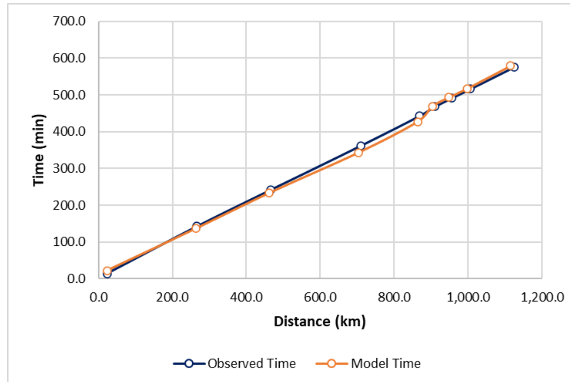


Figure 3-36. Observed and Modeled Travel Time Comparisons

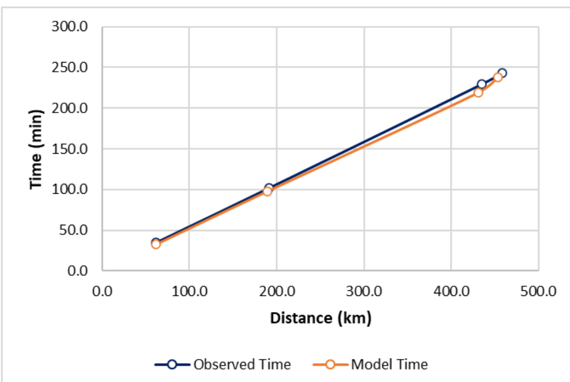
19. From San Antonio to Odessa – AM



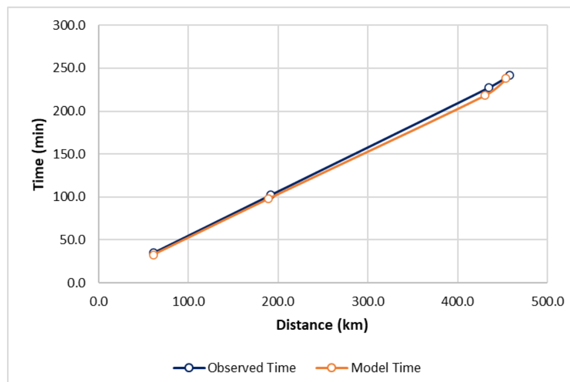
19. From San Antonio to Odessa – MD



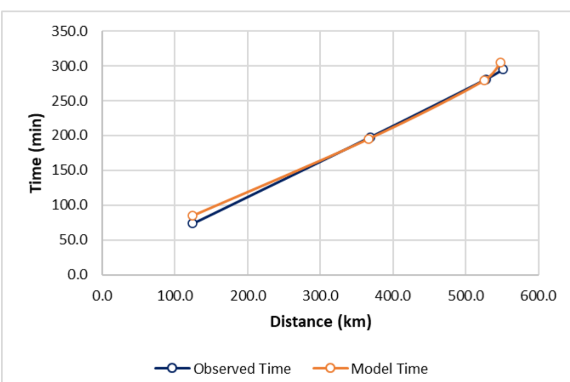
20. From San Antonio to El Paso – AM



20. From San Antonio to El Paso – MD



21. From San Antonio to Laredo – AM



21. From San Antonio to Laredo – MD

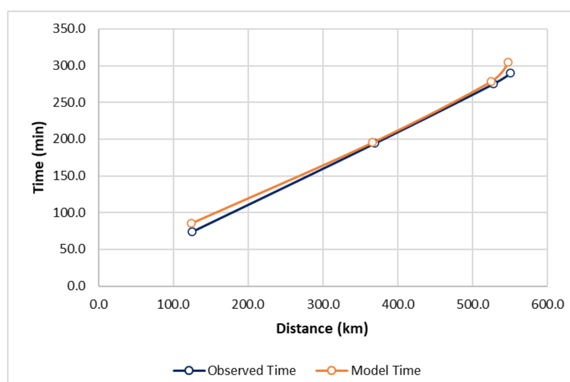
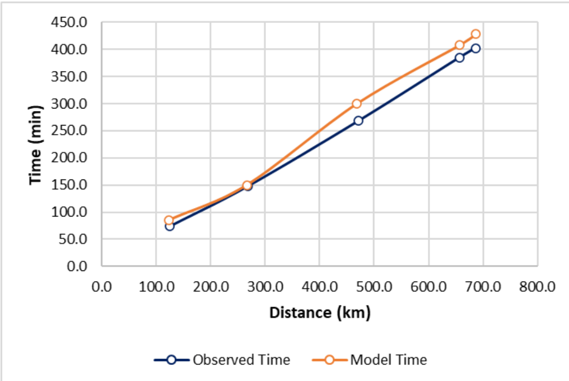
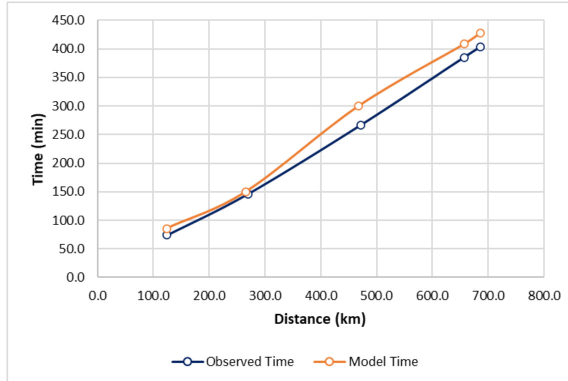


Figure 3-37. Observed and Modeled Travel Time Comparisons

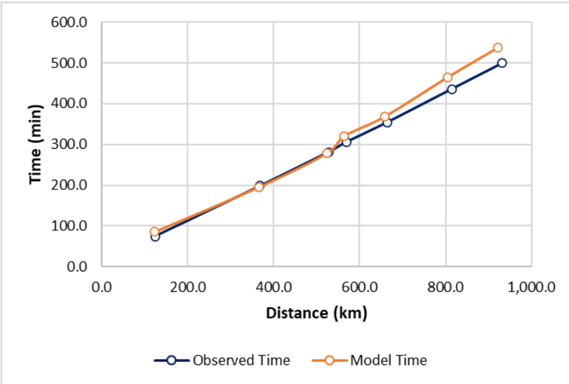
22. From San Antonio to Corpus Christi – AM



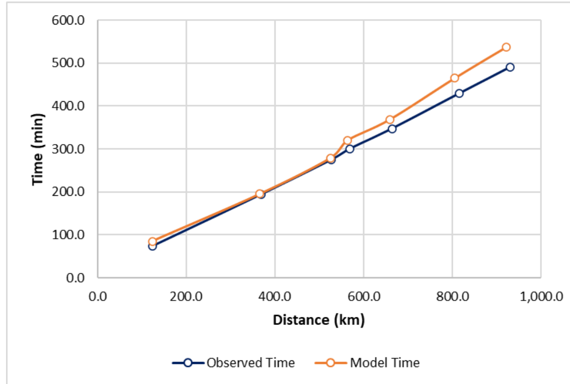
22. From San Antonio to Corpus Christi – MD



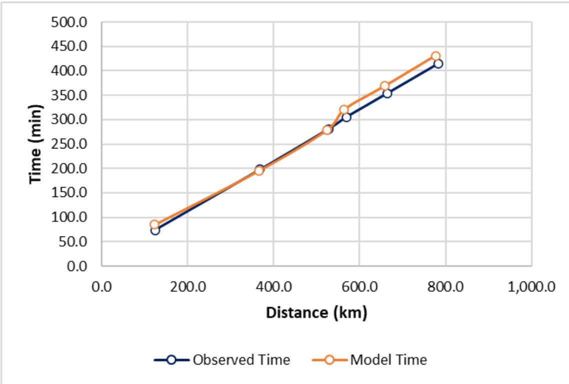
23. From San Antonio to McAllen – AM



23. From San Antonio to McAllen – MD



24. From San Antonio to Brownsville – AM



24. From San Antonio to Brownsville – MD

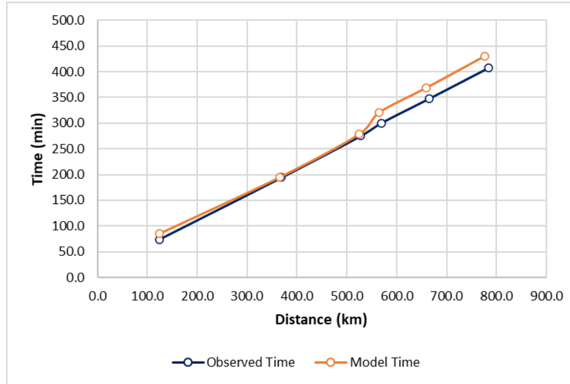
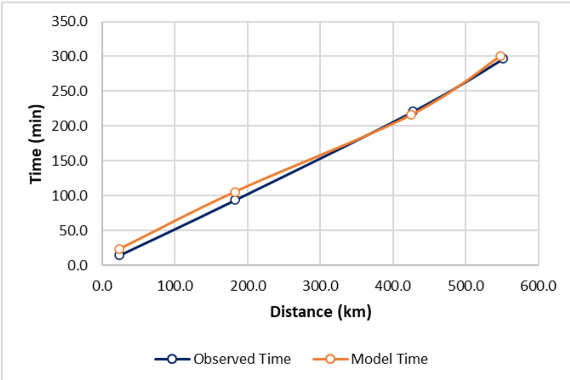
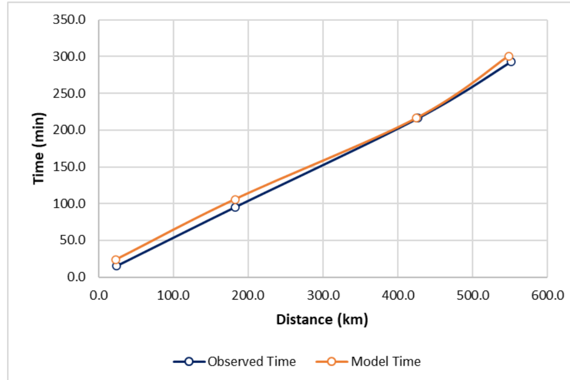


Figure 3-38. Observed and Modeled Travel Time Comparisons

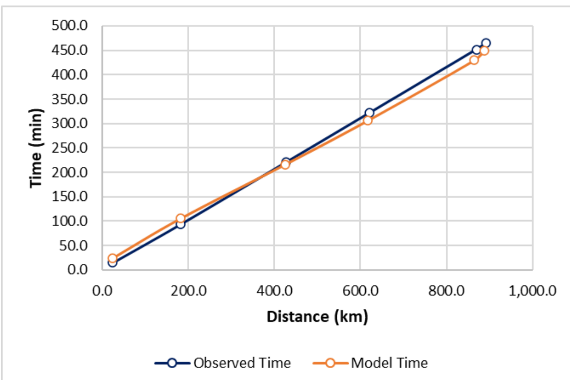
25. From Laredo to Corpus Christi – AM



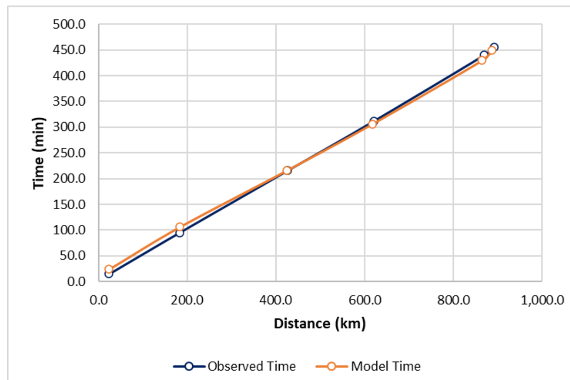
25. From Laredo to Corpus Christi – MD



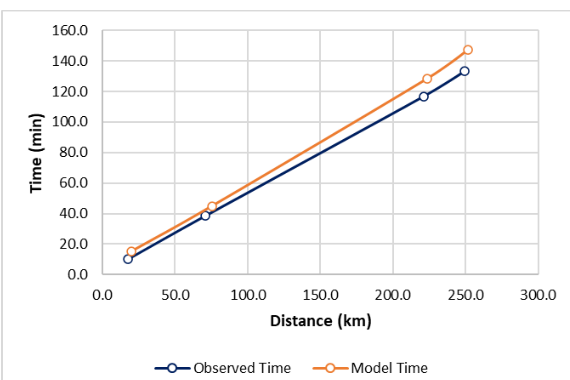
26. From Laredo to Odessa – AM



26. From Laredo to Odessa – MD



27. From Laredo to El Paso – AM



27. From Laredo to El Paso – MD

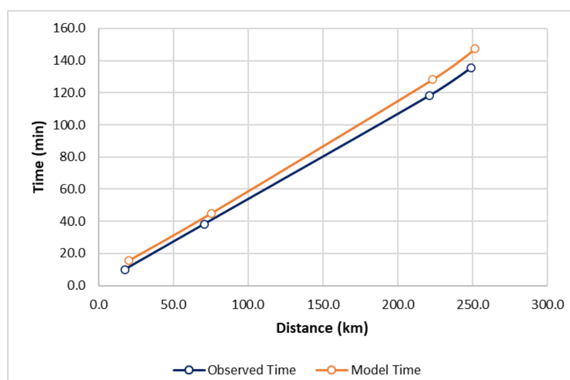
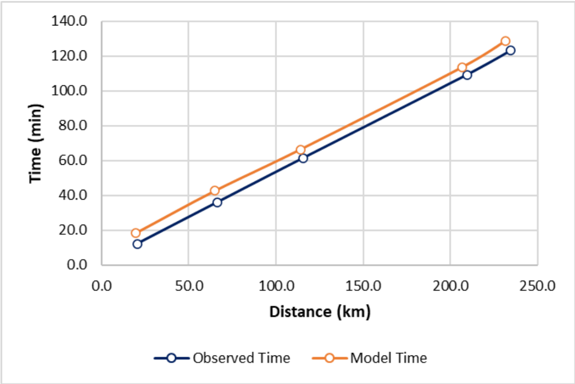
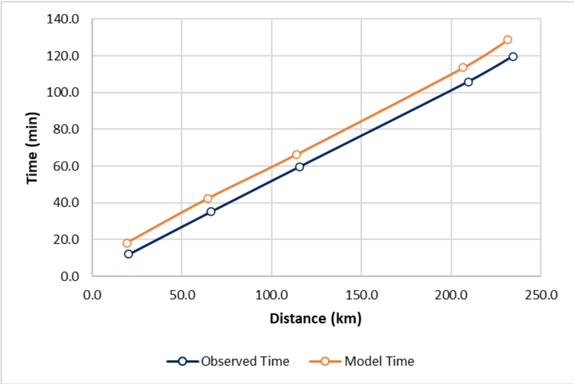


Figure 3-39. Observed and Modeled Travel Time Comparisons

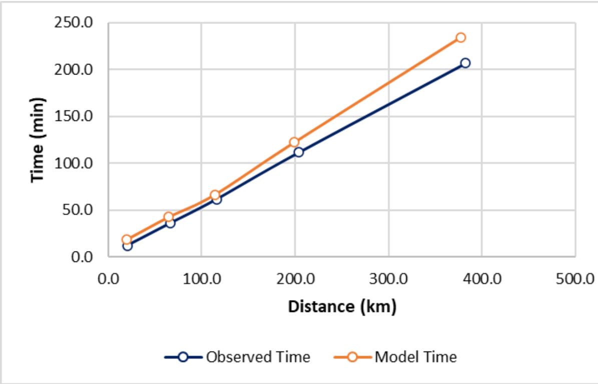
28. From Laredo to San Antonio – AM



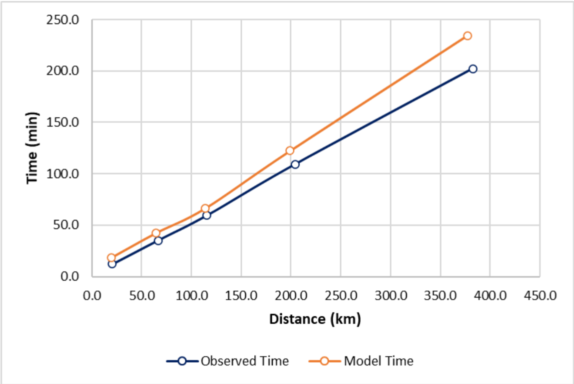
28. From Laredo to San Antonio – MD



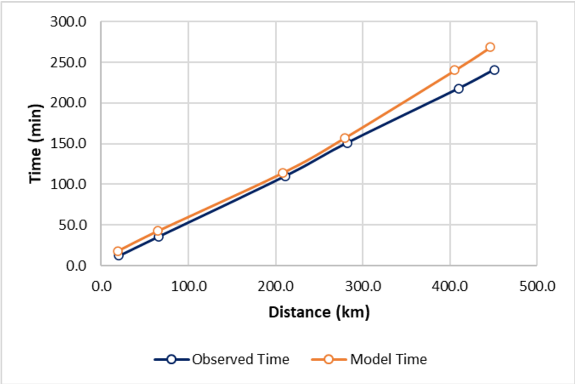
29. From Laredo to Brownsville – AM



29. From Laredo to Brownsville – MD



30. From Laredo to McAllen – AM



30. From Laredo to McAllen – MD

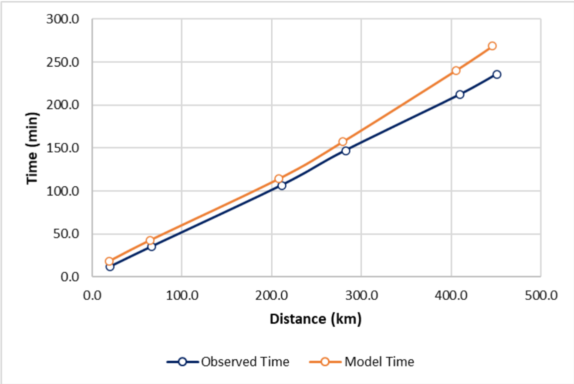
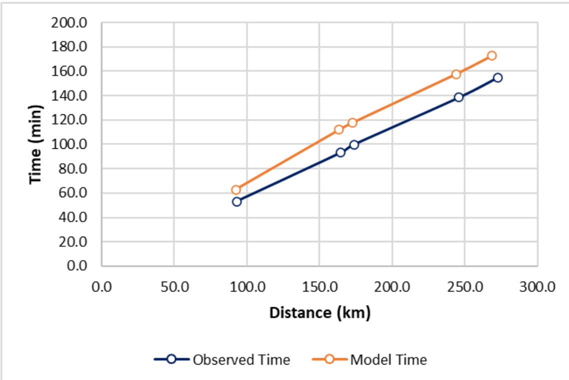
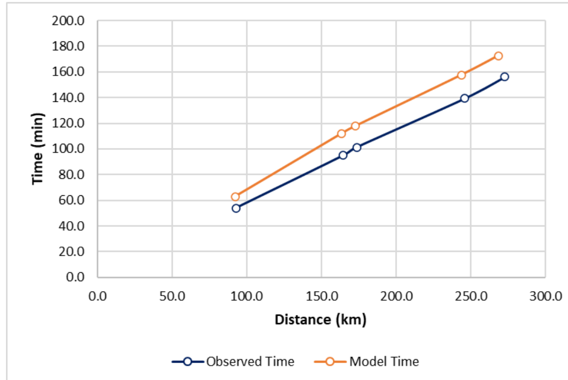


Figure 3-40. Observed and Modeled Travel Time Comparisons

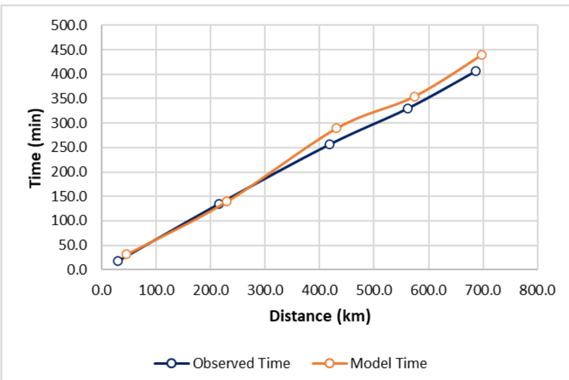
31. From Corpus Christi to McAllen – AM



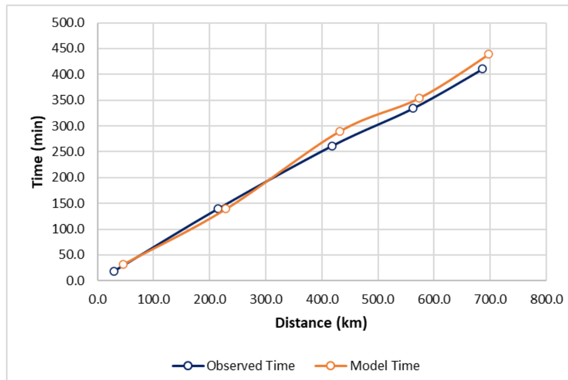
31. From Corpus Christi to McAllen – MD



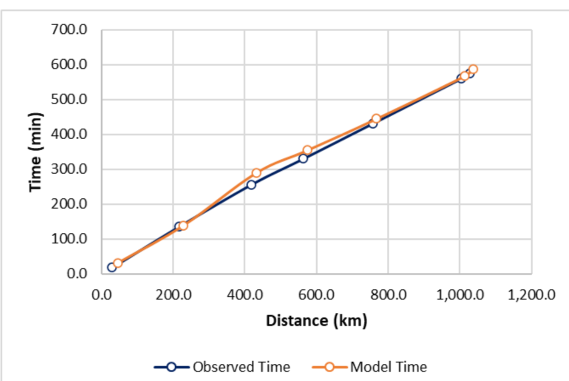
32. From Corpus Christi to Brownsville – AM



32. From Corpus Christi to Brownsville – MD



33. From Corpus Christi to San Antonio – AM



33. From Corpus Christi to San Antonio – MD

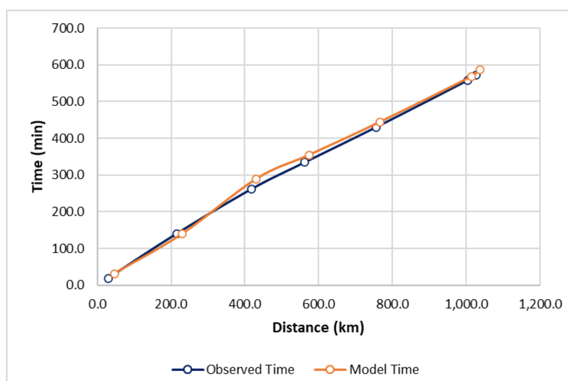
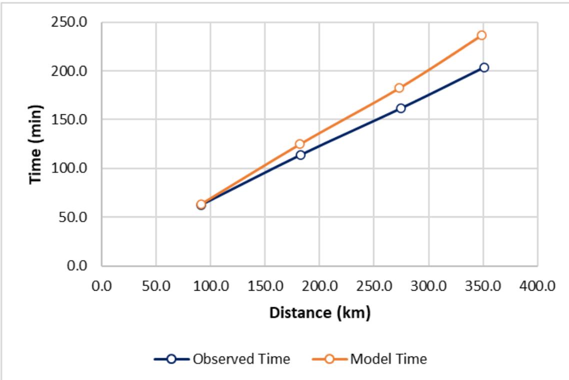
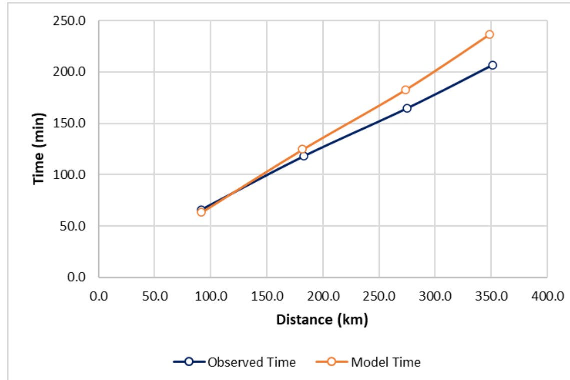


Figure 3-41. Observed and Modeled Travel Time Comparisons

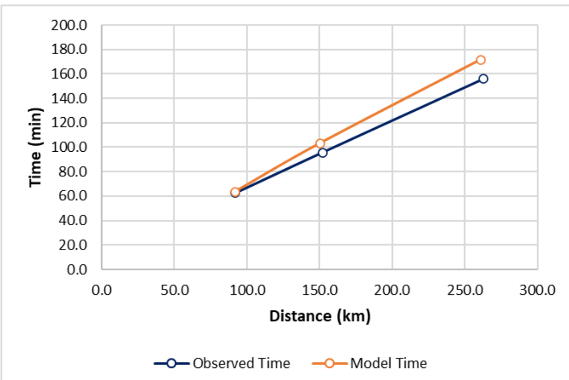
34. From Corpus Christi to Odessa – AM



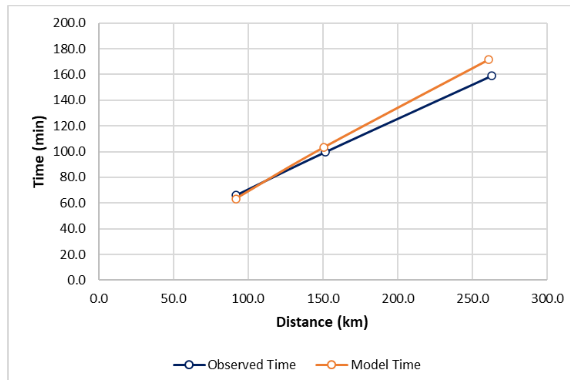
34. From Corpus Christi to Odessa – MD



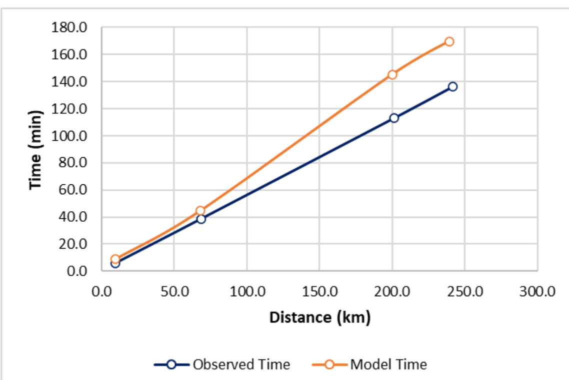
35. From Corpus Christi to El Paso – AM



35. From Corpus Christi to El Paso – MD



36. From Corpus Christi to Laredo – AM



36. From Corpus Christi to Laredo – MD

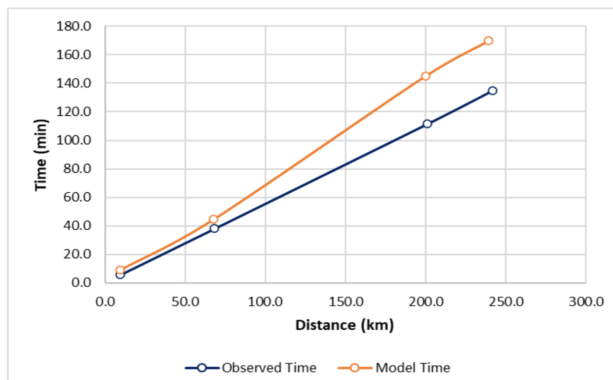
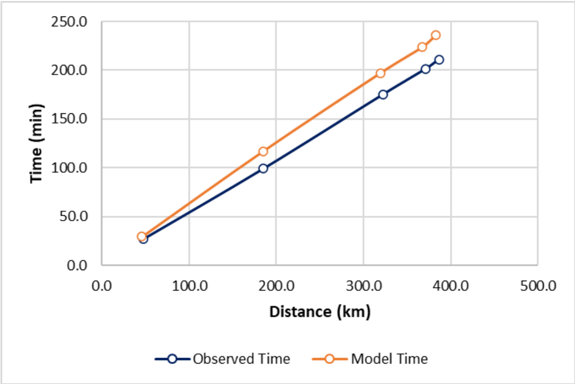
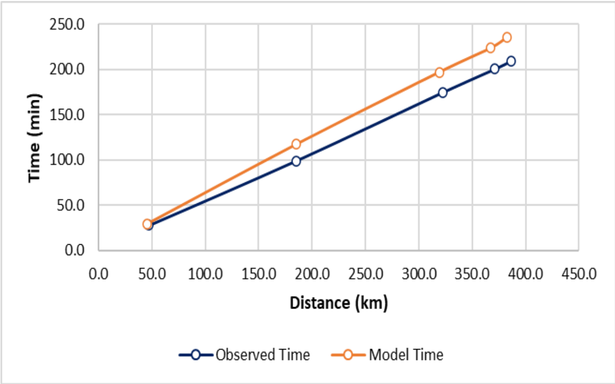


Figure 3-42. Observed and Modeled Travel Time Comparisons

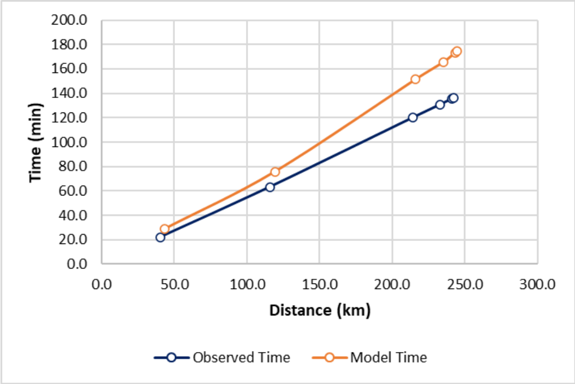
37. From Brownsville to Laredo – AM



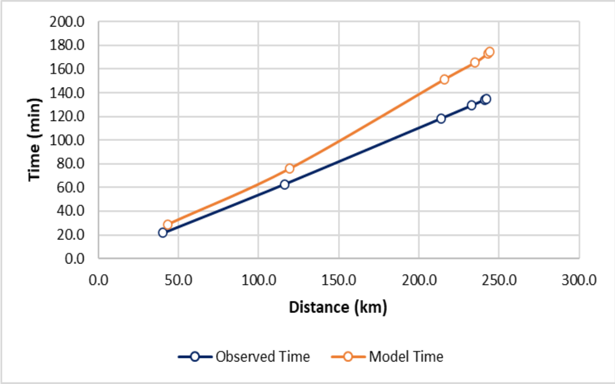
37. From Brownsville to Laredo – MD



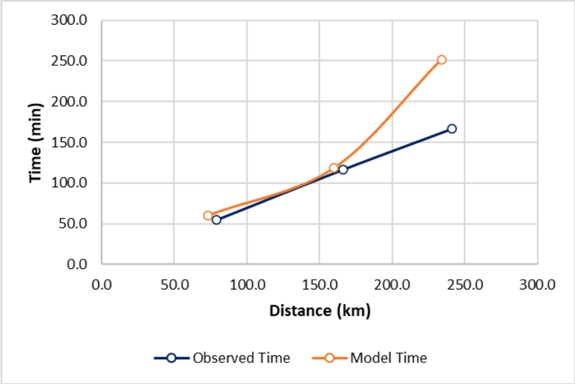
38. From Brownsville to Odessa – AM



38. From Brownsville to Odessa – MD



39. From Brownsville to El Paso – AM



39. From Brownsville to El Paso – MD

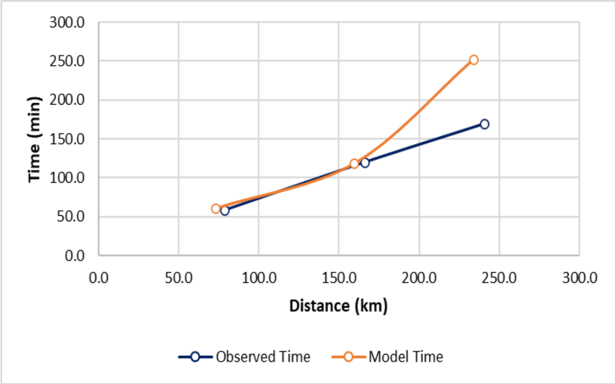
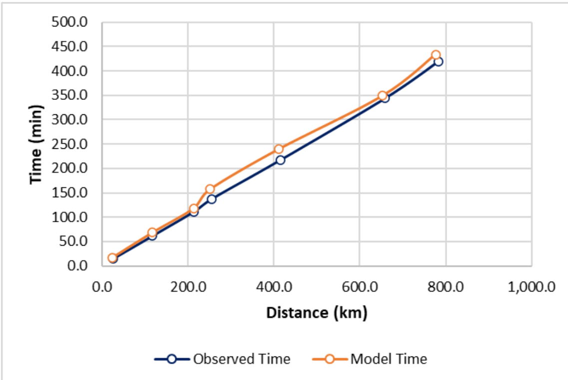
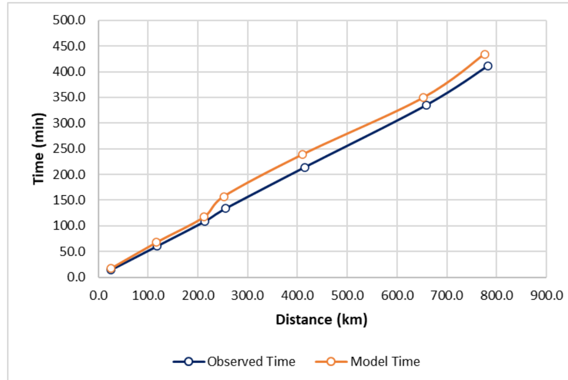


Figure 3-43. Observed and Modeled Travel Time Comparisons

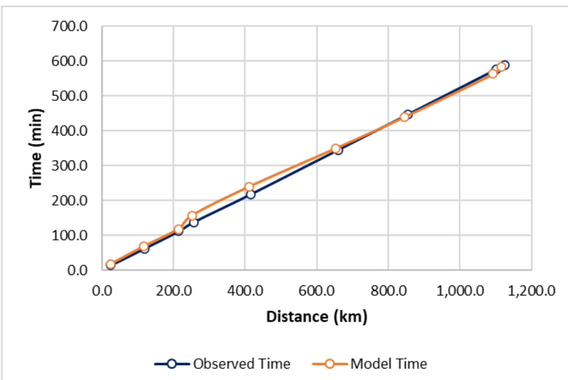
40. From Brownsville to San Antonio – AM



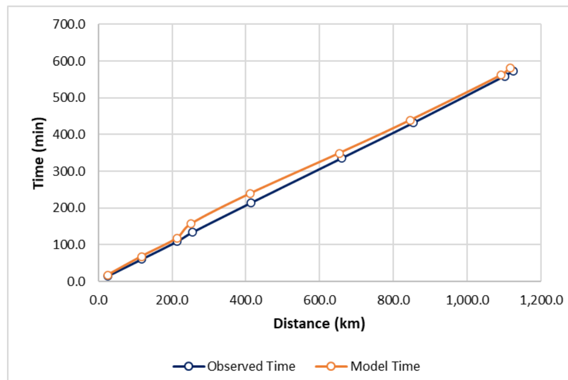
40. From Brownsville to San Antonio – MD



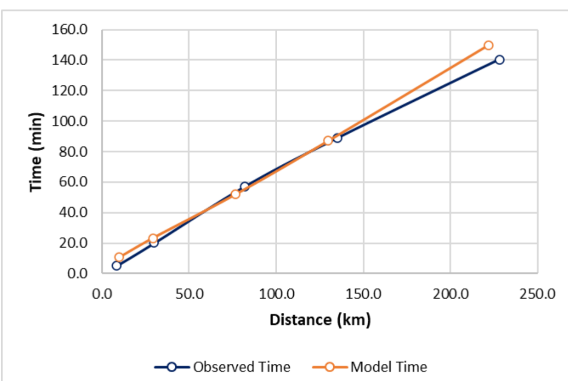
41. From Brownsville to Corpus Christi – AM



41. From Brownsville to Corpus Christi –MD



42. From Brownsville to McAllen – AM



42. From Brownsville to McAllen – MD

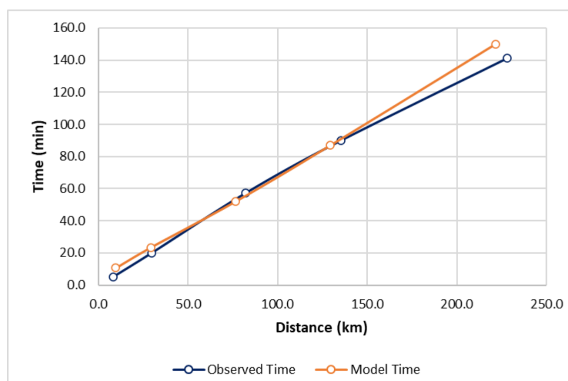


Figure 3-44. Observed and Modeled Travel Time Comparisons

3.2.5.5 Traffic Assignment

Once the model was calibrated, C&M performed the traffic assignment to estimate link volumes at a sufficient approximation to the observed count data. Figure 3-45 shows the traffic flows from the calibrated 2022 base network that crosses the study area.

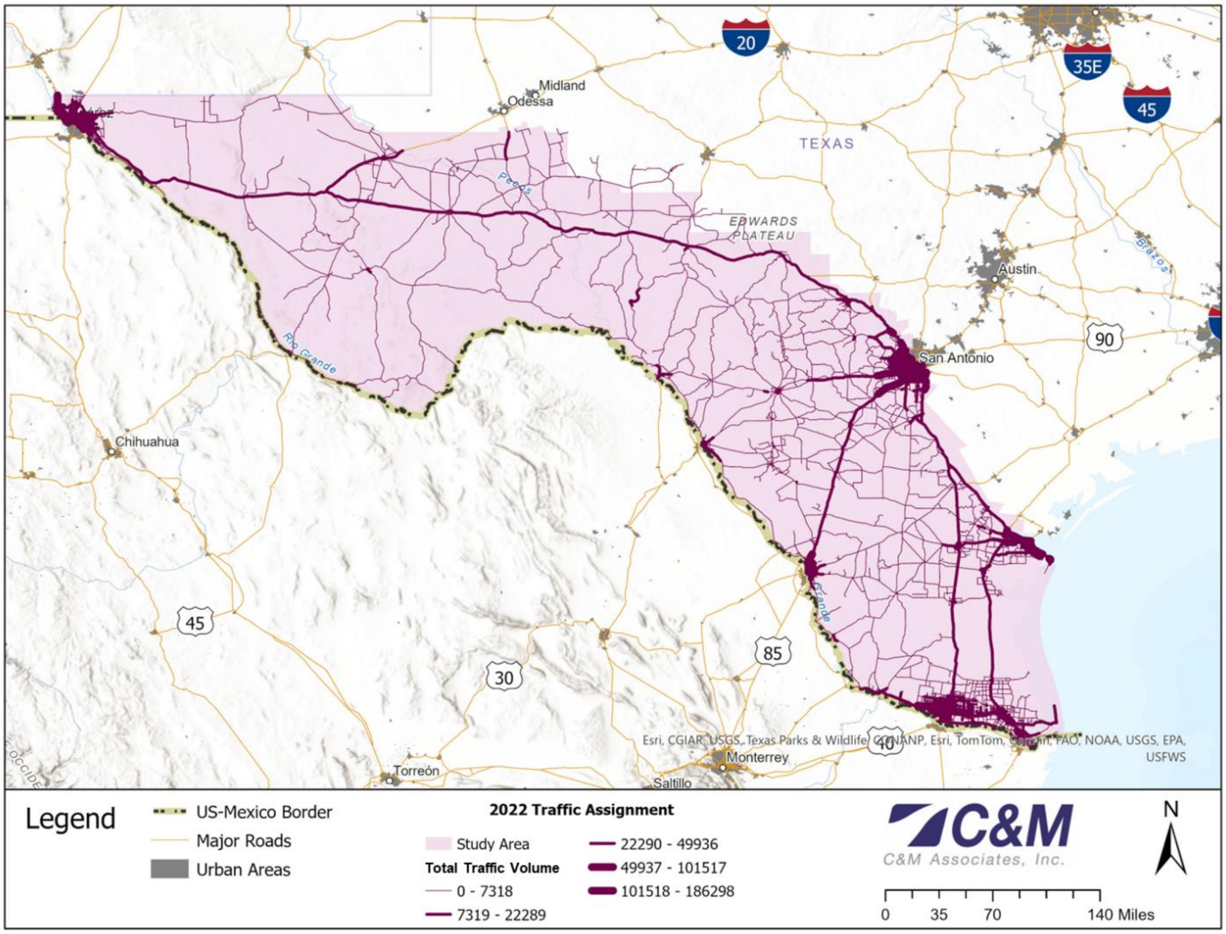


Figure 3-45. 2022 Traffic Assignment

Figure 3-46 and Figure 3-47 shows 2022 traffic assignments in the main Texas–Mexico border cities.

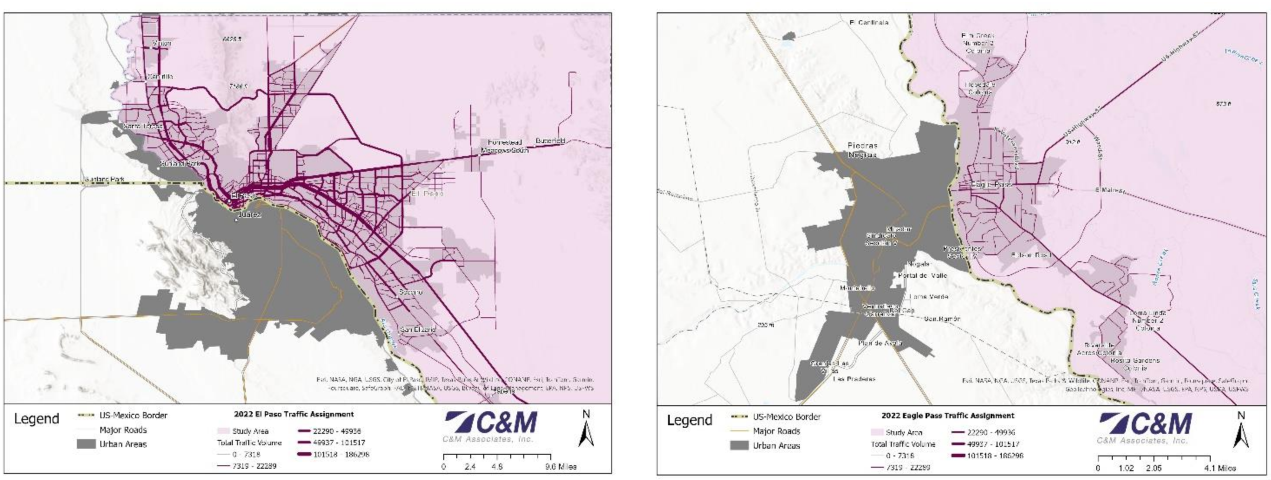
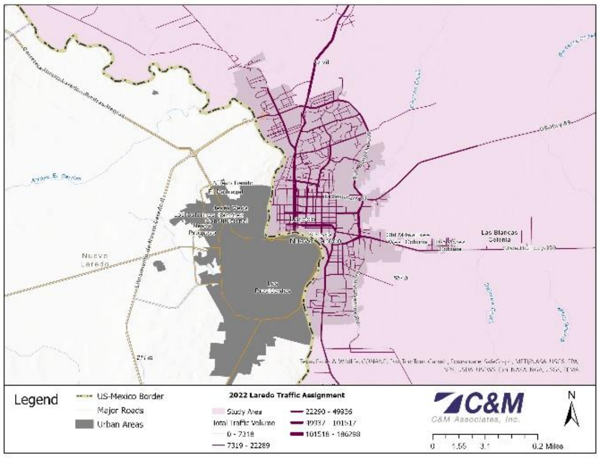


Figure 3-46. 2022 El Paso and Eagle Pass Traffic Assignments



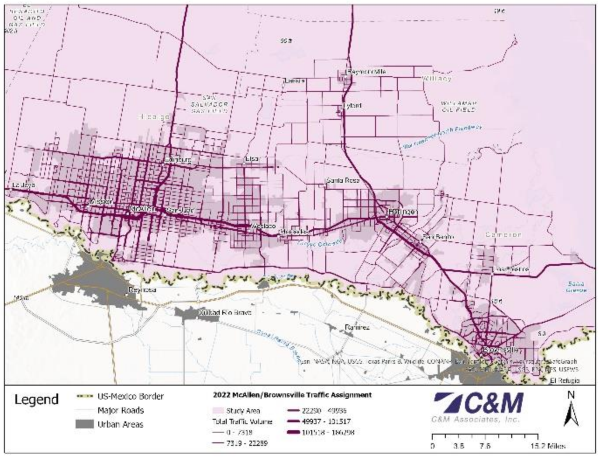


Figure 3-47. 2022 Laredo, McAllen, and Brownsville Traffic Assignments

In general, the traffic assignment is consistent with the traffic assignment results presented in SAM-V4. It is noteworthy that interstate traffic corridors like I-10, I-35, US 281, and US 77 currently present representative congestion in the study area.

Figure 3-48 show 2022 passenger vehicle assignments. Figure 3-49 and Figure 3-50 show 2022 passenger vehicle assignments in the main border cities.

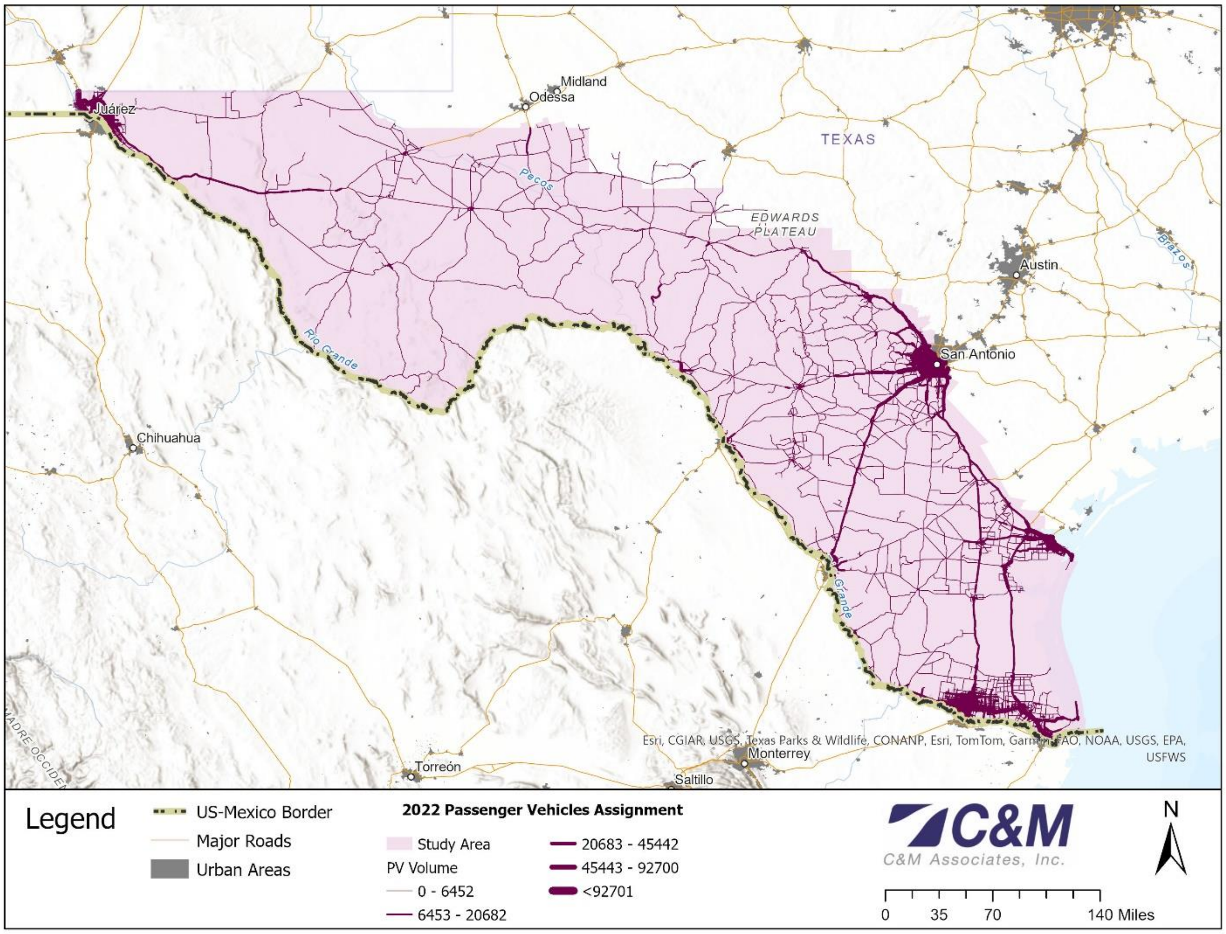


Figure 3-48. 2022 Passenger Vehicle Assignments

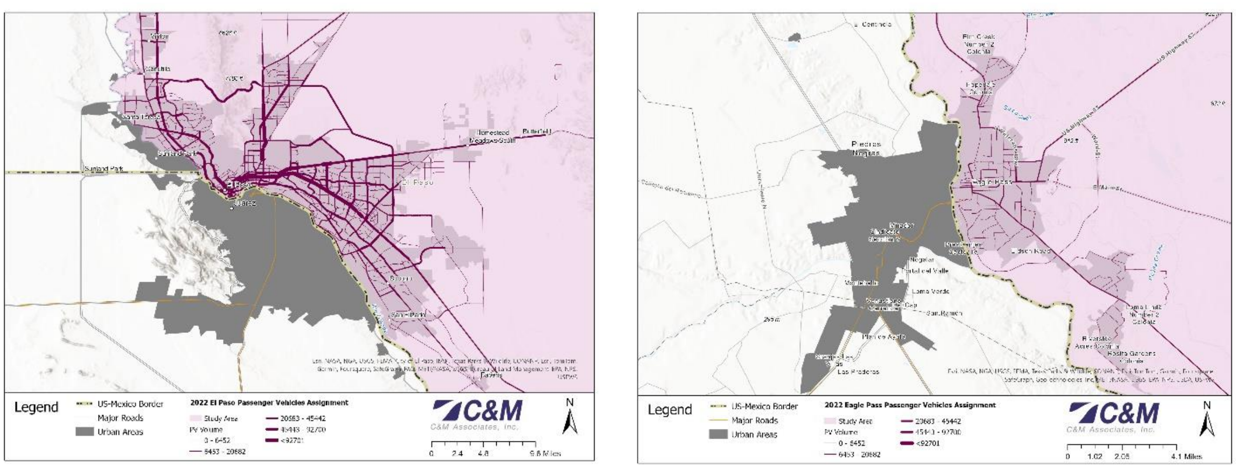


Figure 3-49. 2022 El Paso and Eagle Passenger Vehicle Assignments

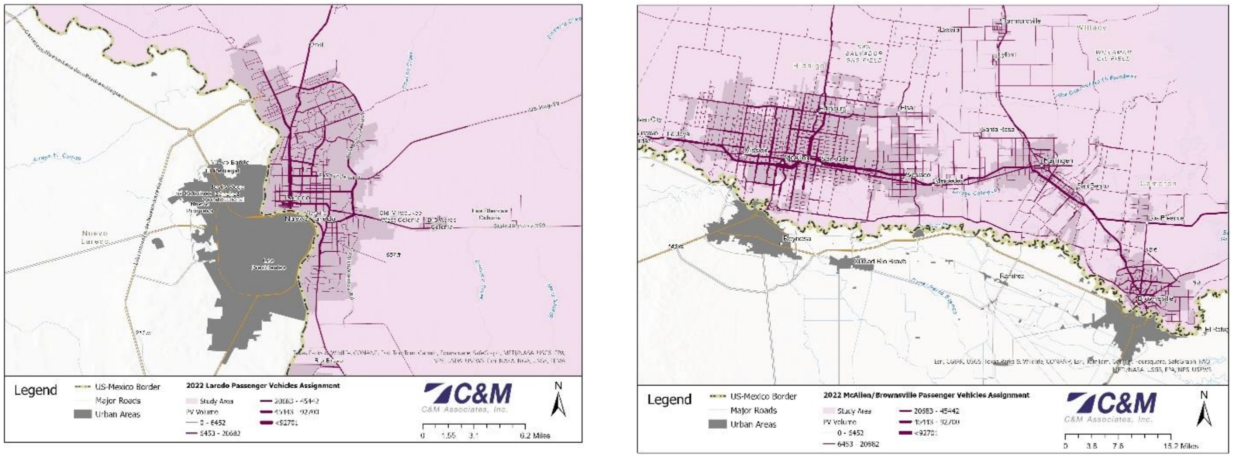


Figure 3-50. 2022 Laredo, McAllen, and Brownsville Passenger Vehicle Assignments

Figure 3-51 shows 2022 truck assignments. Figure 3-52 and Figure 3-53 shows 2022 truck assignments in the main border cities.

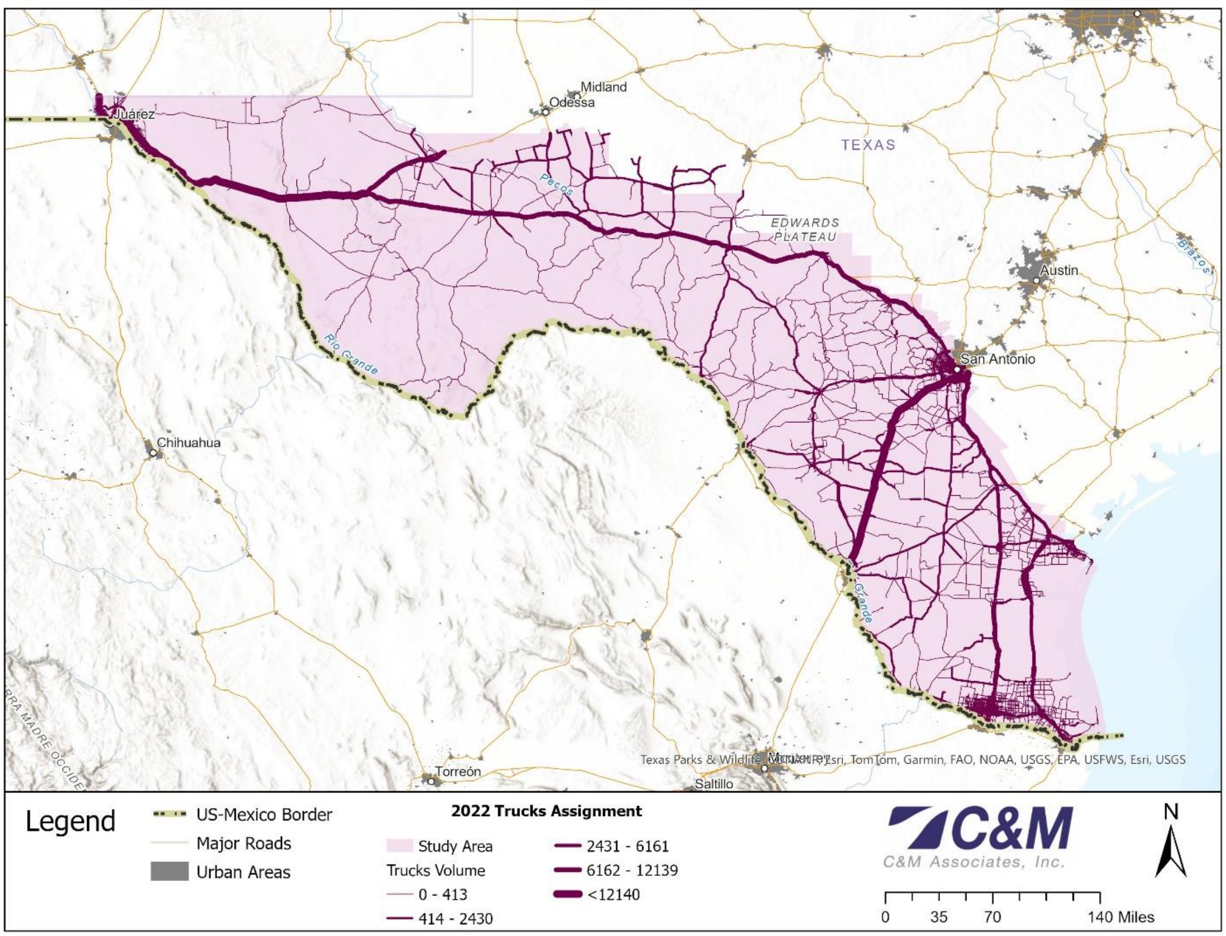


Figure 3-51. 2022 Truck Assignments

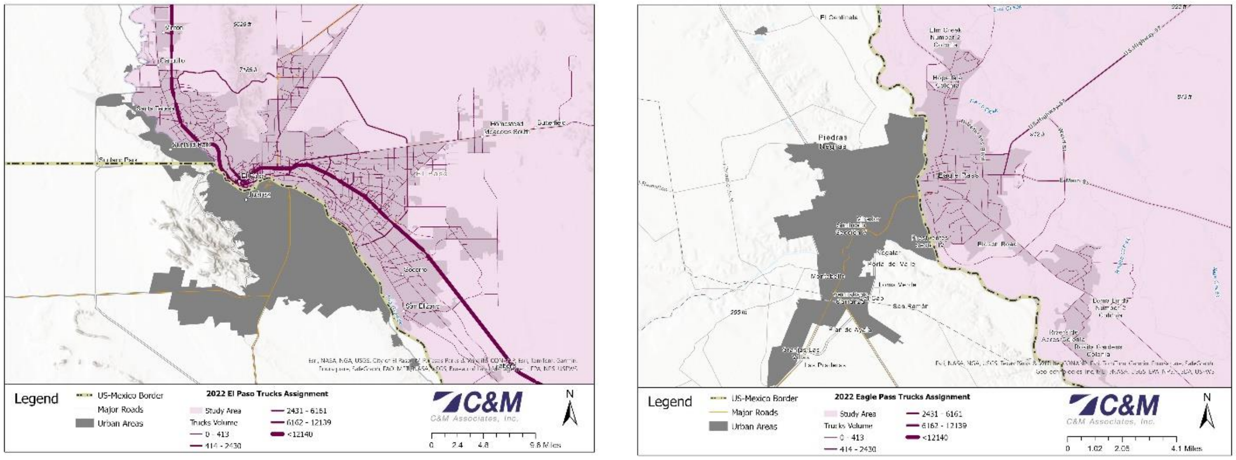


Figure 3-52. 2022 El Paso and Eagle Pass Truck Assignments

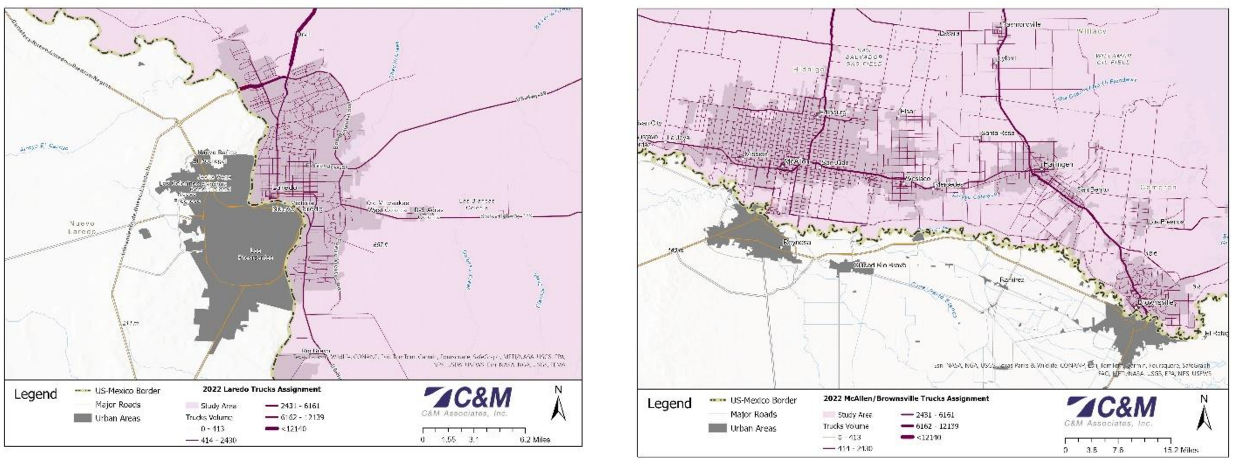


Figure 3-53. 2022 Laredo, McAllen, and Brownsville Truck Assignments

3.2.5.6 Border Crossing by District Comparison

Conversely and as previously mentioned, once the model was fully calibrated to 2022 traffic and speed conditions, cross-border traffic was adjusted to reflect the crossing conditions in the study area for main districts (El Paso, Laredo, and Pharr). An equivalent calibration was carried out with 2022 border traffic volumes. Table 3-42 summarize the POE and border crossings that were considered within each district and Table 3-43 summarizes the comparison between the observed traffic and model results in 2022 for the northbound direction.

Table 3-42. POEs and Border Crossings by District

District	Port of Entry	Border Crossing
Pharr	Brownsville	Gateway International Bridge
		Brownsville & Matamoros (B&M) Bridge
		Veterans International Bridge
		Free Trade Bridge
	Progreso	Weslaco-Progreso International Bridge
		Donna International Bridge
	Hidalgo	Pharr-Reynosa International Bridge
		McAllen-Hidalgo International Bridge
		Anzalduas International Bridge
	Rio Grande City	Camargo Bridge
		Los Ebanos Ferry
	Roma	Lake Falcon Dam International Crossing
		Roma-Ciudad Miguel Aleman International Bridge
Laredo	Laredo	Colombia Solidarity Bridge
		World Trade Bridge
		Gateway to the Americas Bridge
		Juarez-Lincoln International Bridge
	Eagle Pass	Eagle Pass International Bridge
		Camino Real International Bridge
	Del Rio	Lake Amistad Dam Crossing
		Del Rio International Bridge
El Paso	El Paso	Paso del Norte Bridge
		Good Neighbor Bridge
		Bridge of the Americas
	Ysleta	Ysleta Bridge
	Tornillo	Fort Hancock-El Porvenir Bridge
		Tornillo-Guadalupe International Bridge
	Presidio	Presidio-Ojinaga International Bridge

Table 3-43. 2022 Daily Cross-Border Traffic by District – Northbound

Direction	Vehicles	Observed Traffic			Modeled Traffic			Difference (%)		
		El Paso	Laredo	Pharr	El Paso	Laredo	Pharr	El Paso	Laredo	Pharr
MX - USA	PV	25,800	24,450	30,700	24,212	24,658	30,747	-6%	1%	0%
MX - USA	CV	2,254	8,445	3,146	1,939	8,190	3,248	-14%	-3%	3%
MX - USA	Total	28,054	32,895	33,846	26,151	32,848	33,995	-7%	0%	0%

[1] U.S. Census (n.d.). Decennial Census (2020, 2010, 2000) retrieved Feb 12, 2024, from https://www.census.gov/data/developers/data-sets/decennial-census.html

[2] U.S. Census (2023) Population and Housing Unit Estimates retrieved Feb 13, 2024, from https://www.census.gov/programs-surveys/popest.html

[3] U.S. Census (2023). American Community Survey Data retrieved Feb 13, 2024, from https://www.census.gov/programs-surveys/acs/data.html

[4] U.S. Census (2023). Texas Population Estimates Program retrieved Mar 28, 2024, from https://demographics.texas.gov/Estimates/2022/

[5] Woods & Poole Economics, Inc. (2023). Complete Economic and Demographic Data Source (CEDDS), (*Purchased data)*.

[6] Texas Water Development Board (n.d.). 2022 State Water Plan Water User Group Population Projections for 2020-2070 Feb 14, 2024 from https://txwaterdatahub.org/dataset/2022-state-water-plan-wug-projections-for-2020-2070

[7] U.S. Bureau of Economic Analysis (BEA) retrieved Feb 14, 2024, from https://www.bea.gov/data/all

[8] U.S. Bureau of Labor Statistics (BLS), Local Area Unemployment Statistics retrieved Feb 14, 2024, from https://www.bls.gov/lau/tables.htm#cntyaa

[9] Texas Workforce Commission (n.d.). Texas Labor Market Information (TexasLMI) retrieved Feb 15, 2024, from https://texaslmi.com/LMIbyCategory/Projections

[10] Moody's Analytics retrieved (*Purchased data*).

[11] U.S. Census Bureau's County Business Patterns Datasets retrieved Feb 16, 2024, from https://www.census.gov/programs-surveys/cbp/data/datasets.html

[12] U.S. Census Bureau 2022 Census of Governments, Survey of Public Employment & Payroll Datasets & Tables retrieved Feb 27, 2024, from https://www.census.gov/programs-surveys/apes/data/datasetstables/2022.html

[13] Integrated Postsecondary Education Data System (IPEDS) retrieved Feb 28, 2024, from https://nces.ed.gov/ipeds/use-the-data

[14] NCFRP. (2010). *Freight-Demand Modeling to Support Public-Sector Decision Making.* Washington, D.C.: TRB.

[15] Transportation Research Board (1982, December). *National Cooperative Highway Research Program Report 255: Highway traffic data for urbanized area project planning and design.*

Chapter 4: Forecast Conditions and Needs Assessment

This chapter describes the efforts related to assessing the future traffic network conditions within the study area. This chapter explains the socioeconomic forecast inputs, which include the most up-to-date forecasted data, and the methodological approach to incorporate the existing forecast into the TAZ-level inputs as the TDM requires. Additionally, the Texas SAM future network updates are described, focusing on the updated infrastructure developments in the study area. Lastly, the future traffic assignment analysis is presented.

4.1 Socioeconomic Data Forecasts

4.1.1 Existing Available Forecasts

The primary purpose of this updated socioeconomic review is to evaluate socioeconomic model inputs to C&M's TDM and ensure C&M's results reflect the latest outlook of the study area. This section will specifically address the forecast methodologies and findings. The analysis includes considering socioeconomic data from the regional TDMs along the border area, which include the El Paso TDM, Laredo TDM, and LRGV TDM. C&M further reviewed socioeconomic data from both public and private sources, targeting consolidated findings to serve as references and assessments for the travel demand modeling procedures and T&R forecasting.

Sources for the socioeconomic forecasts include the following:

- LRGV, Laredo, and El Paso regional TDMs
- Texas SAM
- Texas Demographic Center (0.5 and 1.0 Migration Scenarios) (TDC)[1]
- Woods & Poole Economics, Inc. (W&P)[2]
- Texas Water Development Board (TWDB)[3]
- Texas Labor Market Information (TexasLMI)[4]
- Moody's Analytics (Moody's)[5]

The data preparation methodology for these sources is discussed in the previous chapter. However, it is important to note that most of these data sources do not provide data for the targeted years of analysis which are 2025, 2035, 2045, and 2050. In the case of regional models that were utilized in the calculation of future year projections, interpolation was used to achieve the socioeconomic values of the targeted years. TDC (1.0 Migration Scenario) and W&P are the only sources with data for every year until 2050. Given the recency and presumed accuracy of both these data sources, they were utilized in the forecast calculation.

4.1.2 Methodology Approach

In transportation demand modeling, the estimation of future socioeconomic data is critical as it provides the foundation for forecasting future transportation requirements and trends. This data, which includes projected population, employment numbers, income levels, and other demographic variables, directly impacts the estimation of travel demand patterns. Accurately capturing future socioeconomic conditions enables precise predictions about how transportation systems will need to adapt to changes in demography, economic conditions, and lifestyle preferences. This foresight is essential for planning and developing infrastructure that meets future transportation needs efficiently and effectively.

C&M conducted a comprehensive review of various sources of socioeconomic data for the State of Texas, including W&P; the LRGV, Laredo, and El Paso Regional TDMs; and the TDC (1.0 Migration Scenario), among others.

For the detailed forecast of socioeconomic data at the TAZ level, the following steps were implemented. It is important to understand the process and modifications performed to arrive at the future-year socioeconomic output results. Notably, preparing the future control totals follow different processes for each socioeconomic factor and will be thoroughly discussed in the respective sections. Once the control totals are established, C&M then used multiple steps to redistribute the control totals to the TAZ level. The method used to calculate the future years merges data from individual MPO models (LRGV for Cameron and Hidalgo Counties and El Paso for El Paso County) and the Texas SAM model (for the remainder of the counties) wherever possible to find key inputs such as household numbers, household population, and employment for each TAZ. The steps followed are detailed below. Note that these steps only show the socioeconomic calculations for the year 2025. The steps for other future years (2035, 2045, and 2050) will follow the same steps; however, each forecast year will use the preceding forecasted year as its base. This approach maintains continuity and accuracy in the progressive forecasting model. Figure 4-1 illustrates methodology in a flow chart.

1. **Update Base Year Data:** Updated Texas SAM 2022 socioeconomic data.
2. **Previous Base Year Data:** Obtain 2022 data from MPO models and the Texas SAM.
3. **Future Year Data:** Obtain 2025 data from MPO models and Texas SAM.
4. **Calculate Socioeconomic Growth:** Determine the difference in socioeconomic data between 2022 and 2025 and determine its distribution across the TAZs in each county along with a count of positive, negative, and no-growth TAZs.
5. **Analyze Control Totals:** Compare the socioeconomic control totals previously established for 2022 and 2025 to find the growth.
6. **Create Ternary Flags:** Develop flags based on growth trends to help categorize calculation methods for each county:
    a. **Flag_a**: Categorizes counties by the growth patterns in their TAZs:
        - **0** = Mixed Growth
        - **1** = Uniform Growth.
        - **2** = No growth.

    b. **Flag_b**: Evaluates the alignment of growth changes between the SAM county-level data and control totals:
        - **0** = Growth directions are opposite.
        - **1** = Growth directions are the same.

    c. **Final Flags**: Combine the results of Flag_a and Flag_b to guide data adjustments:
        - **0** = Both TAZ and county-level indicate mixed-growth directions.
        - **1** = TAZ-level indicates either mixed or uniform growth or decline and county-level indicates the same

  - **2** = TAZ-level indicates no growth or when there are opposite growth trends between Texas SAM and the control totals.

7. **Adjust Future TAZ Data:** Modify future TAZ data based on these flags:
   a. **0** = Subtract the proportion of county-level growth from updated 2022 data.
   b. **1** = Add the proportion of county-level growth to the updated 2022 data.
   c. **2** = Distribute the 2025 control total evenly across all TAZs using the updated 2022 socioeconomic data to determine each TAZ's share.
8. **Consolidate and Calibrate Data:** Aggregate the future TAZ data at the county level and compare it with the control total. If there is a discrepancy, adjust the TAZ data to align with the control totals, ensuring accurate future projections.
9. **QA/QC:** To resolve inconsistencies where household sizes were less than 1 or greater than 6, adjust the population and group quarters (GQ) population based on the household size data from Texas SAM.

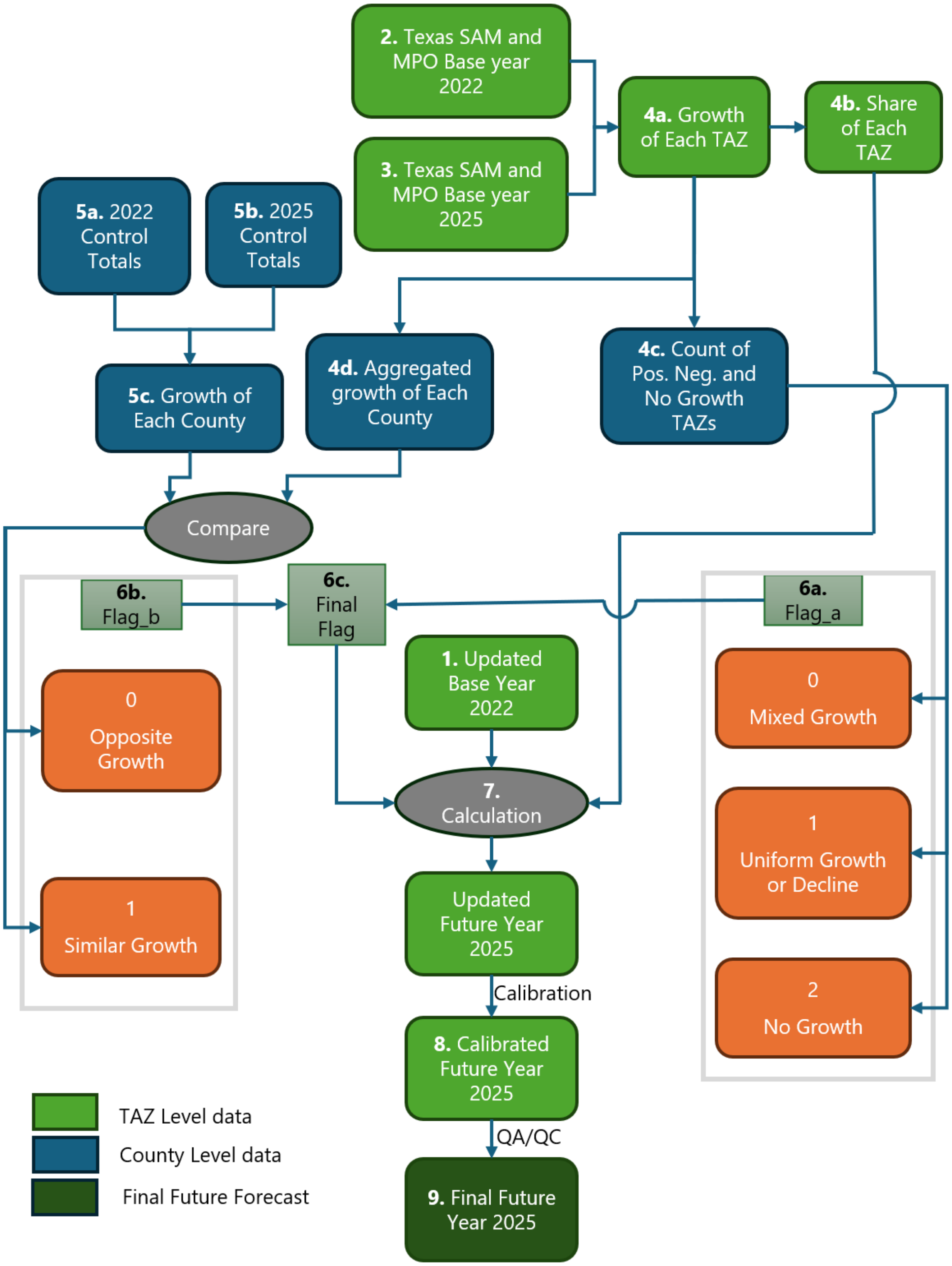


Figure 4-1. Socioeconomic Forecast Methodology

4.1.3 Socioeconomic Forecast

4.1.3.1 Population Forecast

C&M reviewed various sources of data for the future population projection forecast. However, given the recency and presumed accuracy of the projections from the TDC, these figures were adopted for the calculation of the control totals at the county level for future years in C&M's TDM for the Border Master Plan.

It should be noted that the methodology used by TDC to calculate the 2022 population estimates and its Vintage 2022 future forecast is different and has resulted in different 2022 values. For 2022 control totals, the 2022 estimates were used, while C&M used the growth rate from Vintage 2022 to recalculate the future-year control totals.

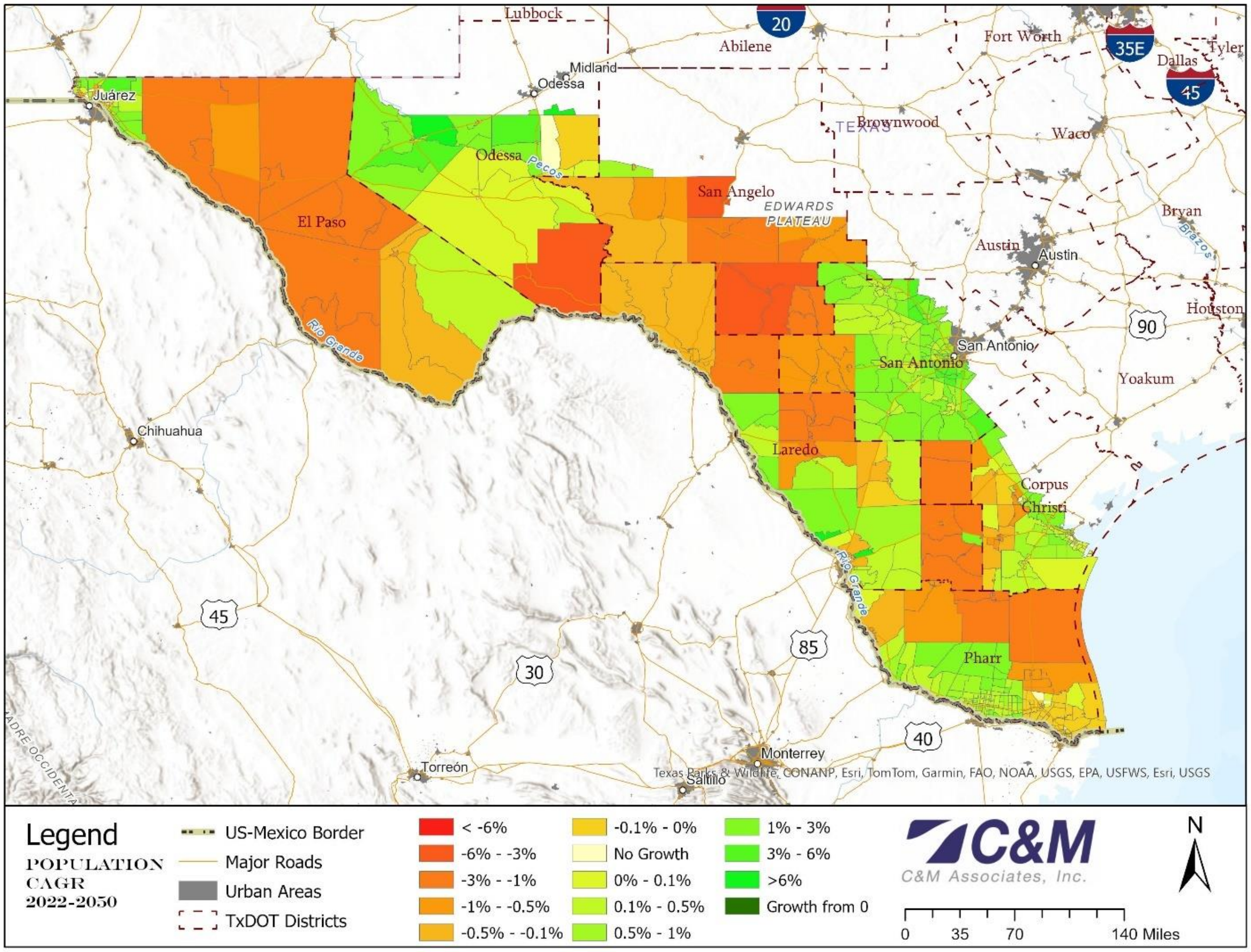


Figure 4-2. Population CAGRs within 100 Miles of the U.S.–Mexico Border, 2022-2050

Figure 4-2 illustrates the overall CAGR of the population within 100 miles of the U.S.–Mexico border from 2022 to 2050. The map indicates that the highest growth has been associated with TAZs in the counties that had the highest share of population, as seen from U.S. Census in Chapter 3. This growth trajectory aligns with historical trends. The forecast indicates that most of the population growth is expected to occur near major urban centers. Conversely, TAZs in counties further from these major urban centers are projected to experience negative growth, highlighting an ongoing demographic shift from rural to urban regions in the future.

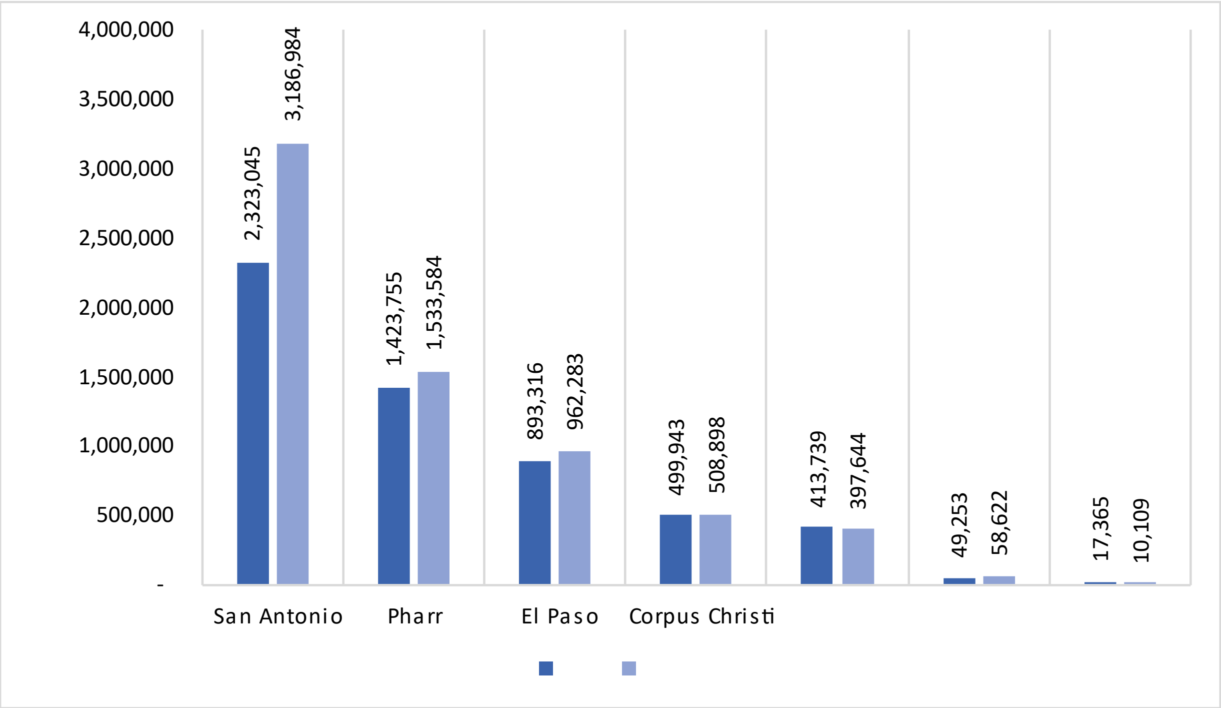


Figure 4-3. District Population Growth

Table 4-1. Population CAGR for Major Texas Counties, 2022-2050

County	POPULATION		
	2022	2050	CAGR
Bexar	2,054,012	2,848,269	1.17%
Hidalgo	888,380	1,005,708	0.44%
El Paso	870,359	946,617	0.30%
Cameron	423,605	417,664	-0.05%
Nueces	350,194	357,884	0.08%
Webb	270,999	262,089	-0.12%
San Patricio	69,229	75,611	0.32%
Starr	65,794	72,583	0.35%
Maverick	57,811	65,164	0.43%
Kerr	53,873	61,129	0.45%

Figure 4-2 illustrates population growth trends across various districts from 2022 to 2050. Among these districts, San Antonio, Corpus Christi, and San Angelo are not adjacent to the U.S.–Mexico border. San Antonio, being a major urban center, has the highest population of 2.3 million in 2022, which is expected to grow to 3.1 million by 2050. Corpus Christi had a population of 0.5 million in 2022, which is expected to grow slightly during this period. San Angelo has the lowest population of 17,365, which is projected to decline to 10,109 by 2050.

The border-area districts like Pharr and El Paso are estimated to experience modest growth from their respective populations in 2022, whereas Laredo is expected to see a slight decline in the population from 0.41 million. Odessa, owing to its partial inclusion in the 100-mile border zone, is estimated to have a population of only 49,253 in 2022, which is estimated to increase slightly.

Table 4-1 further narrows down the population trends of major counties within a 100-mile zone from the U.S.–Mexico border. It is important to note that the growth rates, which have declined over the last two decades, are projected to continue declining until 2050. Despite this overall slowdown, most counties are expected to grow, but at reduced rates. However, Cameron and Webb Counties are expected to experience a decline in population, while Bexar County is still expected to grow with the highest growth rate among all major counties.

4.1.3.2 Household Forecast

C&M again reviewed various data sources for the future household projections. However, to ensure consistency with the population data derived from TDC, C&M computed household size from the W&P data and then applied that to the future-year population control total to compute the total number of households as control totals for 2022. This method assures that the household estimates are consistent with the demographic forecasts.

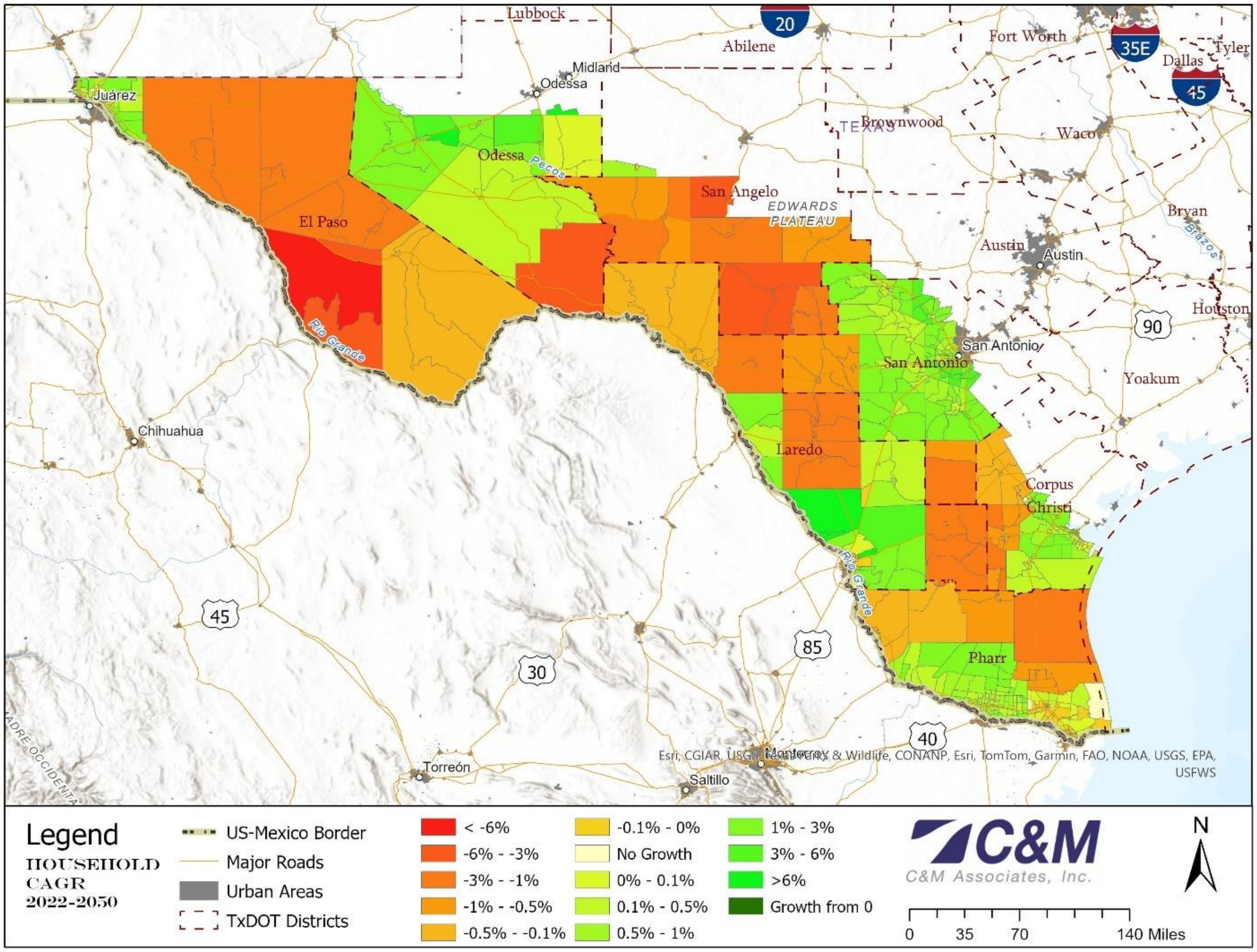


Figure 4-4. Household CAGRs within 100 miles of the U.S.–Mexico Border, 2022-2050

Figure 4-4 illustrates the overall household CAGRs within 100 miles of the U.S.–Mexico border from 2022 to 2050. The map indicates that the highest growth has been associated with TAZs that had the highest growth in population. This correlation is logical, as the number of occupied households is directly related to the population size. The map effectively highlights regions with varying growth rates, emphasizing areas with substantial household expansion alongside those with minimal or negative growth.

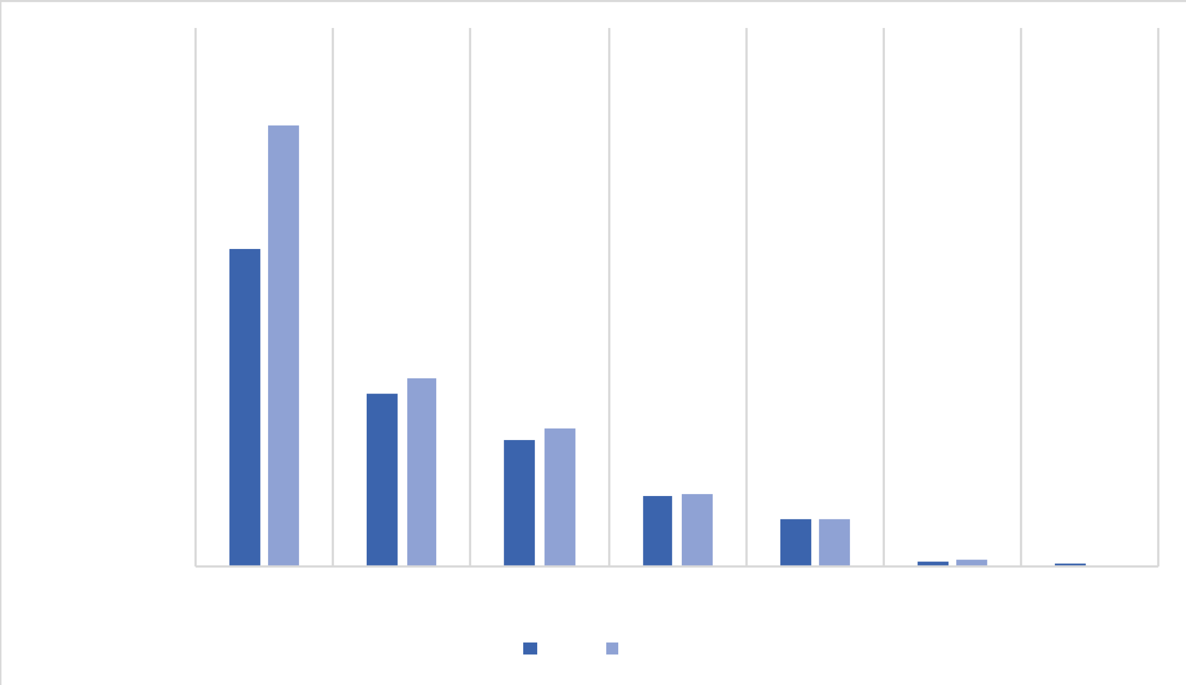


Figure 4-5. Household Growth by District

Table 4-2. Household CAGRs for Major Counties, 2022-2050

County	POPULATION		
	2022	2050	CAGR
Bexar	733,160	733,160	1.21%
Hidalgo	272,861	272,861	0.49%
El Paso	319,927	319,927	0.34%
Cameron	142,960	142,960	-0.03%
Nueces	128,348	128,348	0.14%
Webb	80,270	80,270	-0.06%
San Patricio	26,137	26,137	0.37%
Starr	20,229	20,229	0.38%
Maverick	18,604	18,604	0.48%
Kerr	23,049	23,049	0.51%

Figure 4-5 Illustrates the household growth trends across various districts from 2022 to 2050. When comparing with the population trends from Figure 4-3, household sizes are directly correlated with population size. Border-area districts like Pharr, El Paso, and Odessa are projected to experience modest growth, whereas Laredo is expected to see a decline, mirroring the population trend in these regions.

Table 4-2 further narrows down the household numbers to the major counties within 100 miles of the border with Mexico. Close inspection of the growth pattern shows a similar trend as seen in the population growth pattern, with a decline in the growth rate compared to previous decade, and Cameron and Webb Counties expected to experience declines. The household CAGRs are quite close to the population CAGRs of the counties, indicating that household sizes are projected to remain relatively stable in the future.

4.1.3.3 Employment Forecast

As discussed in Chapter 3, C&M utilized the most reliable alternative data sources available to forecast 2022 employment statistics for various industries and then aggregated them to get the overall employment numbers. C&M then utilized the CAGRs from W&P to project the future employment numbers from the base year. However, to determine the control totals of specific industry groups, C&M utilized the previous Texas SAM industry-specific employment numbers. Using the CAGRs calculated from it, future numbers were estimated from the updated base year numbers. These employment numbers, however, differed slightly from the aggregated employment control total calculated previously. To ensure consistency and alignment with the W&P forecast, these numbers were appropriately scaled so that their sum matched the overall employment total. This adjustment guarantees that the employment forecasts accurately reflect expected industry trends.

For the development of the freight model, C&M utilized the future forecasts provided by W&P to calculate the CAGRs and applied it to project employment figures for future years from the base-year data. However, W&P’s data provided employment numbers only at the two-digit NAICS-code level. C&M then used the proportion of Texas SAM employment numbers to distribute the two-digit employment to three-digit employments.

However, discrepancies were again observed which needed addressing, particularly as the Texas SAM model indicated zero employment for certain three-digit NAICS codes in many counties, whereas the 2022 control total (derived from Census CBP data) showed some employment figures for these areas. To address this, C&M used the updated proportions from the 2022 control total to more accurately distribute the two-digit NAICS employment into three-digit categories, ensuring a more detailed allocation of employment across all the industry sectors.

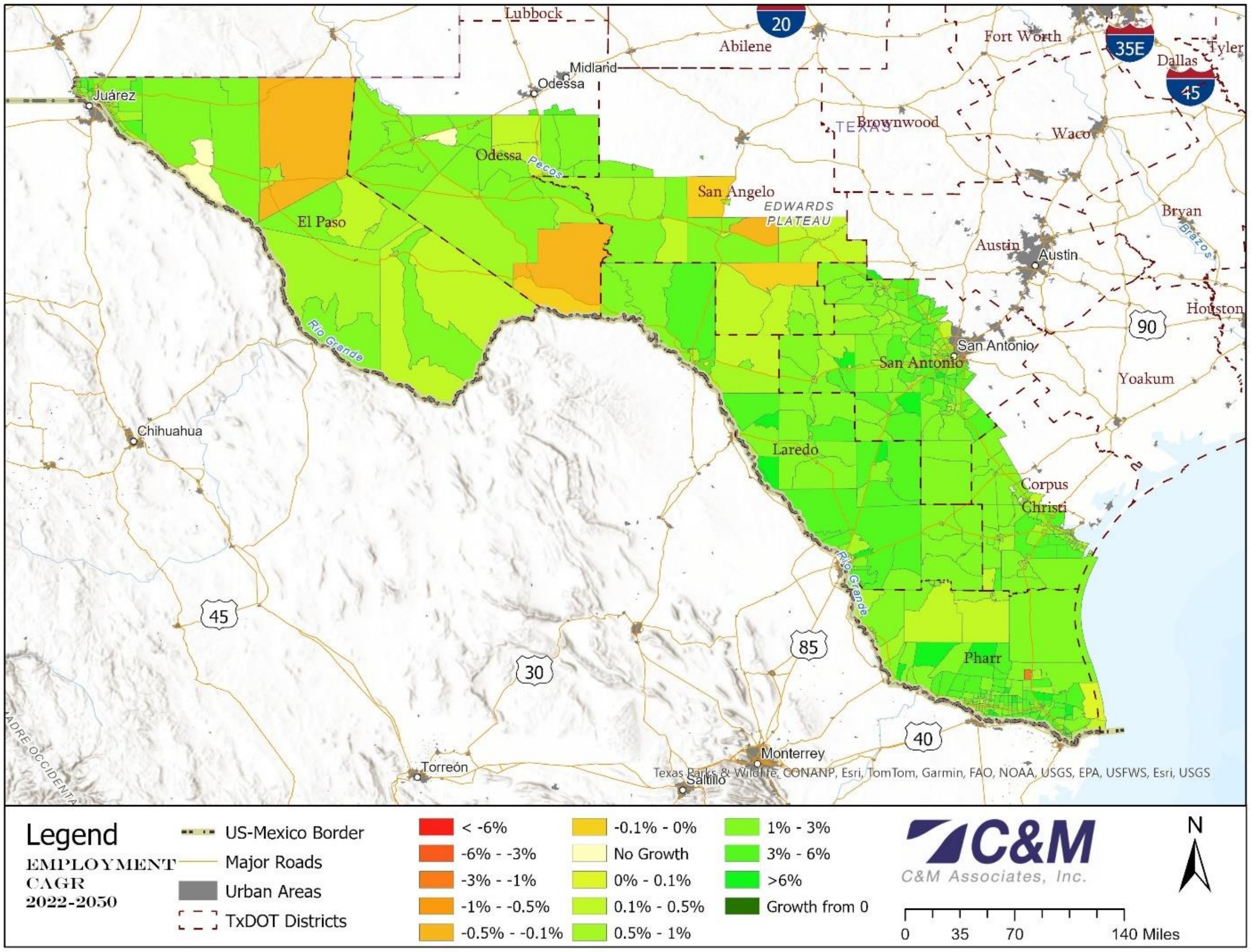


Figure 4-6. Employment CAGRs within 100 Miles of the U.S.–Mexico Border, 2022-2050

Figure 4-6 illustrates the overall employment CAGRs within 100 miles of the U.S.–Mexico border from 2022 to 2050. The map indicates that only a few TAZs located far away from any major urban centers are expected to experience a slight decline in employment numbers over the period of 2022 to 2050. Most of the area, however, is expected to experience growth in employment numbers, with higher growth rates near urban centers and slightly slower growth rates for TAZs further away from urban centers.

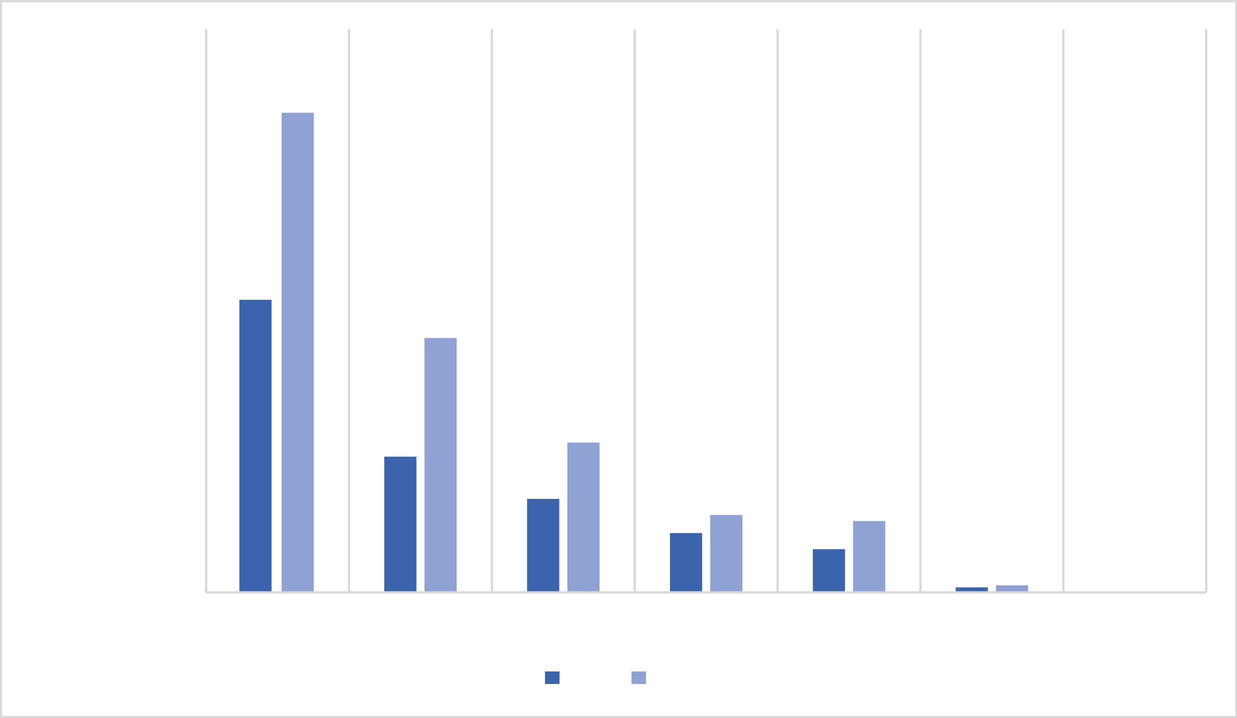


Figure 4-7. Employment Growth by District

Table 4-3. Employment CAGRs for Major Counties, 2022-2050

County	POPULATION		
	2022	2050	CAGR
Bexar	860,513	1,405,303	1.77%
Hidalgo	266,580	489,245	2.19%
El Paso	290,449	469,513	1.73%
Cameron	143,088	287,850	2.53%
Nueces	146,443	193,295	1.00%
Webb	97,468	159,865	1.78%
San Patricio	22,832	28,779	0.83%
Starr	14,236	25,382	2.09%
Maverick	12,213	20,922	1.94%
Kerr	14,412	20,575	1.28%

Figure 4-7 illustrates employment growth trends across various districts from 2022 to 2050. As seen from the map in Figure 4-6, all the districts within the 100-mile border area are expected to experience growth in overall employment numbers. San Antonio, being a major urban center, has the highest employment numbers in 2022 at 0.94 million, which is expected to grow to 1.53 million by 2050. Corpus Christi and San Angelo, too, are expected to grow modestly over the same period. Among the districts along the U.S.–Mexico border, Pharr is expected to grow from its respective employment numbers of 0.43 million in 2022 at a higher rate of 2.25%, whereas El Paso, Laredo, and Odessa are expected to grow at a slightly slower rate of 1.75% over the period of 2022 to 2050.

Table 4-3 further narrows down the employment trends to the major counties within 100 miles of the U.S.–Mexico border. Notably, Hidalgo and Cameron Counties are expected to have the highest growth rate; however, Bexar County, due to its proximity to the major city of San Antonio, has the highest employment numbers. Most of the counties along the border are expected to have a growth rate of more than 1.5% from 2022 to 2050, highlighting significant employment expansion in these regions.

4.2 Texas SAM Future Scenarios

This section presents the main inputs that were included in the future-year network, the 2050 final future assignment, the volume/capacity ratio analysis, and the analysis of the CAGR of the total flow of passenger and commercial vehicles.

C&M considered a series of future projects as part of the network updates. For this task, C&M reviewed relevant public information about future infrastructure projects in the study area. The main sources are listed below:

- TxDOT Project Tracker
- Texas Freight Mobility Plan 2050
- El Paso MTP Projects
- Laredo and Webb Counties' MTP Projects
- Corpus Christi MPO Projects
- Permian Basin MPO Projects
- Rio Grande Valley MPO Projects
- Alamo MPO MTP and TIP Projects

This section incorporates the future physical characteristics that have been planned within the network for the improvement of traffic. Likewise, it incorporates an assignment analysis by 2050, to review the forecast consistency of socioeconomic data and depict a real approach to future traffic behavior of the network.

4.2.1 Future-Year Network

As mentioned in Chapter 2, C&M identified 207 future projects on 1,374 network links, which include short, medium, and long-term future projects within and near the study area. Table 4-4 shows the modification in the number of lanes by year from 2015 to 2050.

Table 4-4. Additional Locations Considered in Texas SAM-V4

CSJ	Name	From	To	Number of Lanes				
				2015	2025	2035	2045	2050
407135	I-20	West of FM 1936	Monahans Draw	2	3	4	4	4
513063	I-20	Monahans Draw	East of JBS Parkway	2	2	4	4	4
513064	I-20	East of JBS Parkway	Midland County Line	2	3	4	4	4
514092	I-20	East of CR 1250	East of SH 349	2	2	3	3	3
514093	I-20	Ector County Line	East of CR 1300	2	3	4	4	4
514094	I-20	East of CR 1300	East of CR 1250	2	3	3	4	4
515093	I-20	East of SH 349	East of FM 1208	2	2	3	3	3
1605111	I-35	Guadalupe/Comal County Line	FM 1103	3	3	4	4	4
1605129	I-35	FM 1103	SL 337	3	3	3	4	4
1606047	I-35	Bexar/Guadalupe County Line	FM 3009	4	4	5	5	5
1606115	I-35	FM 3009	Guadalupe/Comal County Line	4	4	5	5	5
1710168	I-35	I-410 S	I-410 N	3	4	4	4	4
1710292	I-35	N. Walters St.	I-410 S	3	3	4	4	4
1803057	I-35	9.8 miles south of Lasalle County Line	8.3 miles south of La Salle County Line	2	2	3	3	3
1803060	I-35	8.3 miles south of Webb/La Salle County Line	Webb/La Salle County Line	2	2	2	3	3
1804058	I-35	1.2 miles north of US 83 Interchange	7.0 miles north of US 83 Interchange	2	2	3	3	3
1804061	I-35	7.0 miles north of US 83 Interchange	9.8 miles south of La Salle County Line	2	2	3	3	3
1805094	I-35	2.68 miles north of Uniroyal Interchange (MM 16.0)	1.2 miles north of US 83 Interchange (MM 19.787)	2	2	3	3	3
2301101	US 90	State Loop 79 S	Val Verde/Kinney County Line	4	4	4	6	6
2302045	US 90	Val Verde/Kinney County Line	15 miles east of Val Verde/Kinney County Line	4	4	4	6	6
2303052	US 90	15 miles east of Val Verde County Line	18 miles west of Kinney/Uvalde County Line	4	4	4	6	6
2304068	US 90	18 miles west of Kinney/Uvalde County Line	Kinney/Uvalde County Line	4	4	4	6	6
2305091	US 90	Kinney/Uvalde County Line	FM 481	2	2	2	4	4
2503097	I-10	Bexar/Guadalupe County Line	FM 465	2	2	3	3	3
2503101	I-10	FM 465	Pioneer Rd.	2	2	3	3	3
3706109	US 83	10 miles north of County Line	Carrizo Springs	2	2	2	4	4

CSJ	Name	From	To	Number of Lanes				
				2015	2025	2035	2045	2050
3708045	US 83	Webb/Duval County Line	10 miles north of County Line	4	4	4	6	6
3709035	US 83	3.6 miles south of SH 44 intersection	Webb/Duval County Line	4	4	4	6	6
3710041	US 83	Los Botines Lane	US 83/I-35 Underpass	2	2	4	4	4
3710044	US 83	4.5 miles north of SH 255 intersection	3.6 miles south of SH 44 intersection	4	4	6	6	6
3710046	US 83	1.5 miles south of SH 255 intersection	4.5 miles north of SH 255 intersection	2	2	2	4	4
3802033	US 83	Webb/Zapata County Line	9.407 miles south of Webb/Zapata County Line	2	2	4	4	4
3803038	US 83	9.407 miles south of Webb/Zapata County Line	0.405 miles north of FM 3169	2	2	4	4	4
3803039	US 83	1.475 miles north of FM 3169	0.975 miles south of FM 3169	2	2	4	4	4
3804064	US 83	3.685 miles south of FM 3169	9.723 miles south of FM 3169	2	2	4	4	4
3805043	US 83	0.77 miles south of Lopeno Ave.	1.955 miles north of Zapata/Starr County	2	2	4	4	4
3806050	US 83	Loma Blanca Road	W. Gonzalez Ave.	2	2	2	4	4
3807076	US 83	Arroyo Roma	Efren Ramirez Ave.	2	2	2	4	4
3807077	US 83	Intersection of N. Garcia St. and N. Grant St.	FM 3167	2	2	2	4	4
3807079	US 83	FM 3167	Fairgrounds Rd	4	4	4	6	6
3901098	US 83	Intersection of E 2nd St. and E Main St.	Embassy St.	2	2	2	4	4
3903108	BUS 83	Inspiration Rd	I-2	2	2	2	3	3
3904131	BUS 83	US 281	FM 491	2	2	2	4	4
3906048	BUS 83	Beckham Road	S. Palm Court Dr.	4	4	4	6	6
3907261	I-69 E/US 77	I-2	SH 107	2	2	2	3	3
3910085	Boca Chica Blvd	Security Dr.	FM 313	4	4	4	6	6
3910092	W Elizabeth St	W 8th St.	Palm Blvd.	2	2	2	4	4
3910094	Boca Chica Blvd	FM 313	FM 511	4	4	4	6	6
3912057	BUS 77	Arroyo Colorado Bridge	FM 510	4	4	4	6	6
7206082	I-10	SH 46	0.2 miles west of Bexar/Kendall County Line	2	2	3	3	3
7206089	I-10 Frontage Road	0.25 miles west of Bexar/Kendall County Line	Kendall/Bexar County Line	2	2	3	3	3

CSJ	Name	From	To	Number of Lanes				
				2015	2025	2035	2045	2050
8601073	SH 359	4.06 miles east of SL 20	8.935 miles east of SL 20	2	4	4	4	4
8702053	SH 359	CR 308	FM 70	2	2	4	4	4
8705030	SH 359	San Patricio County Line	US 181	2	2	4	4	4
10207046	SH 285	FM 2191	Brooks/Kleberg County Line	2	2	2	4	4
14205083	SH 27	Spur 100	Kendall/Kerr County Line	2	2	2	4	4
14206027	SH 27	Kendall/Kerr County Line	Pankratz Rd	4	4	4	6	6
14303049	US 87	Bexar/Wilson County Line	FM 1346	4	4	6	6	6
15506213	FM 2678	FM 774	FM 136	2	4	4	4	4
16004052	US 277	16.1 miles north of US 377	Val Verde/Edwards County Line	2	2	2	4	4
16005051	US 277	US 377	16.1 miles north of US 377	2	2	2	4	4
16006036	US 277	9.3 miles north of US 90 S intersection	US 377	4	4	4	6	6
16007035	US 277	SL 79 (Del Rio)	9.3 miles north of US 90 S intersection	4	4	4	6	6
18005073	Commercial	Shaver Road	Stapp Road	2	2	4	4	4
21501051	SH 46	Bentwood Dr.	FM 3159	4	4	6	6	6
21501054	SH 46	FM 3159	Cranes Mill Road	2	2	4	4	4
21502059	SH 46	Cranes Mil Road	FM 2722	2	2	4	4	4
21506045	SH 46	Amman Road	Kendall/Comal County Line	2	2	4	4	4
21507049	SH 46	Bulverde Road	Farhills Dr.	4	4	6	6	6
21507052	SH 46	Comal/Kendall County Line	Farhills Dr.	2	2	4	4	4
21509029	FM 725	Zipp Road	County Line Road	4	4	6	6	6
21601059	SH 46	I-35	Guadalupe/Comal County Line	4	4	4	6	6
21602067	SH 46	Guadalupe/Comal County Line	I-10	4	4	4	6	6
21901063	Military Hwy/FM 1016	Melba Carter Rd	I-2	4	4	4	6	6
21901064	N. Conway Ave./SH 107	I-2	BUS 83 S	4	4	4	6	6
22004050	US 281/ Military Hwy	FM 732	0.5 miles west of FM 1577	2	2	6	6	6
22004056	Military Hwy	FM 3248	0.02 miles west of Old Military Hwy	4	4	4	6	6
22005082	Boca Chica Blvd.	0.02 miles west of Old Military Hwy	BUS 77-Z	4	4	4	6	6

CSJ	Name	From	To	Number of Lanes				
				2015	2025	2035	2045	2050
22005085	Boca Chica Blvd.	BUS 77Z	I-69 E	4	4	4	6	6
22007070	Brownsville-Port Isabel	FM 511	Boxcar Rd	4	4	4	6	6
23702020	SH 44	BI-35 intersection	1.13 miles east of BI-35 intersection	2	2	2	4	4
25507151	I-69 C/US 281	Rogers Road	FM 2812	2	2	2	3	3
25509107	Comal	SH 336	US 281	2	2	2	3	3
25511023	Frontage Road	SH 107	I-69C	2	2	2	3	3
27601045	US 57	SL 480 S	14 miles east of US 277 Intersection	2	2	4	4	4
27602030	US 57	14 miles east of US 277 Intersection	Maverick/Zavala County Line	2	2	4	4	4
27603044	US 57	Maverick/Zavala County Line	US 83 intersection	2	2	2	4	4
27604032	US 57	US 83	FM 117	4	4	4	6	6
27605029	US 57	FM 117	Zavala/Frio County Line	4	4	4	6	6
29106053	SH 16	Robindale E Road	Old San Antonio Road	4	6	6	6	6
29107033	SH 16	FM 1283	Medina/Bandera County Line	2	2	4	4	4
29108023	SH 16	Medina/Bandera County Line	PR 37	2	2	4	4	4
29901077	US 277	13.6 miles north of Maverick County Line	SL 79 (Del Rio)	4	4	4	6	6
29902038	US 277	Maverick/Val Verde County Line	13.6 miles north of Maverick County Line	4	4	4	6	6
29903075	US 277	0.6 miles north of SH 131	Maverick/Val Verde County Line	2	2	2	4	4
29904084	US 277	SL 480 N (Eagle Pass)	0.6 miles north of SH 131	2	2	2	4	4
29914036		US 277 N	US 277 S	0	2	2	2	2
30001110	US 277	11.8 miles west of Dimmit County Line	SL 480 S (Eagle Pass)	4	4	4	6	6
30002044	US 277	Dimmit/Maverick County Line	11.8 miles west of Dimmit County Line	4	4	4	6	6
30003080	US 277	Carrizo Springs	Dimmit/Maverick County Line	2	2	2	4	4
32601061	SH 286	FM 2444 S	South of CR 18	2	2	4	4	4
32601067	SH 286	South of CR 18	FM 70	2	2	4	4	4
32708110	BUS 77	Washington Ave	SL 499	4	4	4	6	6
32710063	I-69 E/US 77	Cameron/Willacy County Line	Spur 413	2	2	2	3	3
33101051	SH 100	I-69 E	FM 1847	4	4	4	6	6
34201096	Edinburg Ave.	FM 493	FM 88	4	4	4	6	6
34201097	Edinburg Ave.	FM 88	FM 3071	4	4	4	6	6
34202052	SH 107	West Levee	FM 1425	2	2	2	4	4

CSJ	Name	From	To	Number of Lanes				
				2015	2025	2035	2045	2050
34202058	Santa Rosa Ave.	FM 3071	FM 1015	4	4	4	6	6
34203040	FM 107	Hidalgo/Cameron County Line	Louisiana St.	2	2	4	4	4
35404043	SH 115	FM 874	CR 313	2	2	4	4	4
35404044	SH 115	Andrews County Line	3 miles south of Andrews County Line	2	2	4	4	4
35406040	SH 115	SH 128	Winkler County Line	2	2	4	4	4
35406041	SH 115	FM 181	SH 128	2	2	4	4	4
35406042	SH 115	W SH 176	FM 181	2	2	4	4	4
38303024	SH 141	US 281	Kleberg County Line	2	4	4	4	4
38304060	SH 141	Jim Wells County Line	Santa Gertrudis Ave.	2	4	4	4	4
46302076	SH 158	SH 349 Reliever Route	SH 191	2	2	2	4	4
46502027	FM 1518	FM 78	I-10 E	2	4	4	4	4
48202034	SH 285	Jim Hogg/Brooks County Line	FM 1329	2	2	2	4	4
48203034	SH 285	FM 1329	BUS 281	2	2	2	4	4
52801118	SH 107/N. Conway Ave.	SH 495	FM 1924 (Mile 3 N)	4	4	6	6	6
53501077	I-10	US 90A	FM 464	2	2	3	3	3
53502047	I-10	SH 130	SH 80	2	2	3	3	3
54204035	US 59	Duval/McMullen County Line	East intersection of SH 44/US 59	2	2	4	4	4
54802042	SH 176	SH 349	SH 137	2	2	4	4	4
62101111	S. 10th St./ SH 336	I-2	UP 281	4	4	4	6	6
62101112	N. 10th St./ SH 336	Trenton Road	SH 107	4	4	6	8	8
66901062	Moore Field Road/FM 681	FM 1925	FM 2221	2	2	2	4	4
68401076	FM 511	SH 48	SH 550	4	4	4	6	6
68401077	FM 511/N. Indiana Ave.	SH 4	0.10 miles south of Capt. Donald L. Foust Road	2	2	2	4	4
68401078	SH 550	I-69 E	FM 1847	2	2	2	3	3
68401079	SH 550	Old Port Isabel Road	FM 1847	0	0	0	3	3
68402030	FM 511/ Dockberry	Florida Road	SH 4	2	2	2	4	4
69802060	Mile 5 W/ FM 88	FM 1925	5th Ave.	2	2	4	6	6
69803105	S. Texas Blvd./FM 88	E. 18th St.	E. 6th St.	2	2	2	4	4
86101072	Texas Ave.	BUS 83S	I-2	4	4	4	6	6
86301079	N. Salinas Road/FM 493	Champion Ave.	Mile 10 Road	4	4	4	6	6

CSJ	Name	From	To	Number of Lanes				
				2015	2025	2035	2045	2050
86401068	N. Shary Road/FM 494	SH 107	FM 676 (Mile 5)	2	6	6	6	6
86501108	FM 1427/ Abraham Road	On Veterans (SH 495), from I-2/US 83	SH 364 (La Homa Road)	4	4	6	6	6
87204036	FM 506	BUS 83S	I-2	2	2	2	4	4
87301028	FM 507	E. Washington Ave.	Rio Hondo Road	4	4	4	6	6
91546045	Rudeloff Road	SH 46	Huber Road	2	4	4	4	4
92102194	Liberty Blvd.	On Liberty Blvd. from Mile 3	US 83	4	4	6	6	6
92102327	S. Taylor Road	On Taylor Road, from I-2	BUS 83	4	6	6	6	6
92102440	W. Freddy Gonzalez Dr.	On Freddy Gonzalez, from US BUS 281 (Closner Blvd.)	I-69C (US 281)	4	4	6	6	6
92102447	Mile 6 W	On Mile 6 W, from Mile 14 1/2	Mile 11 N	4	4	6	6	6
92102449	E. 6th St.	Westgate Dr.	BUS 83	4	4	6	6	6
92102451	N. Airport Dr.	BUS 83	US 83	4	4	4	6	6
92102453	S. Border Ave./Mile 5 1/5 W	On Border Ave. from BUS 83S	S. 18th St.	4	4	4	6	6
92102455	Bentsen Palm Dr.	US 83 S	BUS 83	4	4	4	6	6
92102457	Jackson Ave.	S. Bicentennial Ave.	S. 2nd St.	4	4	4	6	6
92102459	Mile 6 N	FM 88	Mile 2 W	4	4	4	6	6
92102463	W. Schunior St.	Sugar Road	4th St.	4	4	4	6	6
92102466	W. Sprague St.	Sugar Road	SH 336 (N. 10th St.)	4	4	6	6	6
92102467	N. Sugar Road	SH 107	Schunior Ave.	4	4	4	6	6
92102468	W. Trenton Road	FM 1926 (23rd St.)	SH 336 (10th St.)	6	6	8	8	8
92102469	S. Westgate Dr./Mile 6 W	BUS 83	Mile 5 N	4	4	4	6	6
92102512	N. Bentsent Road	On Bentsen Road, from FM 676	FM 1924	2	2	4	4	4
92106290	Old Alice Road	On Old Alice Road, Sports Park Blvd.	SH 100	4	4	6	6	6
92406625	Railroad Dr.	Purple Heart Highway	Shrub Oak Dr.	2	2	4	4	4
98901031	FM 624	Orange Grove	US 281	2	2	4	4	4
106401027	Mile 5 N/FM 676	SH 107 (Conway)	Taylor Road	4	4	6	6	6

CSJ	Name	From	To	Number of Lanes				
				2015	2025	2035	2045	2050
106401032	Mile 5 N/FM 676	SH 364 E (La Homa Road)	SH 107 (Conway)	4	6	6	6	6
106401043	Mile 5 N/ FM 676	Taylor Road	FM 2220	4	6	6	6	6
106502043	Oscar Williams	I-69 E	BUS 77X	4	4	4	6	6
113601021	FM 800	I-2	FM 2994	2	2	2	4	4
114003019	FM 802	SH 48	FM 511	4	4	4	6	6
115805002	(blank)	750 feet south of Looney Spur Road	Junction with FM 3541	2	2	4	4	4
150401040	International Blvd.	E. Jefferson St.	Ringold St.	4	4	4	6	6
154901055	FM 1781	FM 3036	Control Break	2	2	4	4	4
155803114	FM 70	CR 53	SH 286	2	2	4	4	4
155803119	FM 70	0.843 miles west of CR 59	0.248 miles west of CR 51	2	2	4	4	4
155803120	FM 70	0.37 miles east of CR 75	0.5 miles east of CR 73	2	2	4	4	4
155803122	FM 70	0.295 miles east of FM 892	0.843 miles west of CR 59	2	2	4	4	4
155803123	FM 70	0.37 miles east of CR 75	US 77	2	2	4	4	4
155803124	FM 70	0.456 miles east of CR 73	1.245 miles east of FM 892	2	2	4	4	4
158601075	Alamo Road/ FM 907	SH 107	Nolana	4	4	4	6	6
180101058	FM 1847/ Paredes Line Road	SH 550	FM 802	4	4	4	6	6
180101060	FM 1847	SH 550	Henderson Road	2	2	2	4	4
180101061	FM 1847/ Paredes Line Road	SH 48	E. Price Road	2	2	2	4	4
180202014	Nolana Loop/FM 3461	FM 2061 (McColl Road)	US 281	6	6	6	8	8
180301092	W. Monte Cristo Road/ FM 1925	10th St.	McColl Road	6	6	8	8	8
180302035	E. Monte Cristo Road/ FM 1925	FM 907 (Alamo Road)	Sharp Road	2	4	4	4	4
180401085	S. 23rd St.	I-2	BUS 83S	3	3	3	4	4
180401086	N. 23rd St./ FM 1926	BUS 83 S	SH 495	4	4	4	6	6
202301021	FM 2165	FM 1781	SH 35	2	2	4	4	4
212103162	I-10	Airway Blvd.	FM 659 (Zaragoza Road)	4	4	5	5	5

CSJ	Name	From	To	Number of Lanes				
				2015	2025	2035	2045	2050
212103163	(blank)	Yarbrough Dr.	FM 659 (Zaragoza Road)	3	3	4	4	4
212104113	I-10	FM 1281 (Horizon Blvd.)	FM 1110 (Clint)	2	2	2	3	3
212104114	I-10	Eastlake Blvd	FM 1281 (Horizon Blvd.)	2	2	2	3	3
214201022	FM 2292	Leopard St.	I-37	4	4	4	6	6
215004086	FM 1472	I-69 W	SH 255	4	4	6	6	6
215004092	FM 1472	I-69 W	2 miles north of FM 3338	4	4	6	6	6
215004093	FM 1472	2 miles north of FM 3338	SH 255	4	4	6	6	6
223001020	FM 1560	FM 471	Galm/Shaenfield	2	2	4	4	4
223001021	FM 1560	Galm/Shaenfield	SH 16	2	2	4	4	4
236901034	FM 509	BUS 77X	I-69 E	4	4	4	6	6
271701027	E. Alton Gloor Blvd.	I-69 E	FM 1847	4	4	6	6	6
271702011	Dr. Hugh Emerson Blvd.	FM 1847	SH 550	4	4	4	6	6
304401016	FM 2994/ Wilson Road	Hand Road	I-69 E	2	2	2	4	4
309801020	Dicker Road/ FM 3072	FM 2061	US 281	4	4	4	6	6
310701046	FM 3009	FM 2252	Bat Cave Road	2	2	2	4	4
311601029	SH 35	FM 3036	BS 35L	2	2	4	4	4
321204008	FM 3351	SH 46	Kendall/Comal County Line	2	2	4	4	4
321205014	FM 3351	Kendall/Comal County Line	Keeneland Dr.	2	2	4	4	4
350801029	SH 151	LP 1604	I-410	2	3	3	3	3

4.2.2 Future Assignment

According to incorporated forecast conditions, Figure 4-8 shows the traffic flows for the 2050 scenario network that crosses the study area. Figure 4-9 through Figure 4-12 show 2050 traffic assignments in the main Texas–Mexico border cities.

Figure 4-13 shows 2050 passenger vehicle assignments. Figure 4-14 through Figure 4-17 show 2050 passenger vehicle assignments in the main border cities of Texas.

Figure 4-18 shows 2050 trucks assignments. Figure 4-19 through Figure 4-22 show 2050 truck assignments in the main border cities of Texas.

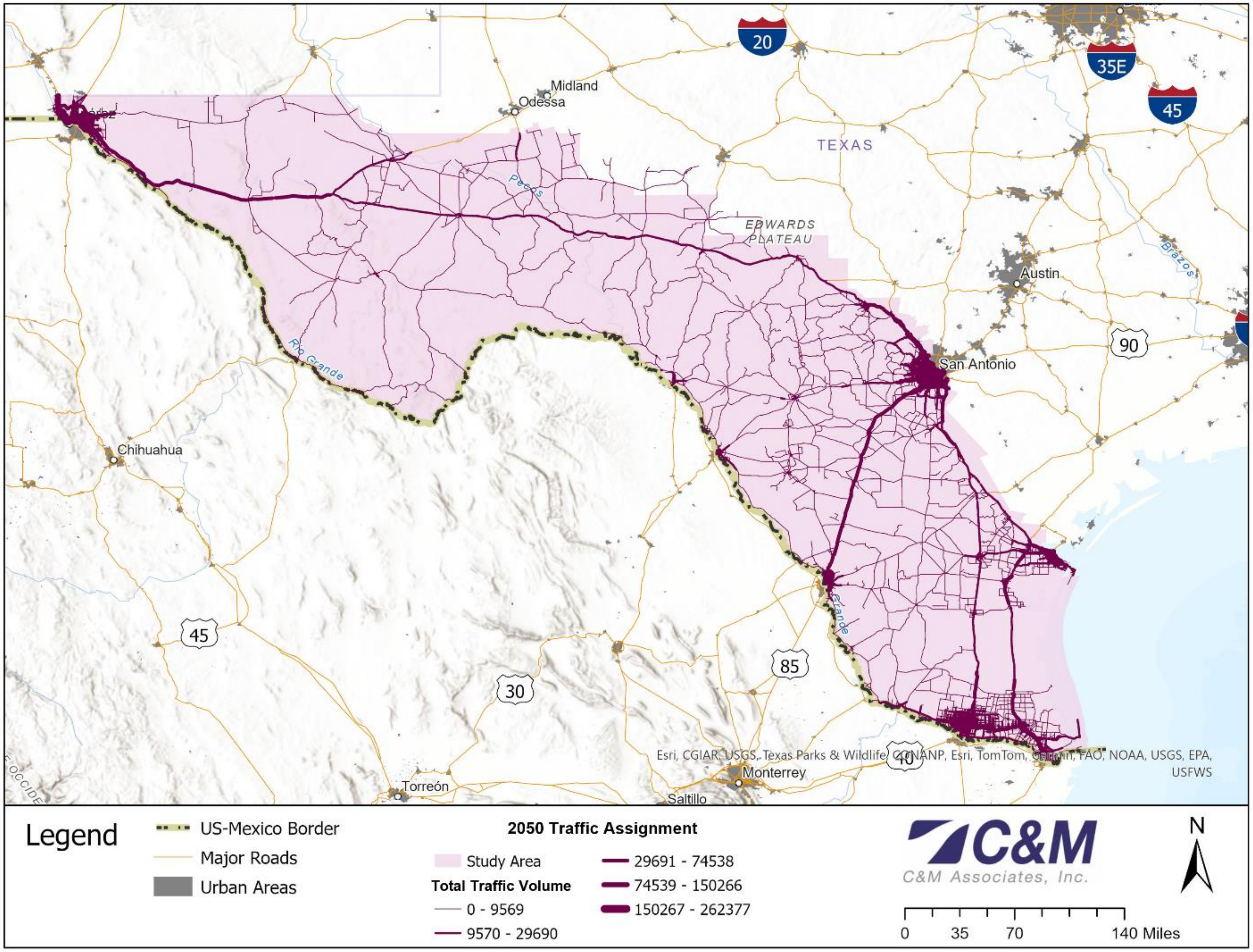


Figure 4-8. 2050 Traffic Assignment

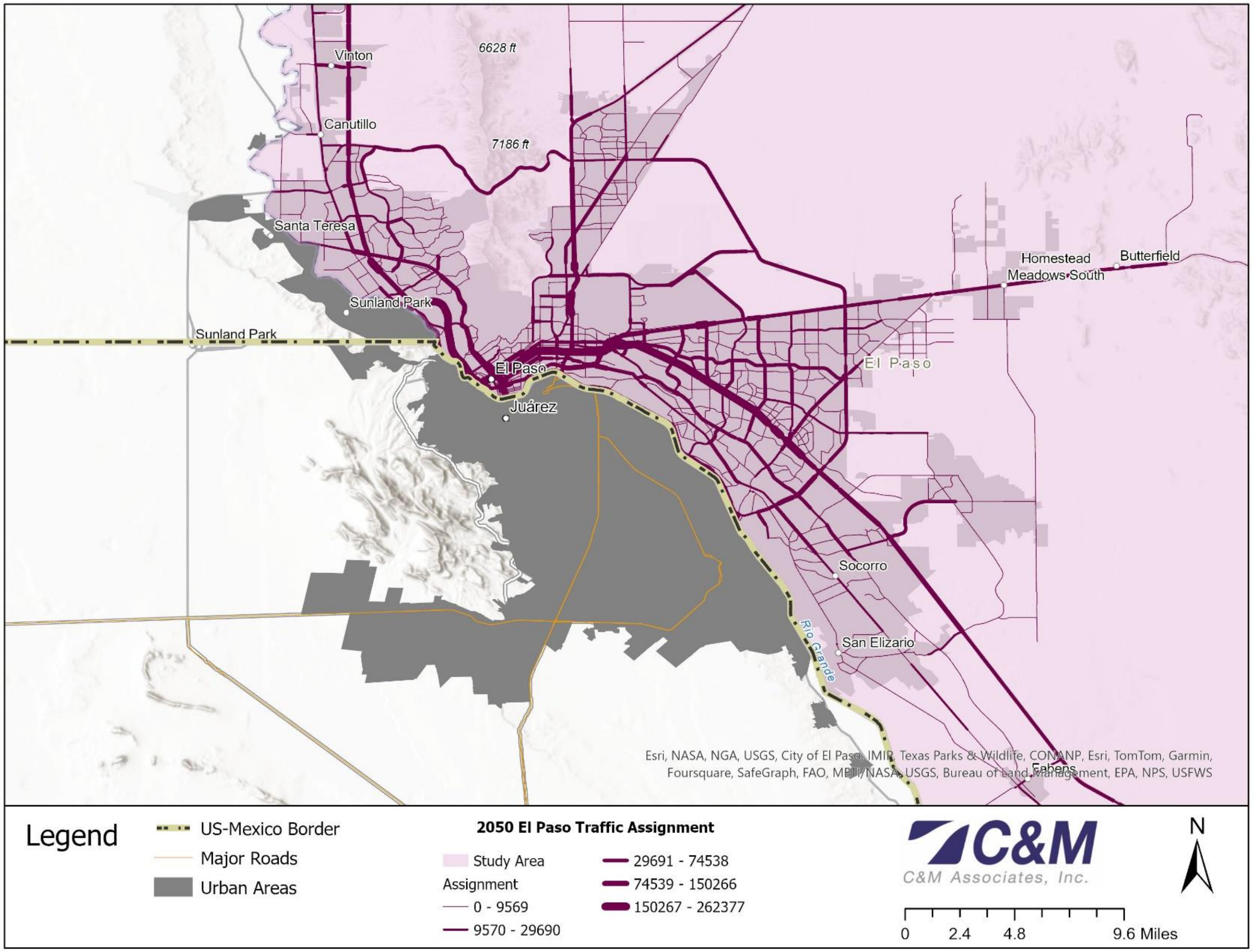


Figure 4-9. 2050 El Paso Traffic Assignment

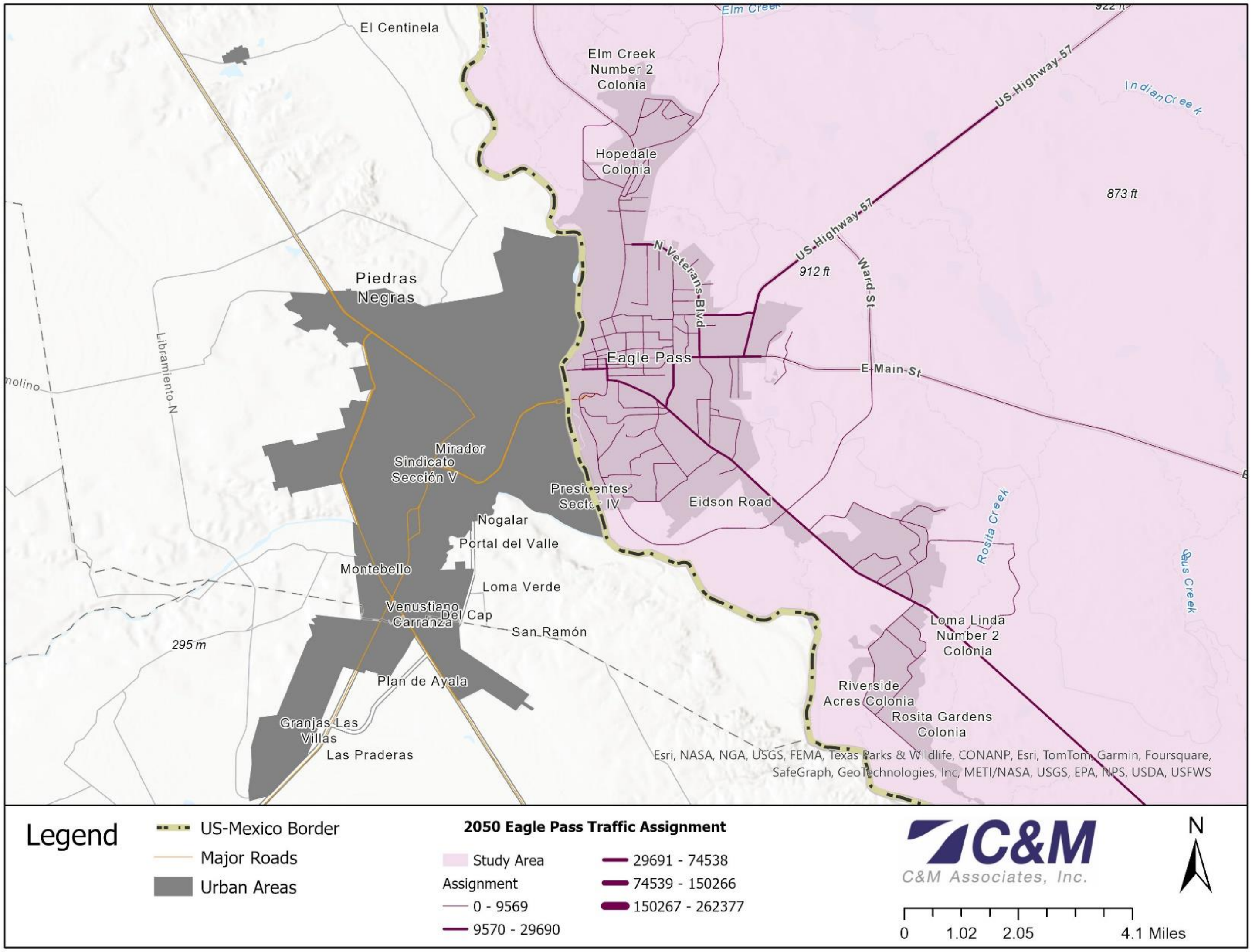


Figure 4-10. 2050 Eagle Pass Traffic Assignment

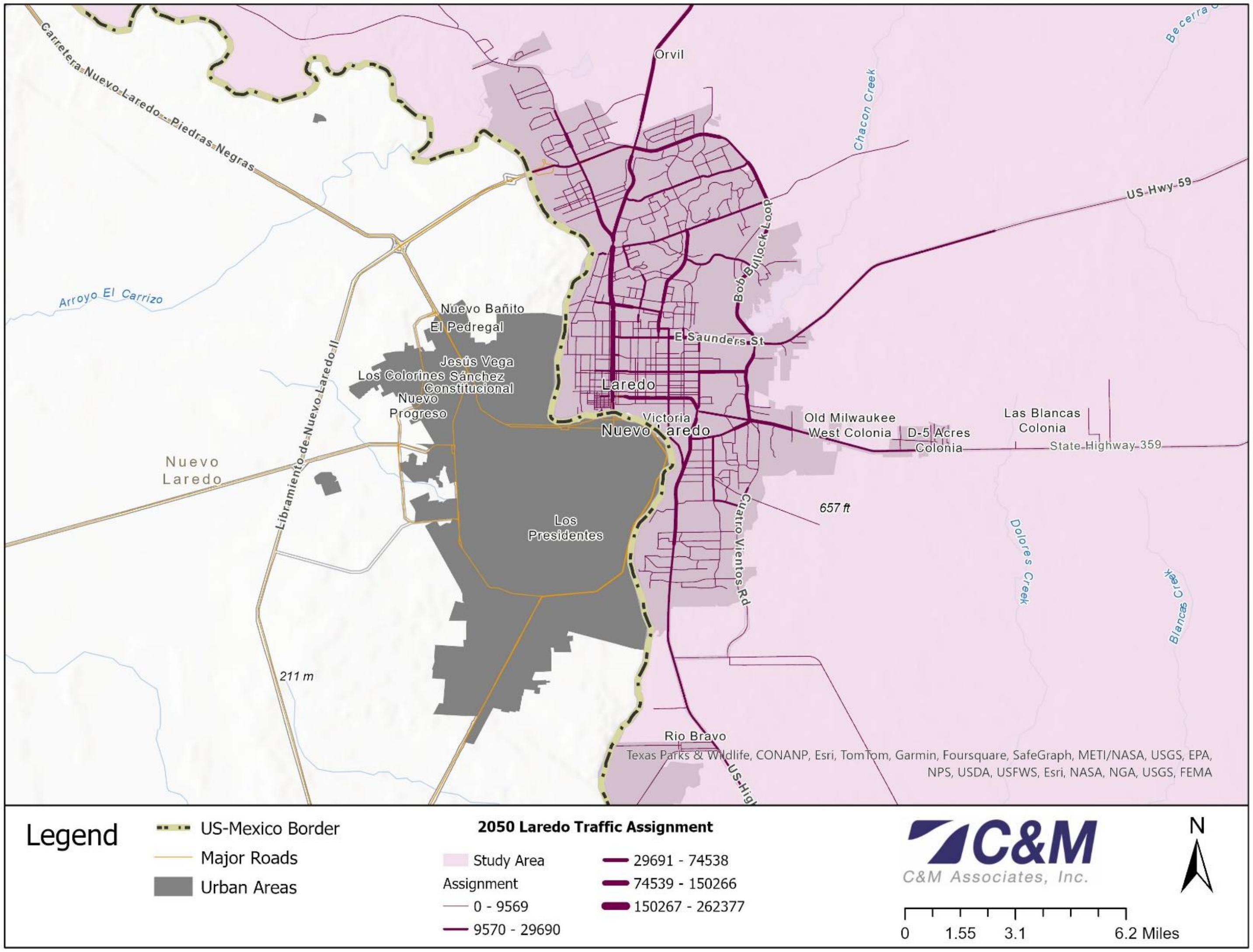


Figure 4-11. 2050 Laredo Traffic Assignment

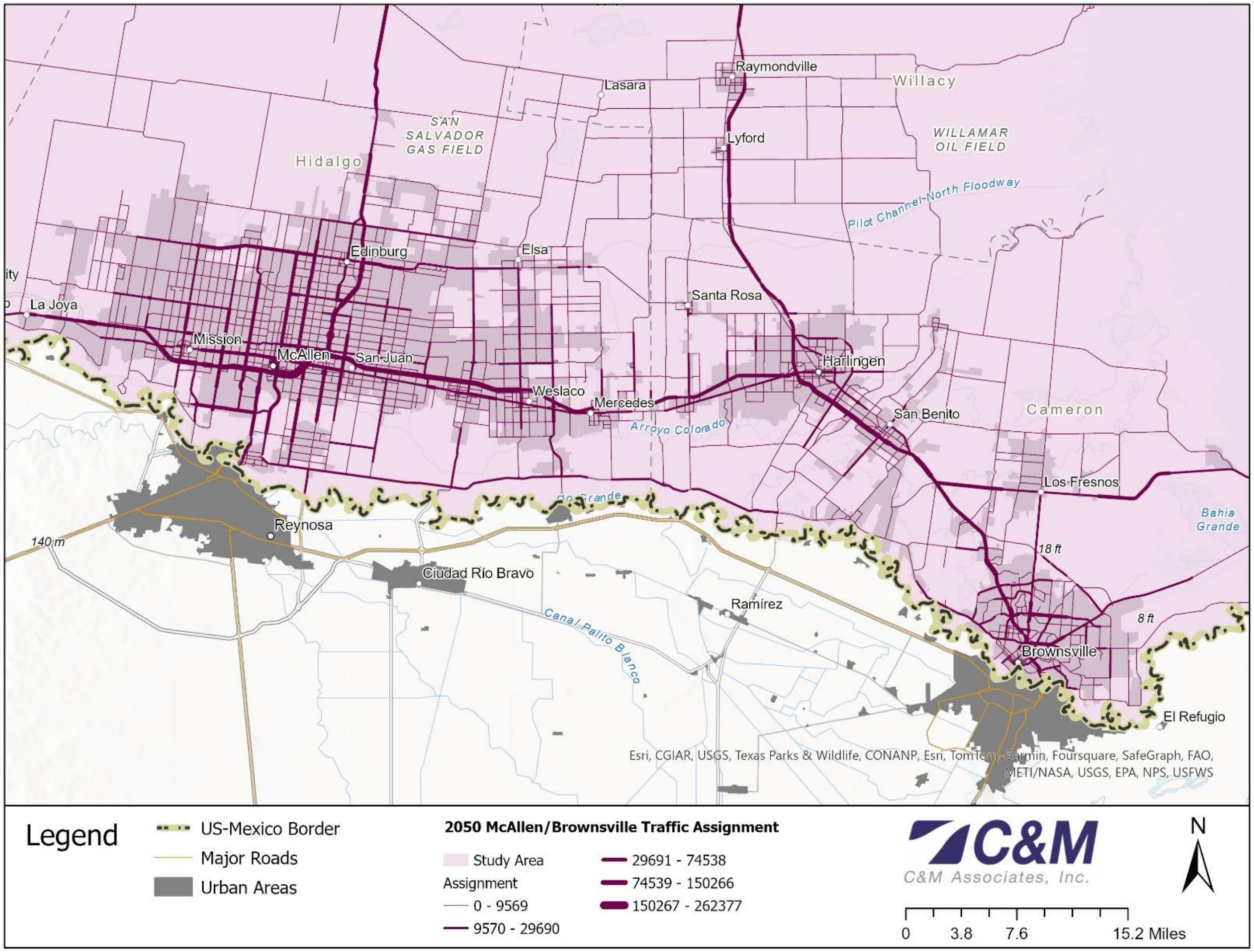


Figure 4-12. 2050 McAllen/Brownsville Traffic Assignment

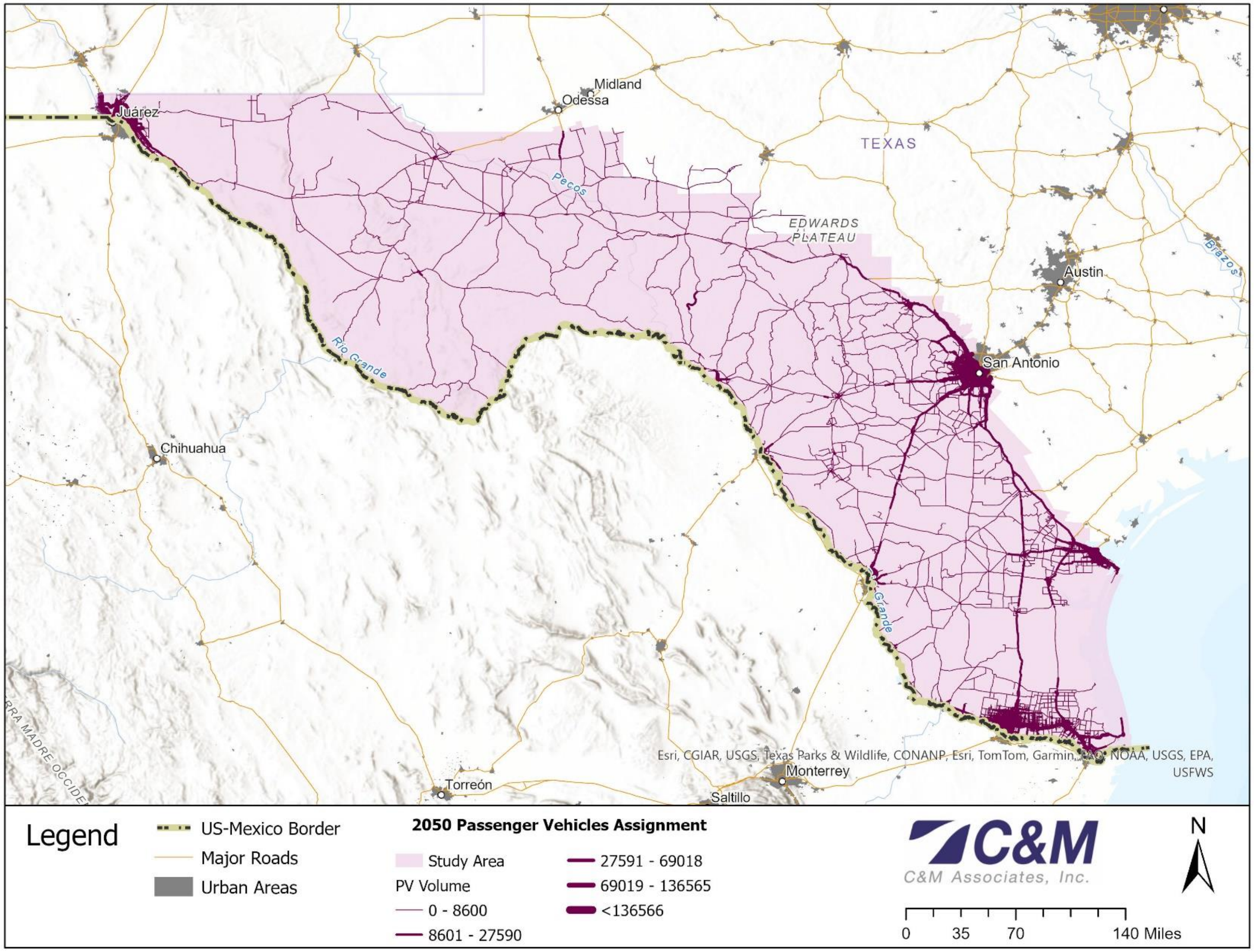


Figure 4-13. 2050 Passenger Vehicle Assignment

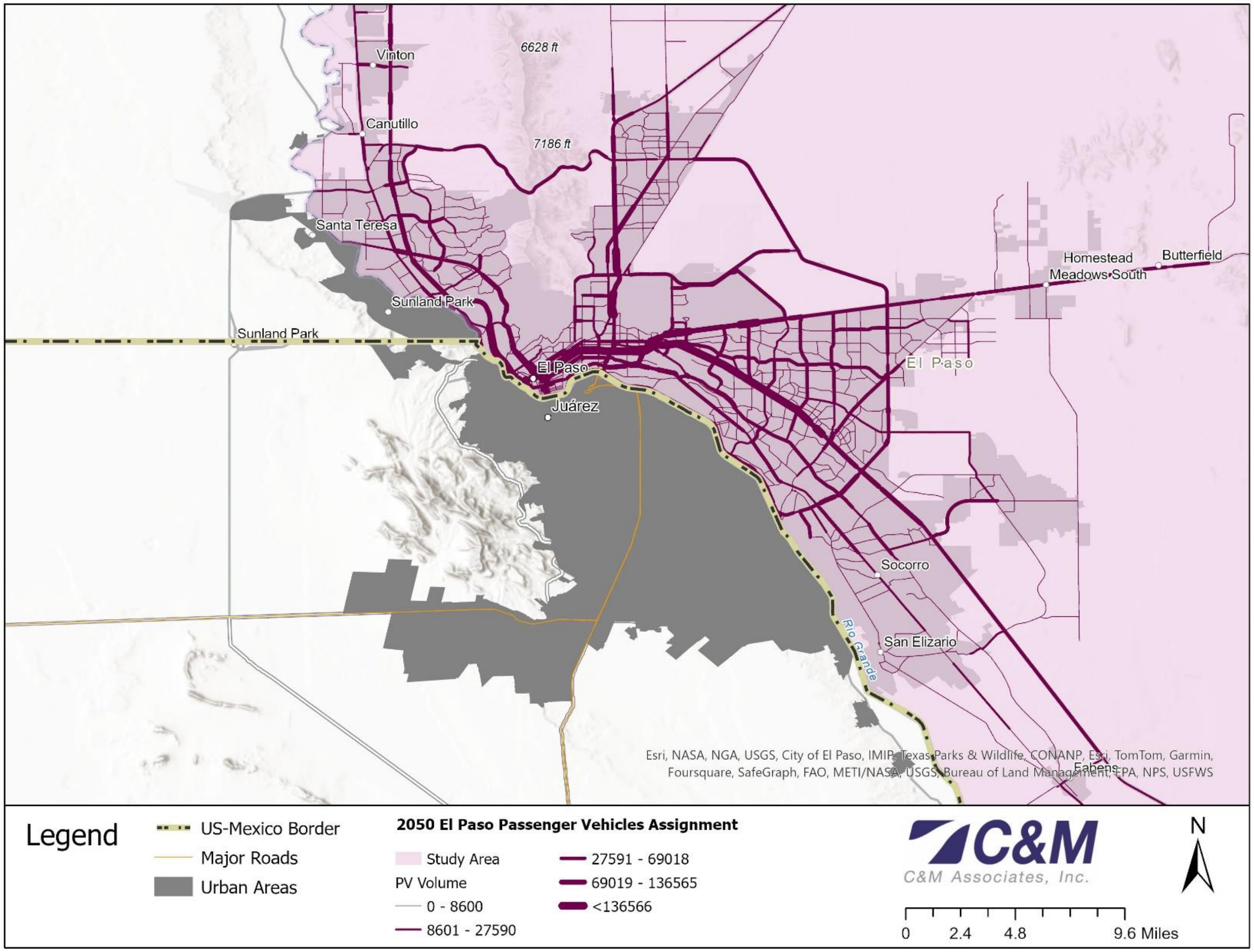


Figure 4-14. 2050 El Paso Passenger Vehicle Assignment

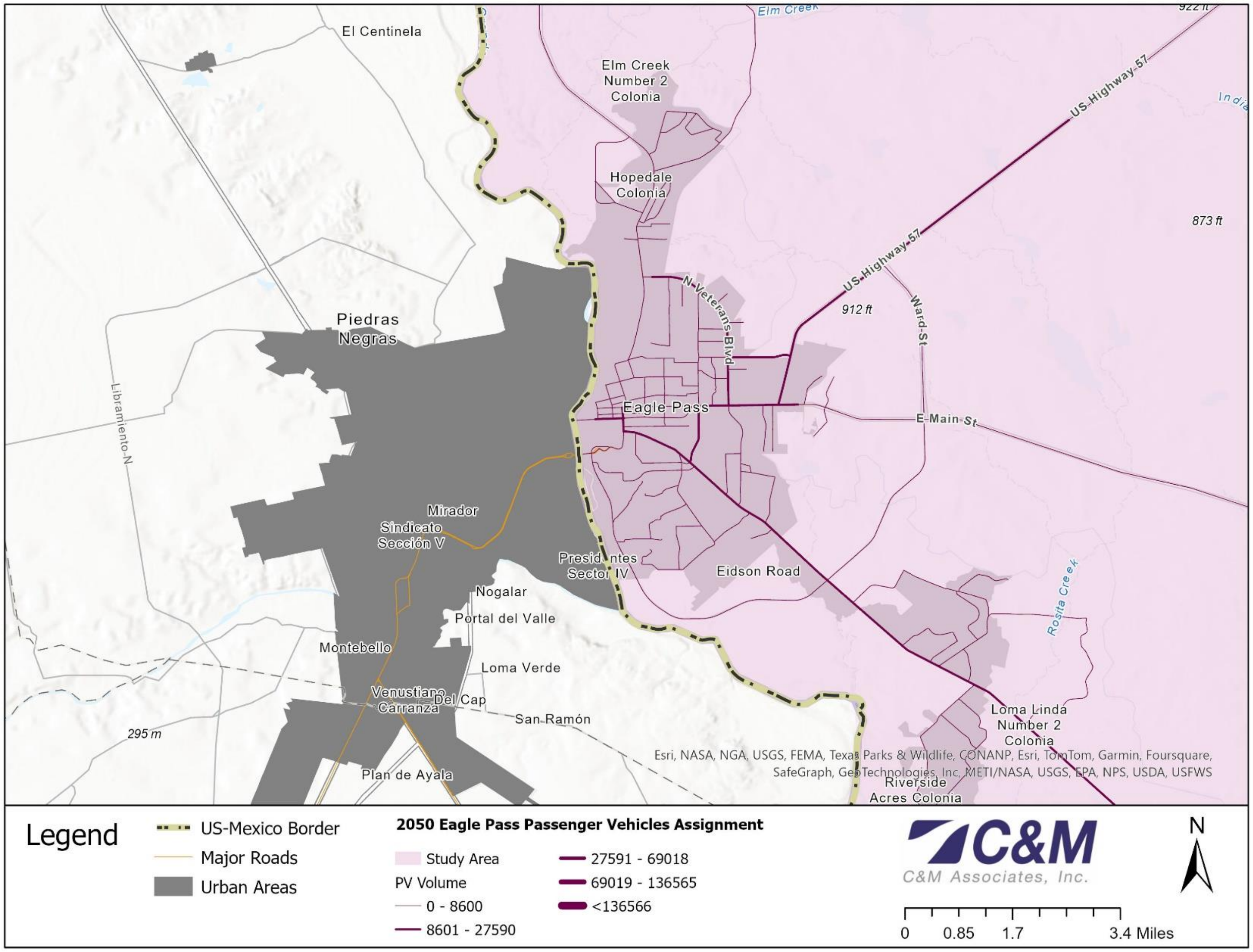


Figure 4-15. 2050 Eagle Pass Passenger Vehicle Assignment

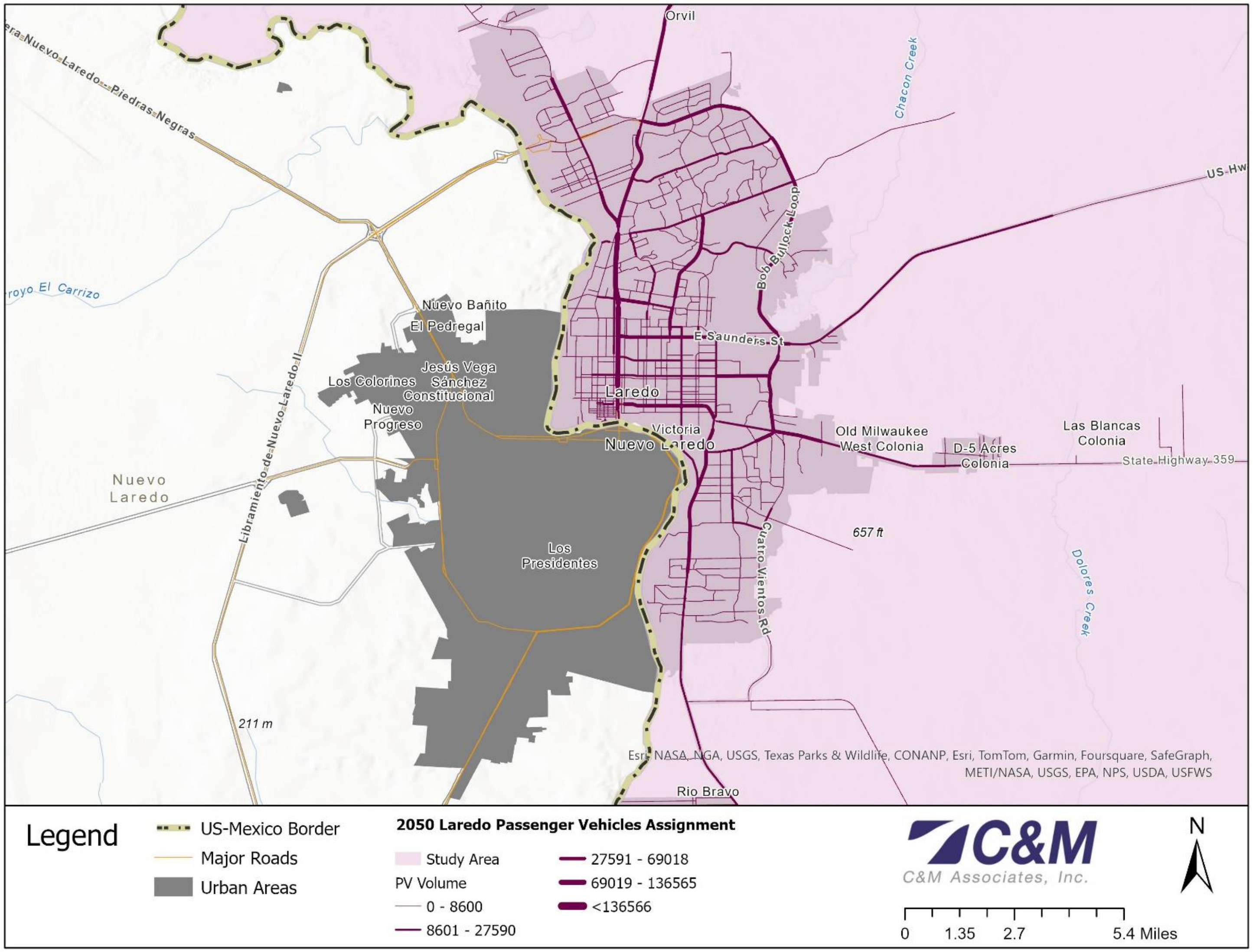


Figure 4-16. 2050 Laredo Passenger Vehicle Assignment

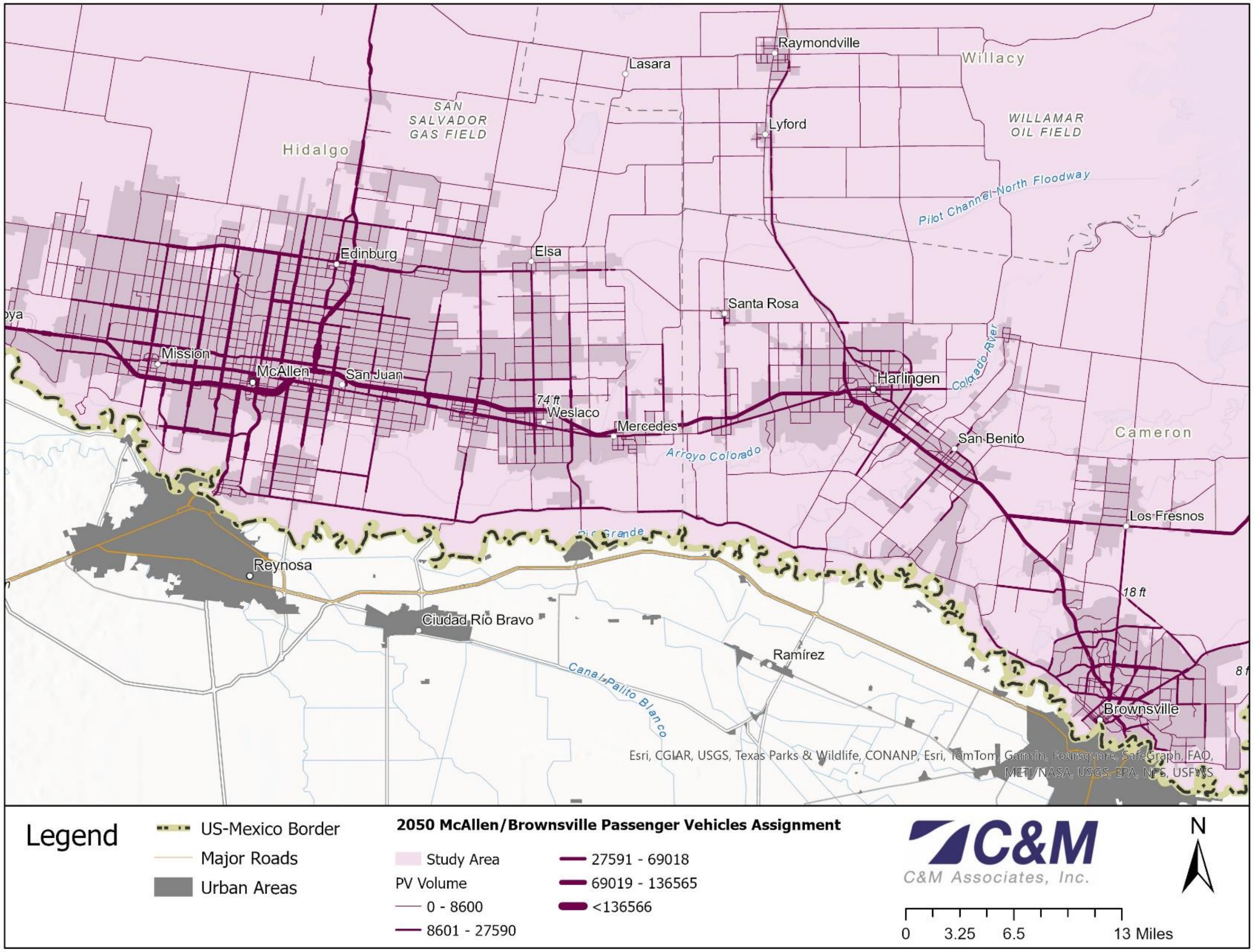


Figure 4-17. 2050 McAllen/Brownsville Passenger Vehicle Assignment

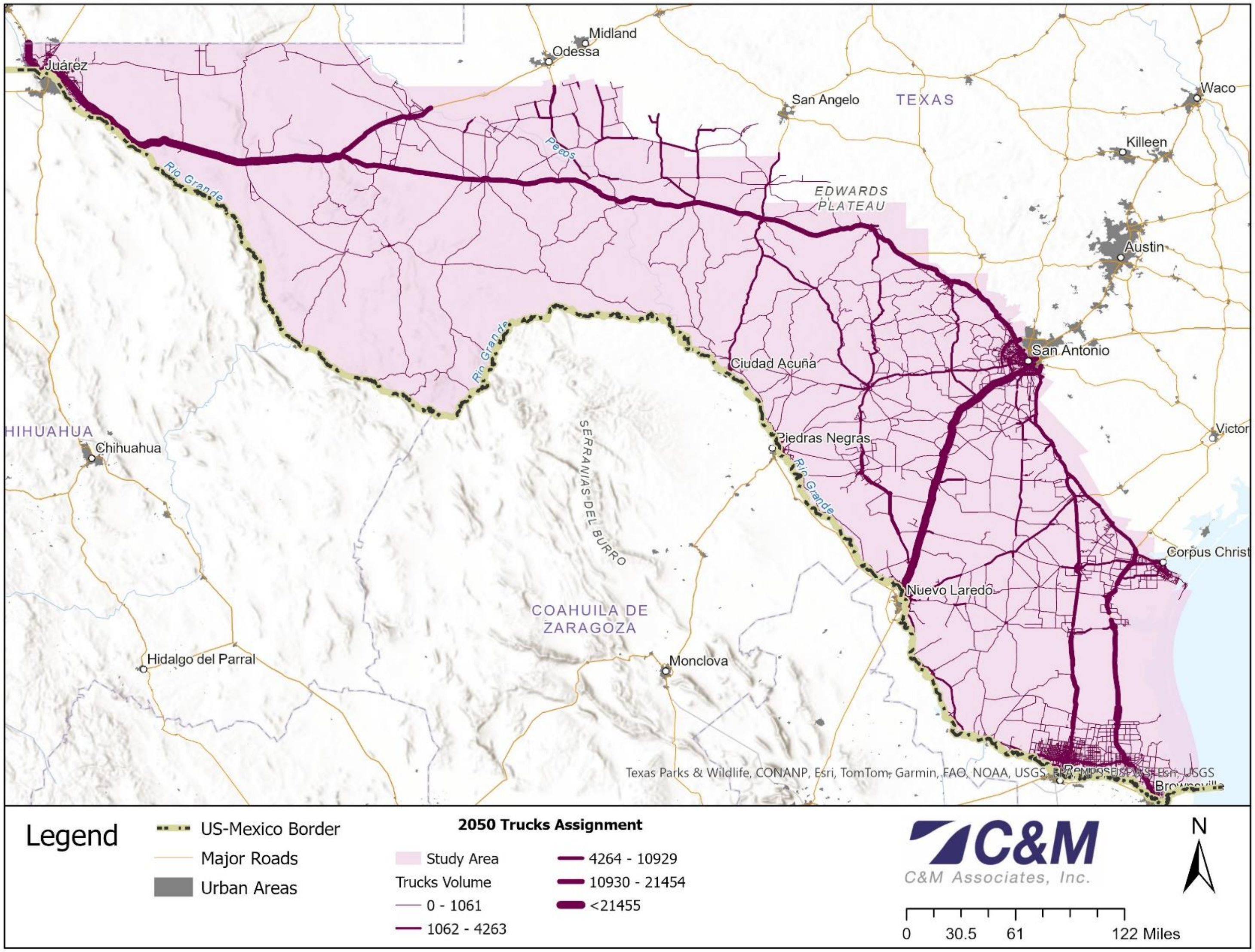


Figure 4-18. 2050 Commercial Vehicle Assignment

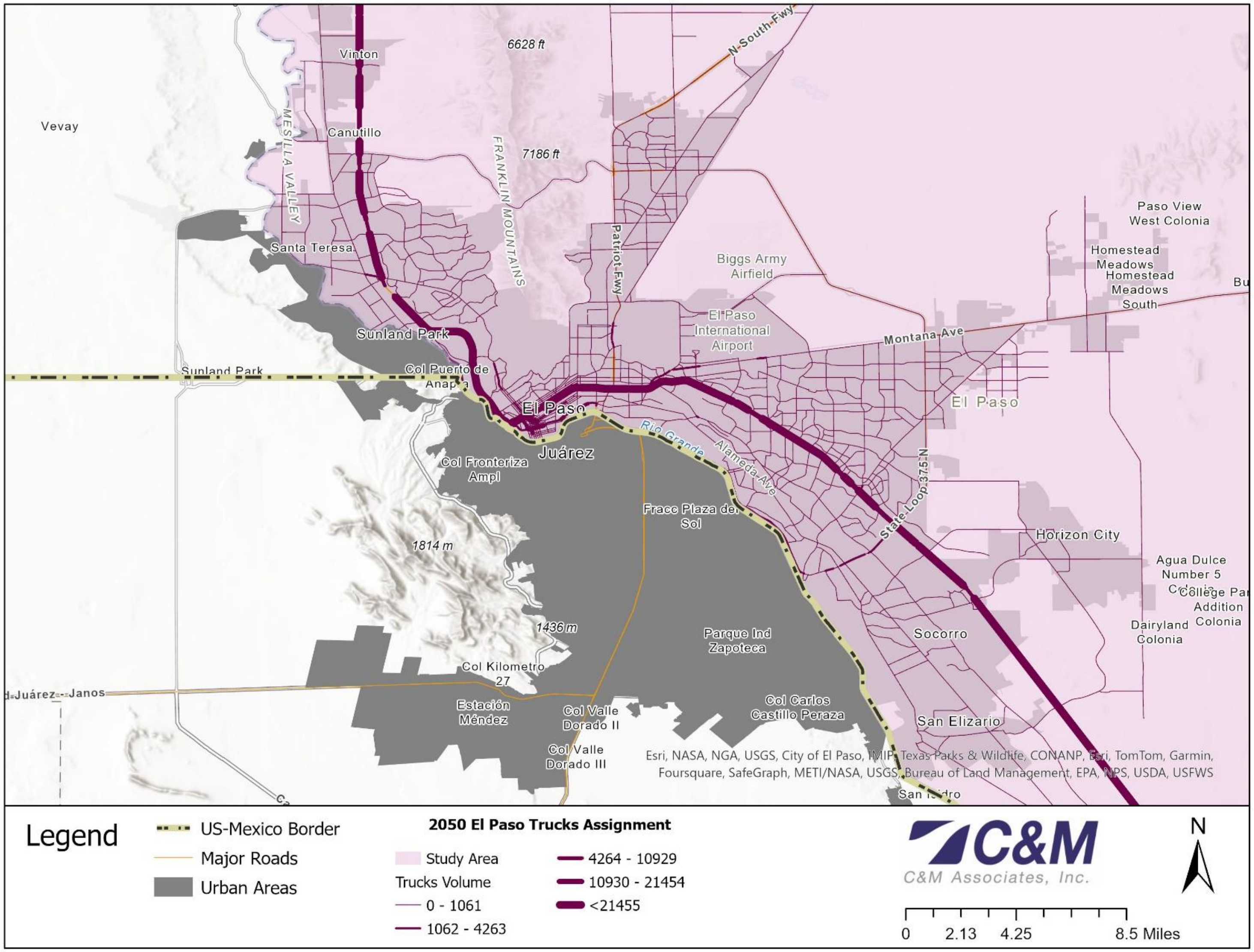


Figure 4-19. 2050 El Paso Commercial Vehicle Assignment

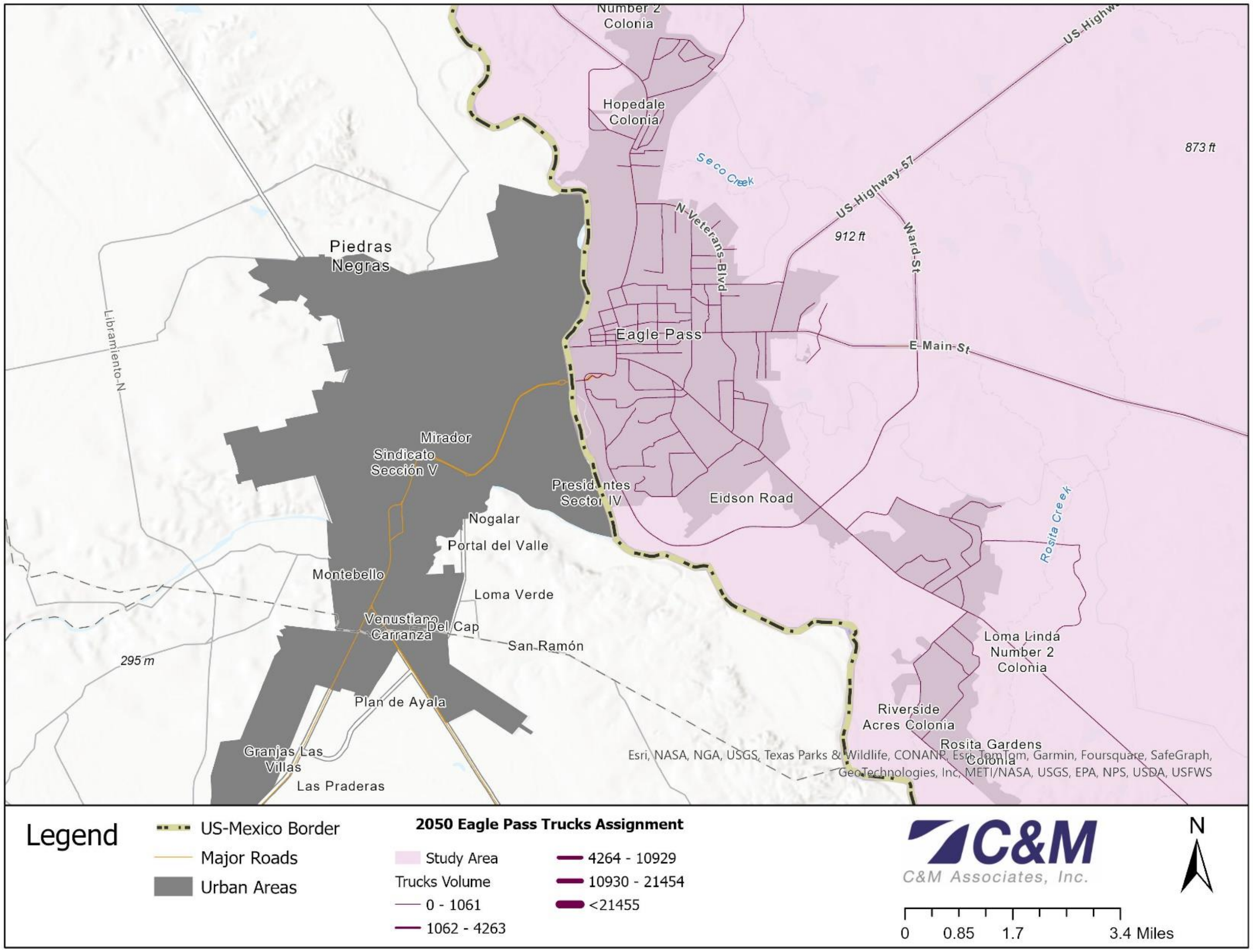


Figure 4-20. 2050 Eagle Pass Commercial Vehicle Assignment

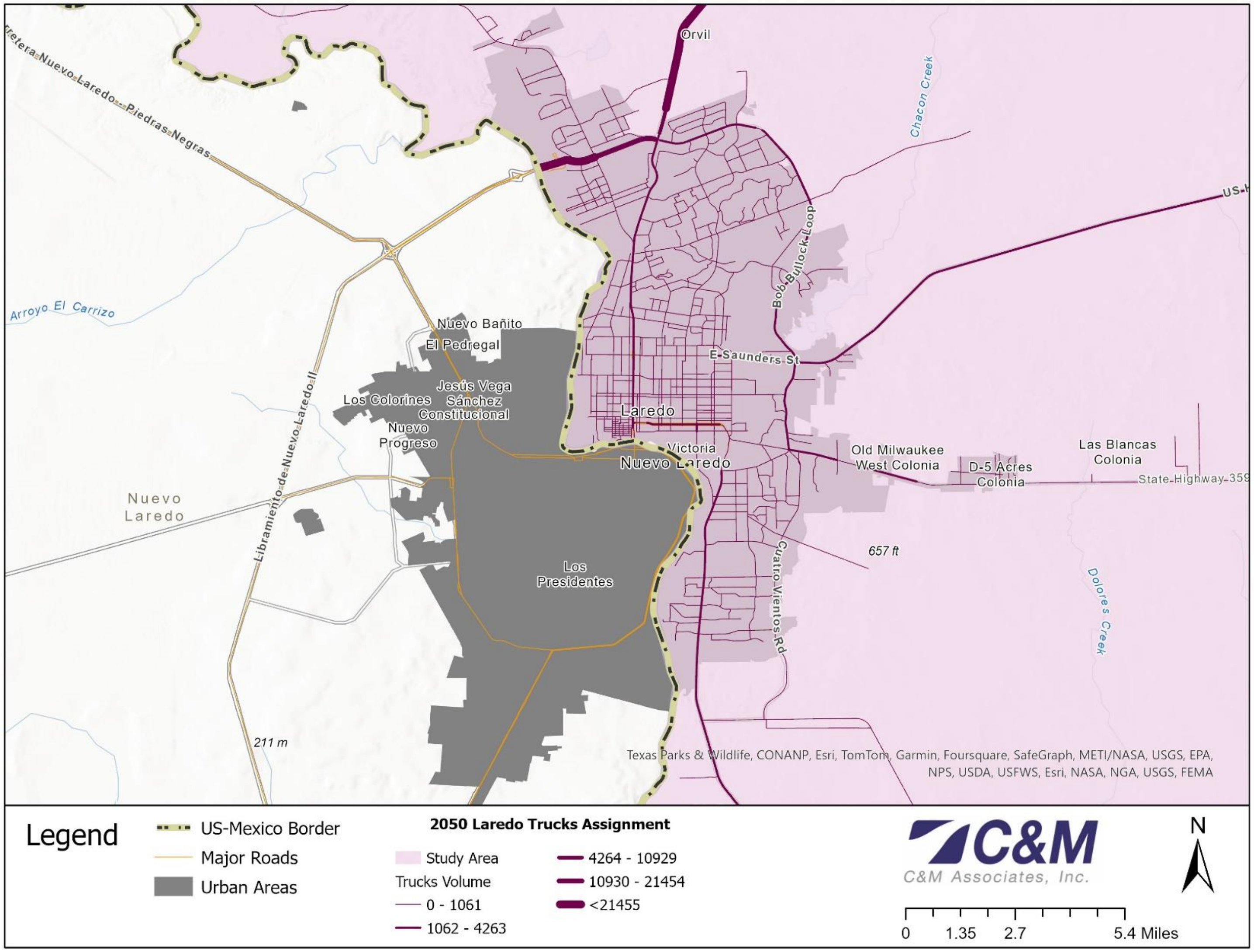


Figure 4-21. 2050 Laredo Commercial Vehicle Assignment

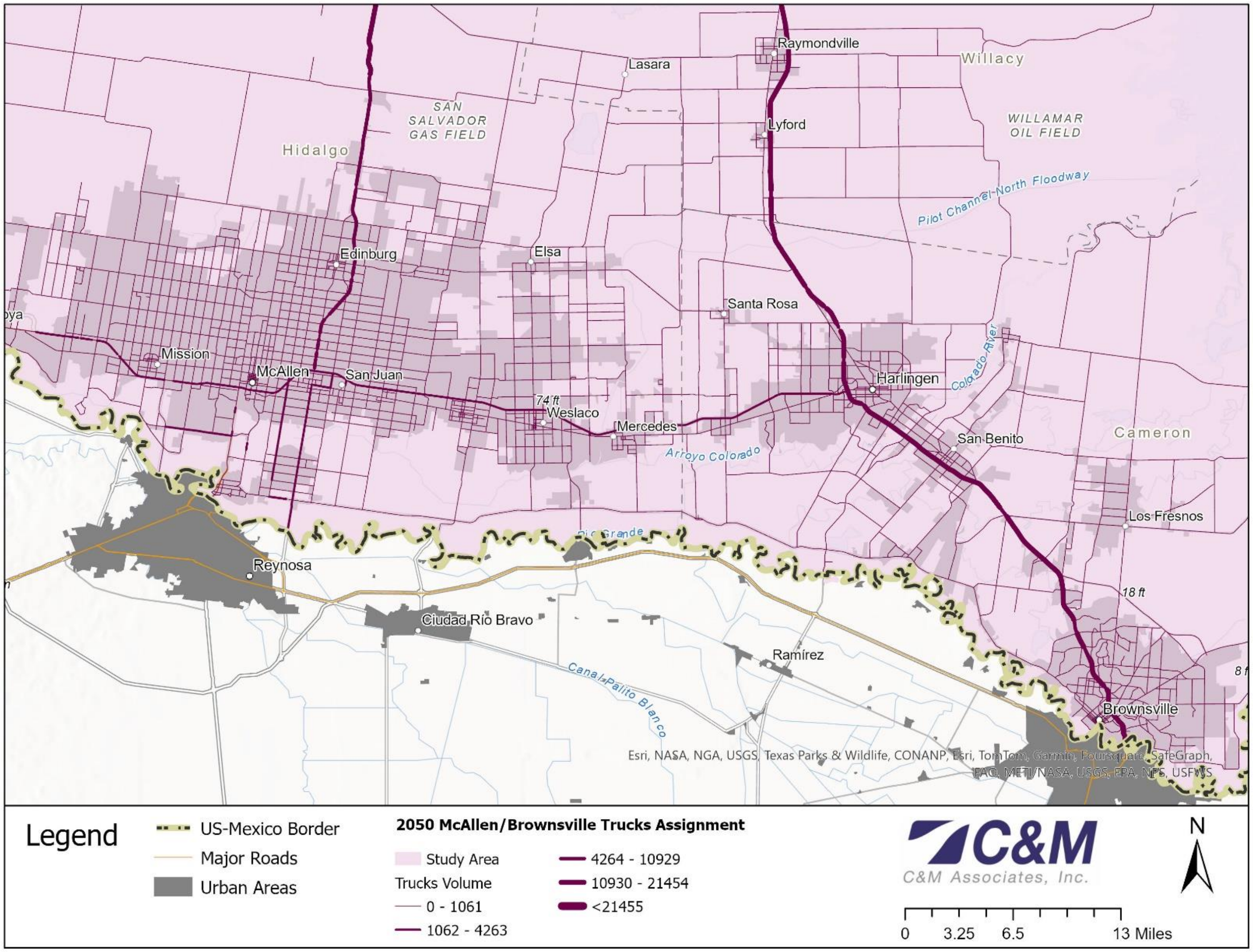


Figure 4-22. 2050 McAllen/Brownsville Commercial Vehicle Assignment

4.2.3 Assignment Analysis

4.2.3.1 Volume/Capacity Ratio

C&M's team developed an estimation of the volume-to-capacity (V/C) ratios for links on the SAM network, which was completed to support the assignment analysis. This measure is key to compare the volume of traffic on a particular road to the capacity of that road. This is defined as the maximum amount of traffic that the road can handle under ideal conditions without significant delays or congestion.

The V/C ratio is calculated by dividing the volume by the capacity.

$$\frac{V}{C}\,ratio = \frac{Volume}{Capacity}$$

Is important to mention this analysis was done using the Passenger Car Equivalent (PCE) divided by 24-hour capacity. Table 4-5 shows the V/C ratio criteria, according to transportation documentation.

Table 4-5. V/C Ratio Criteria

V/C Ratio	Capacity Condition
V/C < 0.5	*Under capacity*. Indicates free flow conditions; the road operates well below capacity.
0.5 ≤ V/C < 0.7	*Near capacity.* Suggest stable conditions where traffic flow is steady, but delays might begin.
0.75 ≤ V/C < 1.0	*At capacity.* Traffic flow is less stable and indicates approaching capacity.
V/C ≥ 1.0	*Over capacity.* Represents conditions where traffic congestion is significant, and delays are common.

Figure 4-23 to Figure 4-32 show the results of the V/C ratio calculation for 2022 and 2050. As shown in Figure 4-23, in 2022, the network presented a V/C ratio between 0.00 and 0.72. Furthermore, the main corridors of I-10, I-35, and US 77 presented a criterion less than 0.29, which indicates a free-flow condition where the roads operate well below the capacity. However, the highest criteria are notable in urban areas, such as El Paso, San Antonio, Laredo, McAllen, and Brownsville; the values indicate the traffic flow is less stable and approaching capacity.

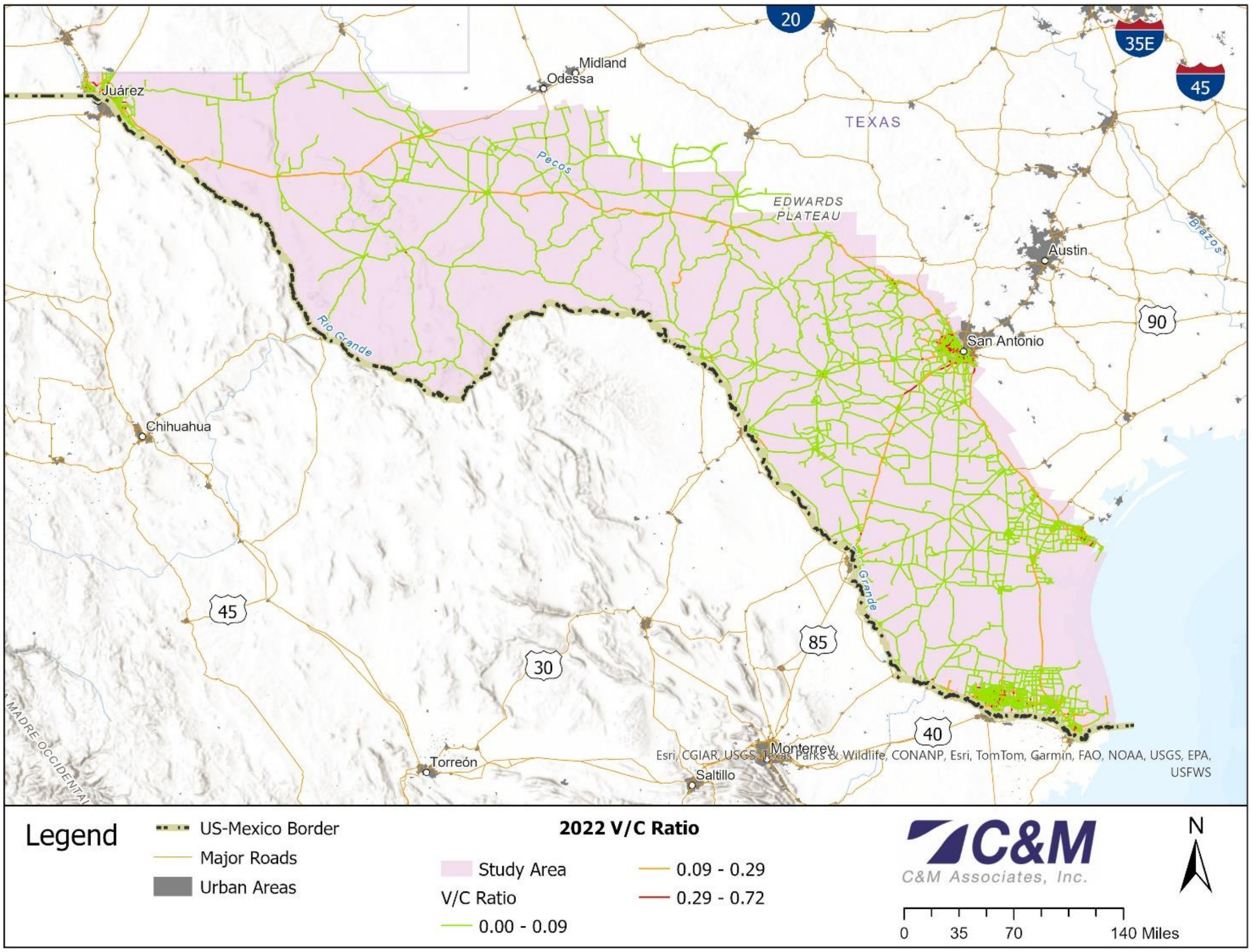


Figure 4-23. Total 2022 V/C Ratio

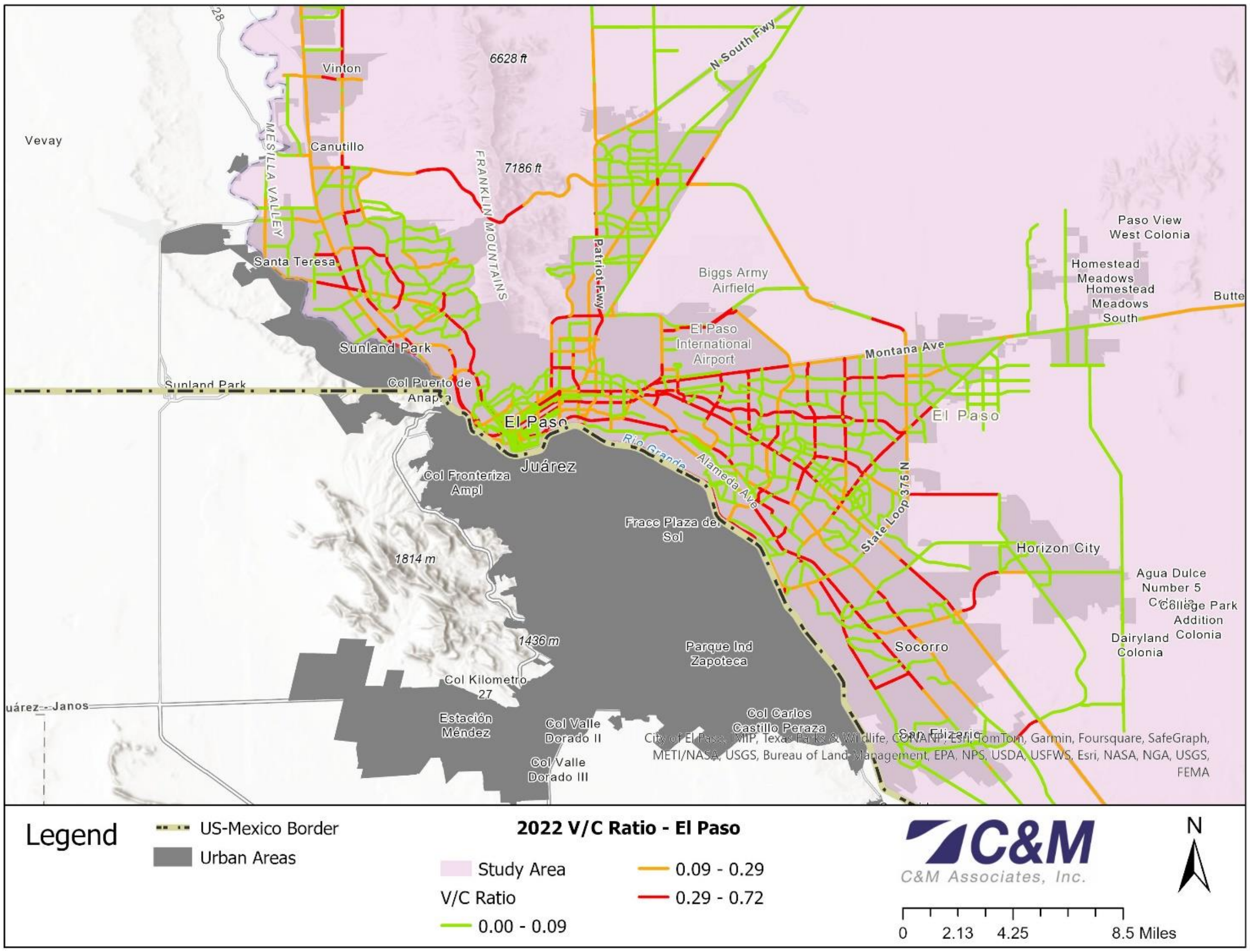


Figure 4-24. 2022 El Paso V/C Ratio

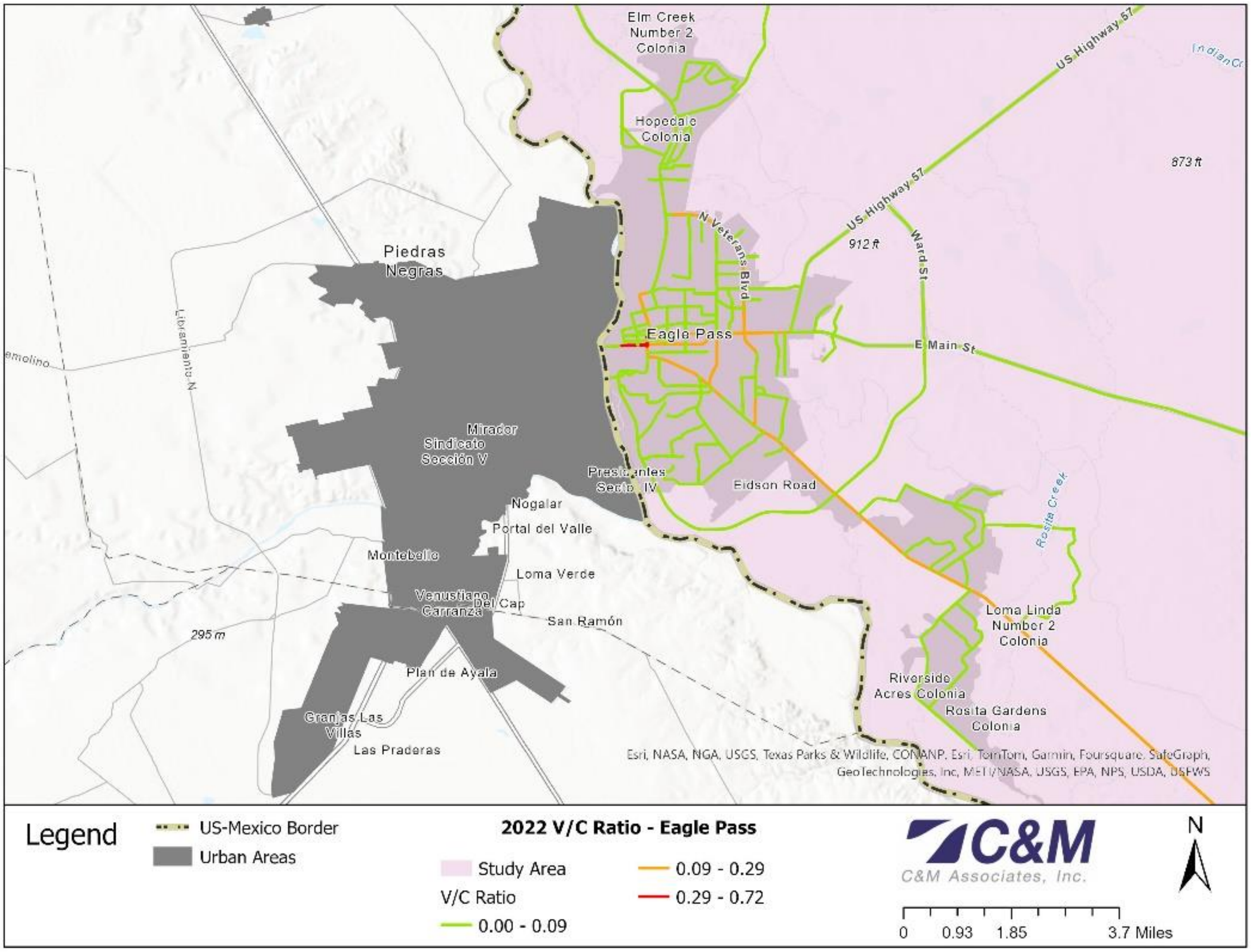


Figure 4-25. 2022 Eagle Pass V/C Ratio

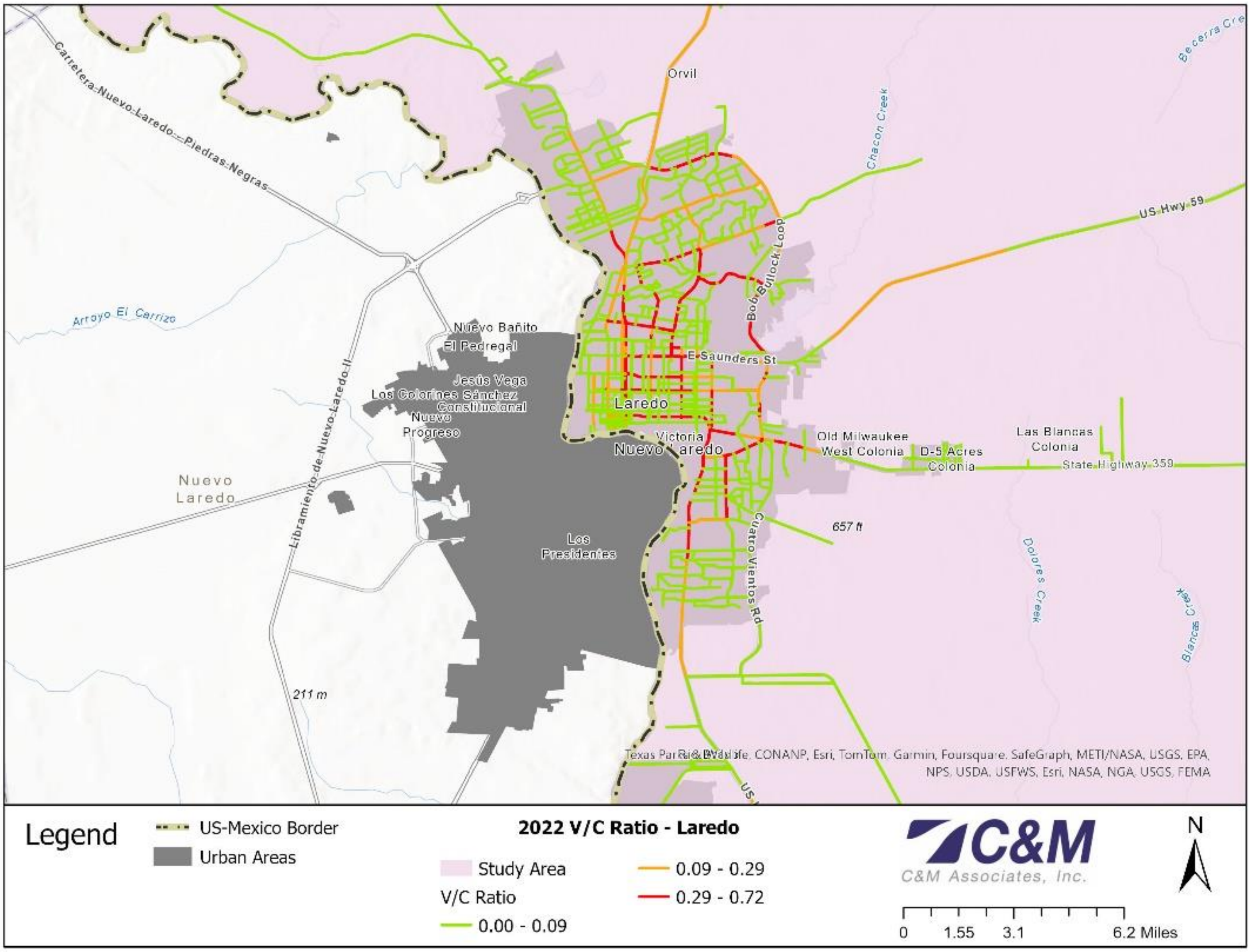


Figure 4-26. 2022 Laredo V/C Ratio

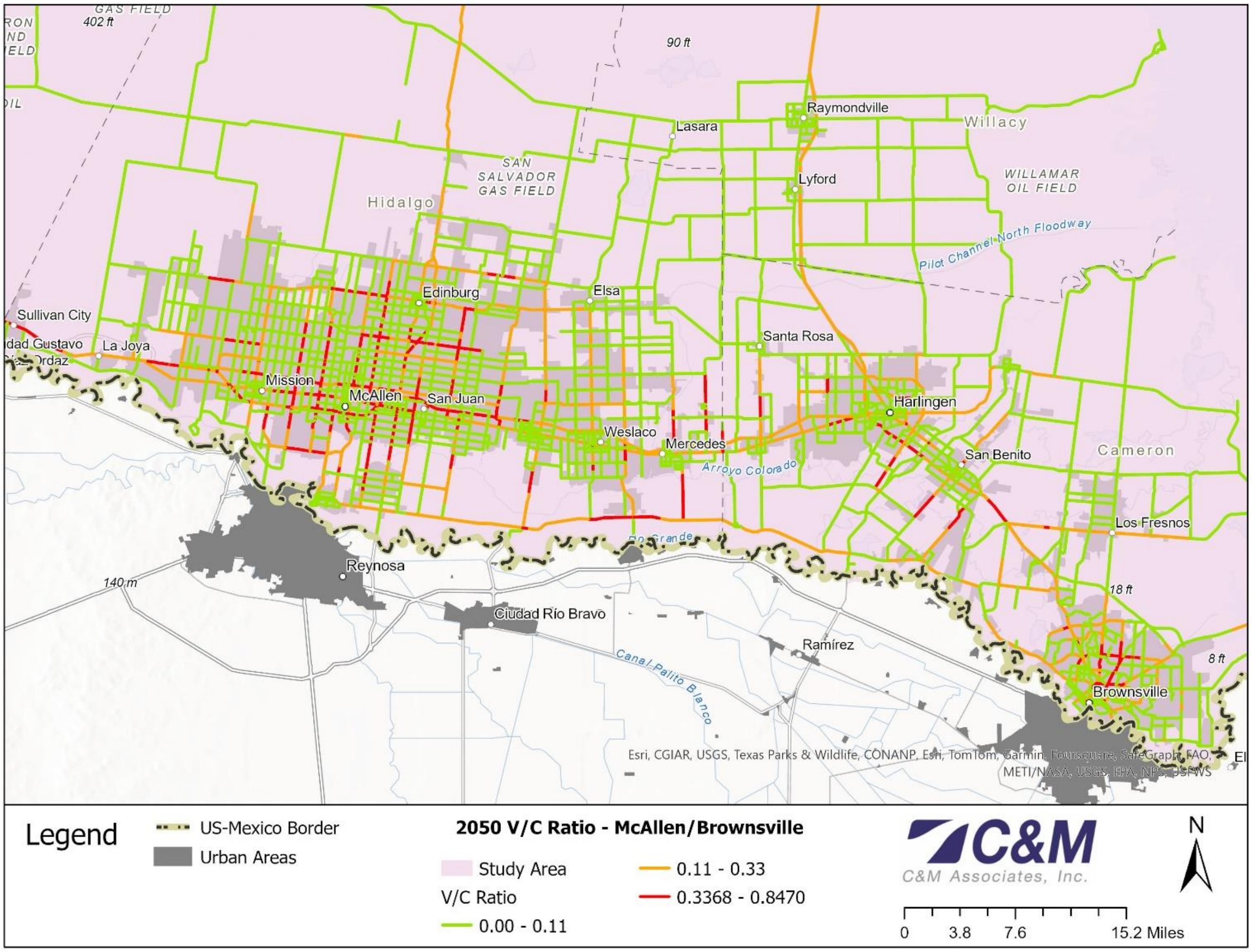


Figure 4-27. 2022 McAllen and Brownsville V/C Ratio

For 2050, the network will present more roads near conditions where traffic experiences significant delays with a V/C ratio between 0.00 and 0.82. This increase will be notable in suburban areas, especially in main roads near the cities of El Paso, San Antonio, Laredo, McAllen, and Brownsville. Likewise, I-10 will present a slight increase of the criteria mainly in the section from El Paso to the junction with I-20.

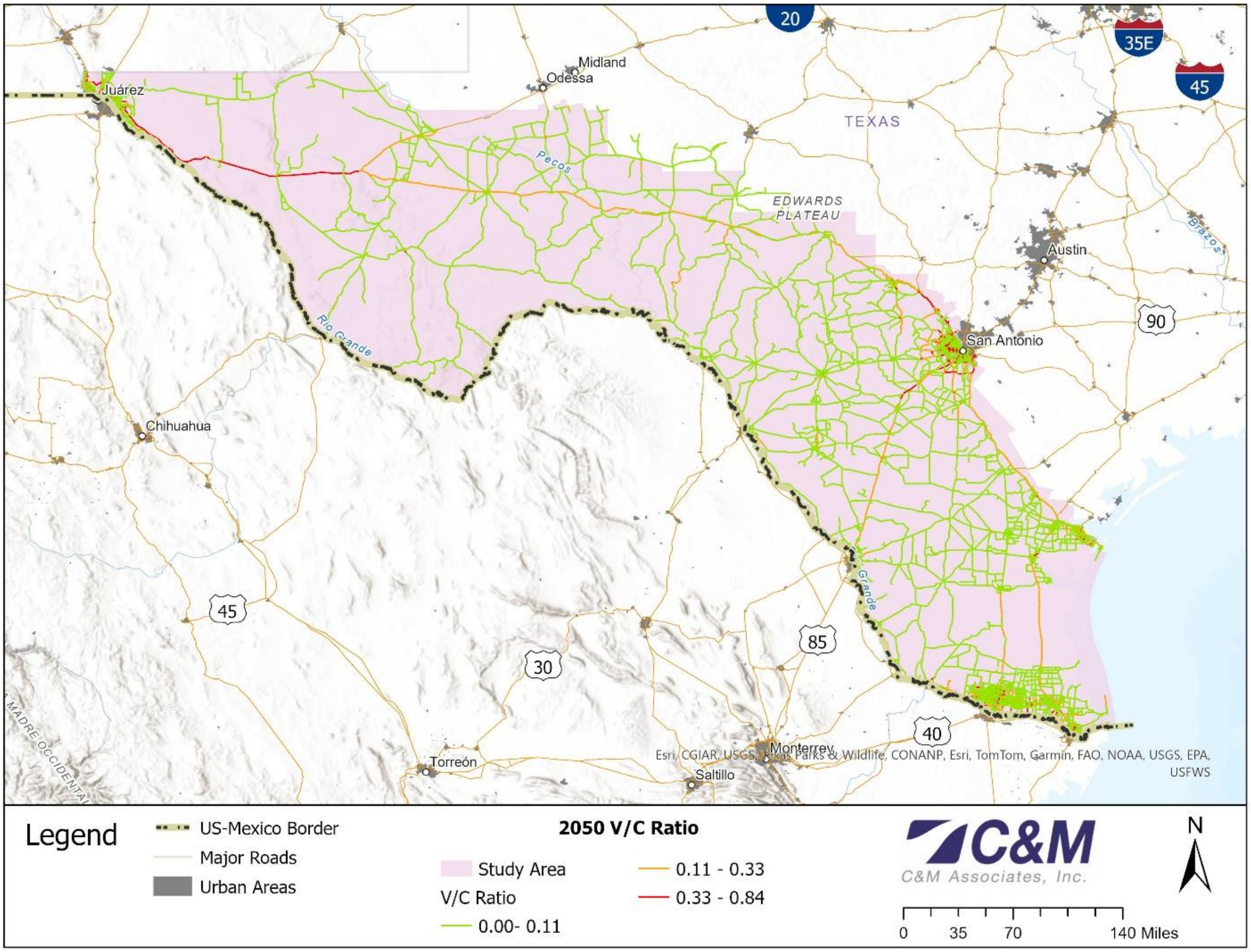


Figure 4-28. Total 2050 V/C Ratio

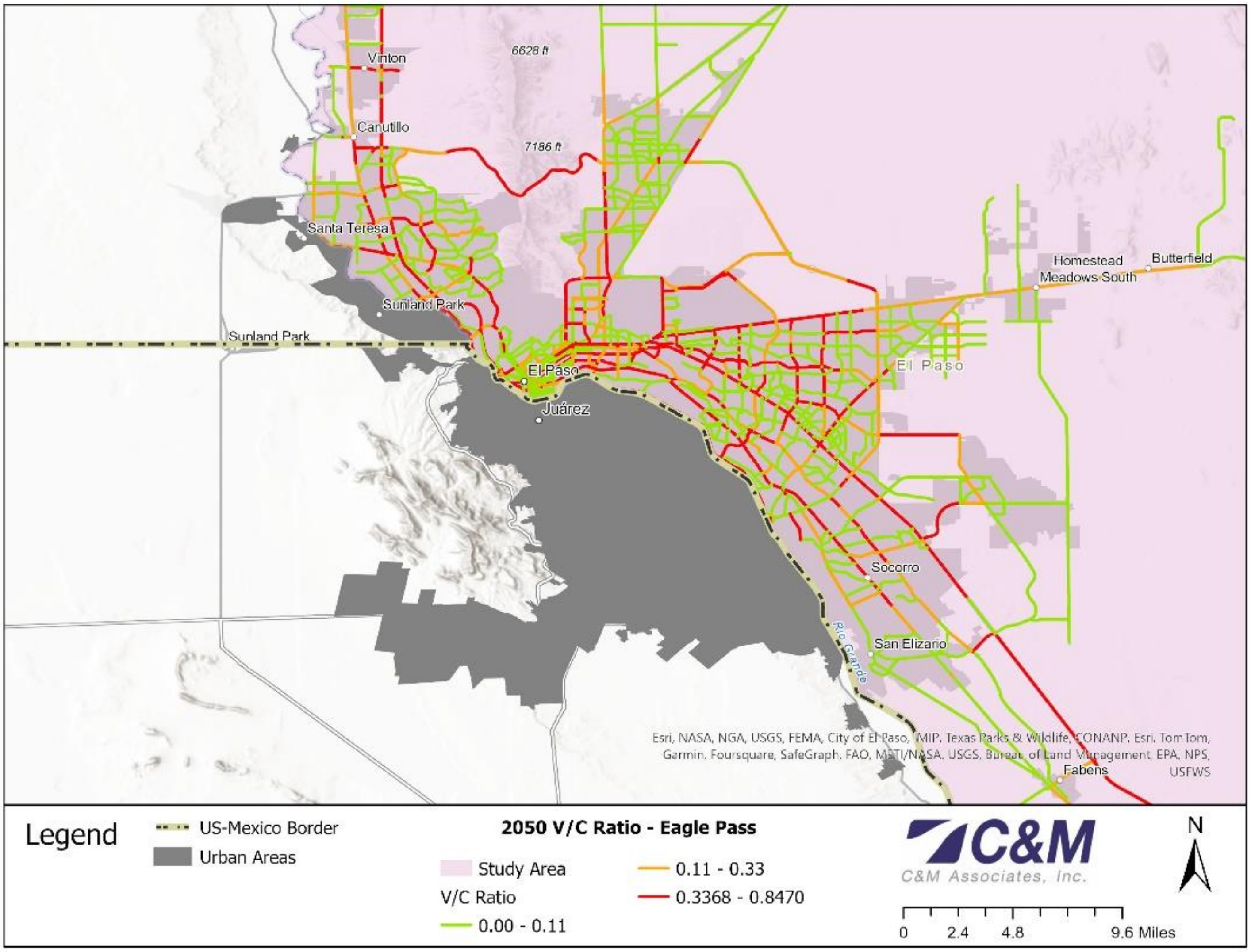


Figure 4-29. 2050 El Paso V/C Ratio

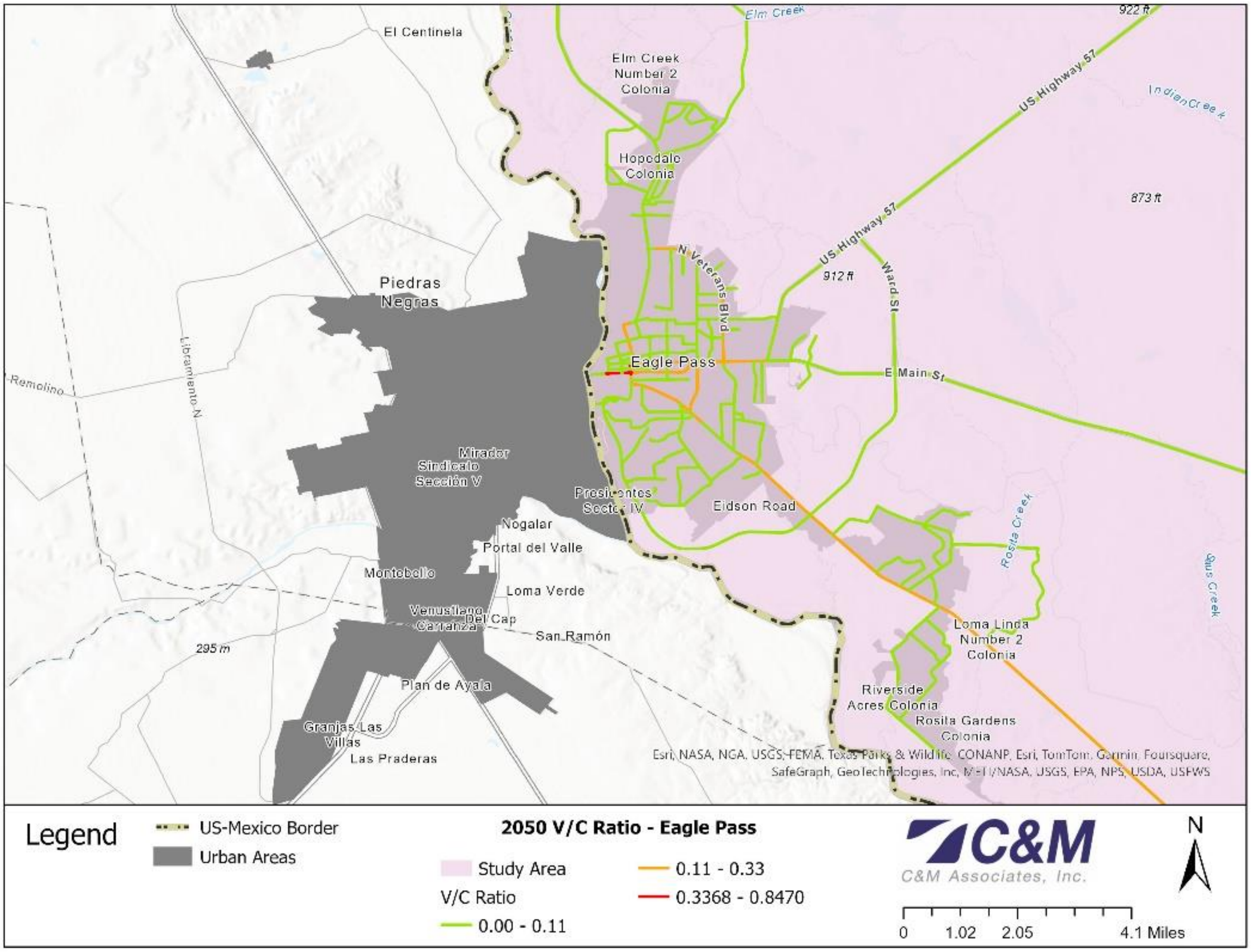


Figure 4-30. 2050 Eagle Pass V/C Ratio

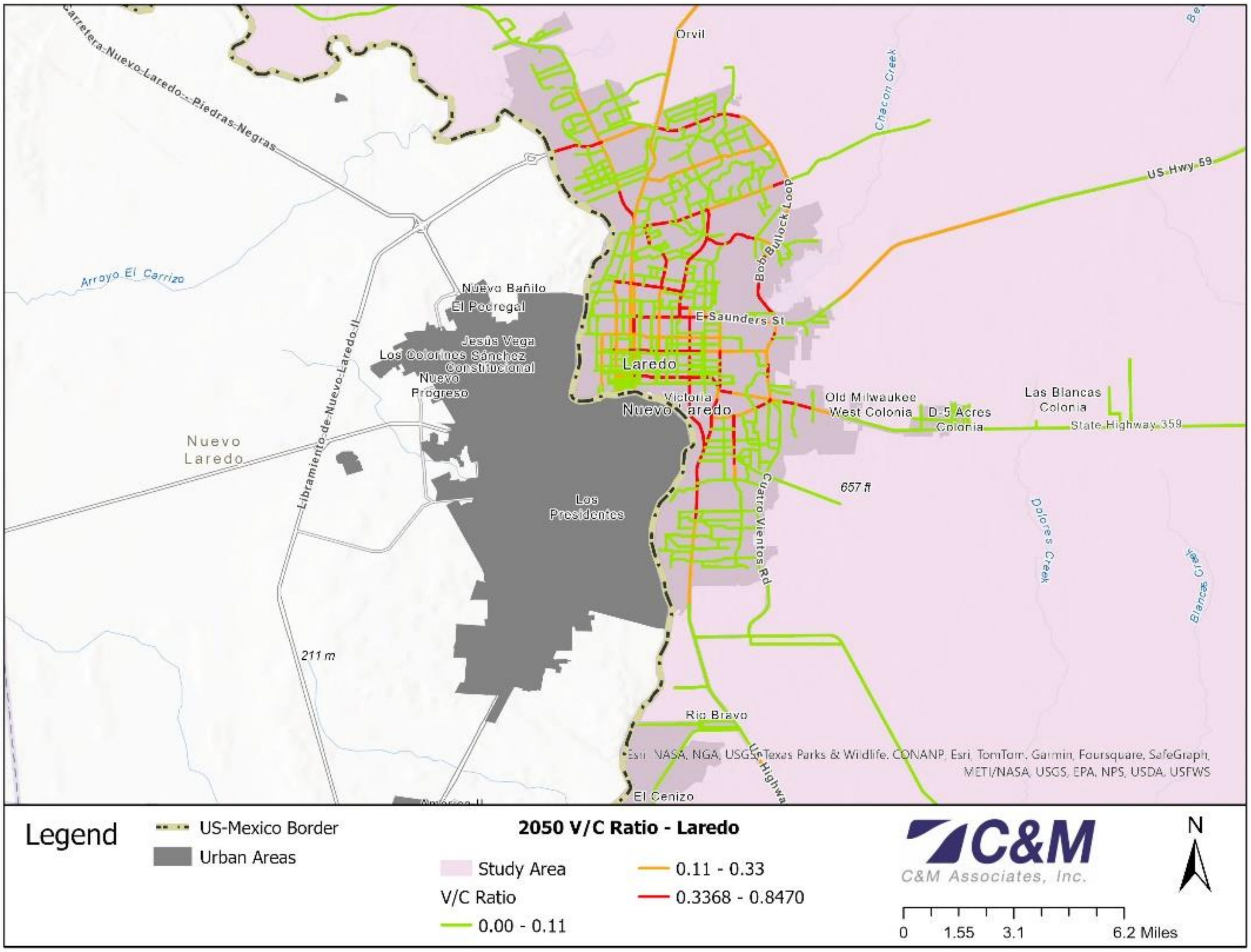


Figure 4-31. 2050 Laredo V/C Ratio

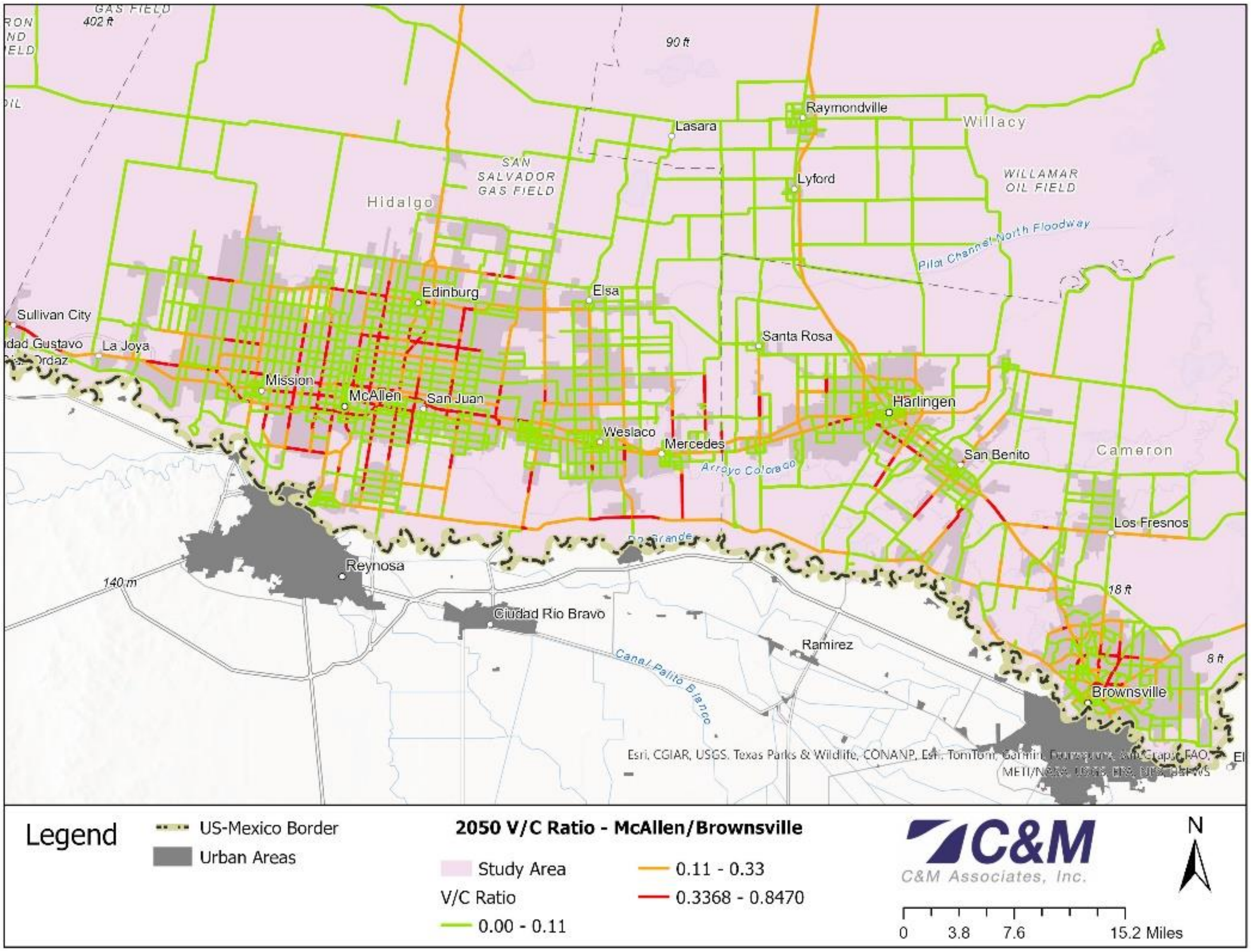


Figure 4-32. 2050 McAllen and Brownsville V/C Ratio

4.2.3.2 Traffic Assignment Future Growth

Figure 4-33 illustrates the CAGR of the total flow (considering passenger and commercial vehicles) by link in the study area network from 2022 to 2050. According to the analysis, the study shows a total flow CAGR between -1.00% and 0.21%. Along the main corridors which connect the region, the CAGR is between 0.00% and 0.02% on roads such as I-10, I-35, and US 281. However, US 77 shows a CAGR between 0.02% and 0.21%; this shows that this road will be the most important corridor in the region in terms of growth flow.

As shown in Figure 4-33 through Figure 4-37, the highest total flow CAGR is estimated near cities such as El Paso, San Antonio, McAllen, and Brownsville; these results could be attributed to the socioeconomic data forecasts (e.g., San Antonio, MacAllen, and Brownsville will present high growth in the population and household variables, and El Paso will present significant growth in the employment variable, as shown in section 4.2.3. Socioeconomic Forecast).

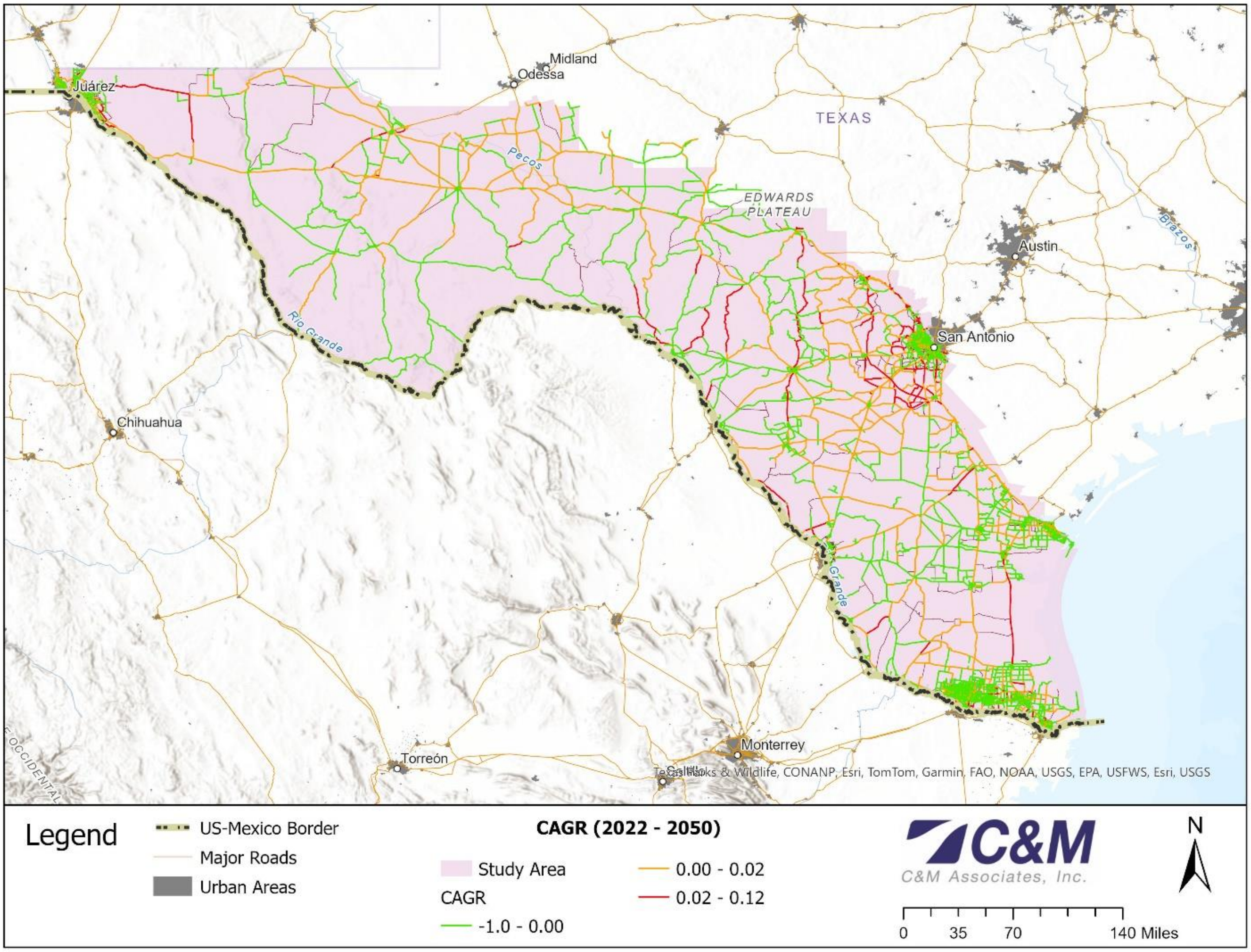


Figure 4-33. Future Traffic Growth CAGRs, 2022–2050

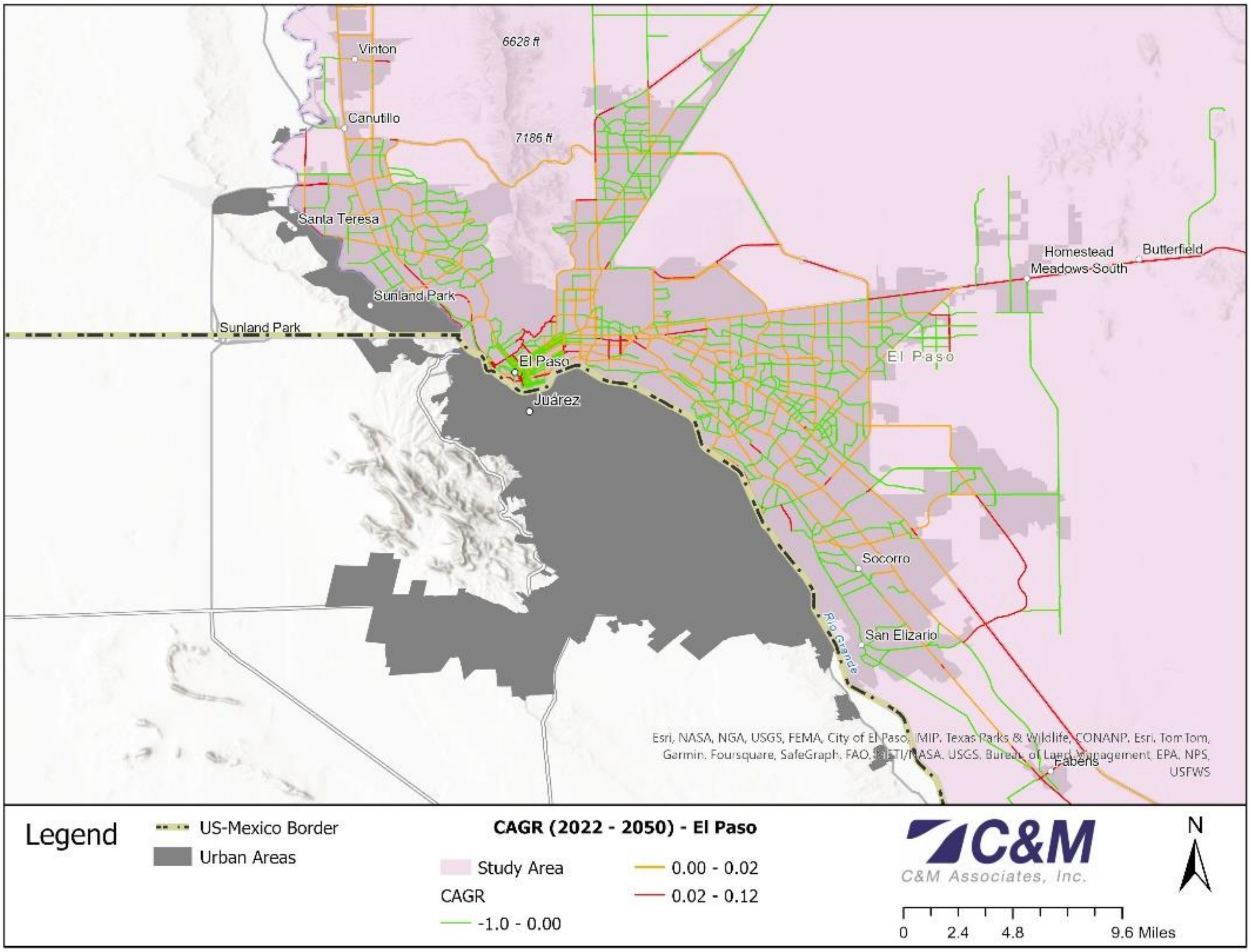


Figure 4-34. El Paso CAGR, 2022–2050

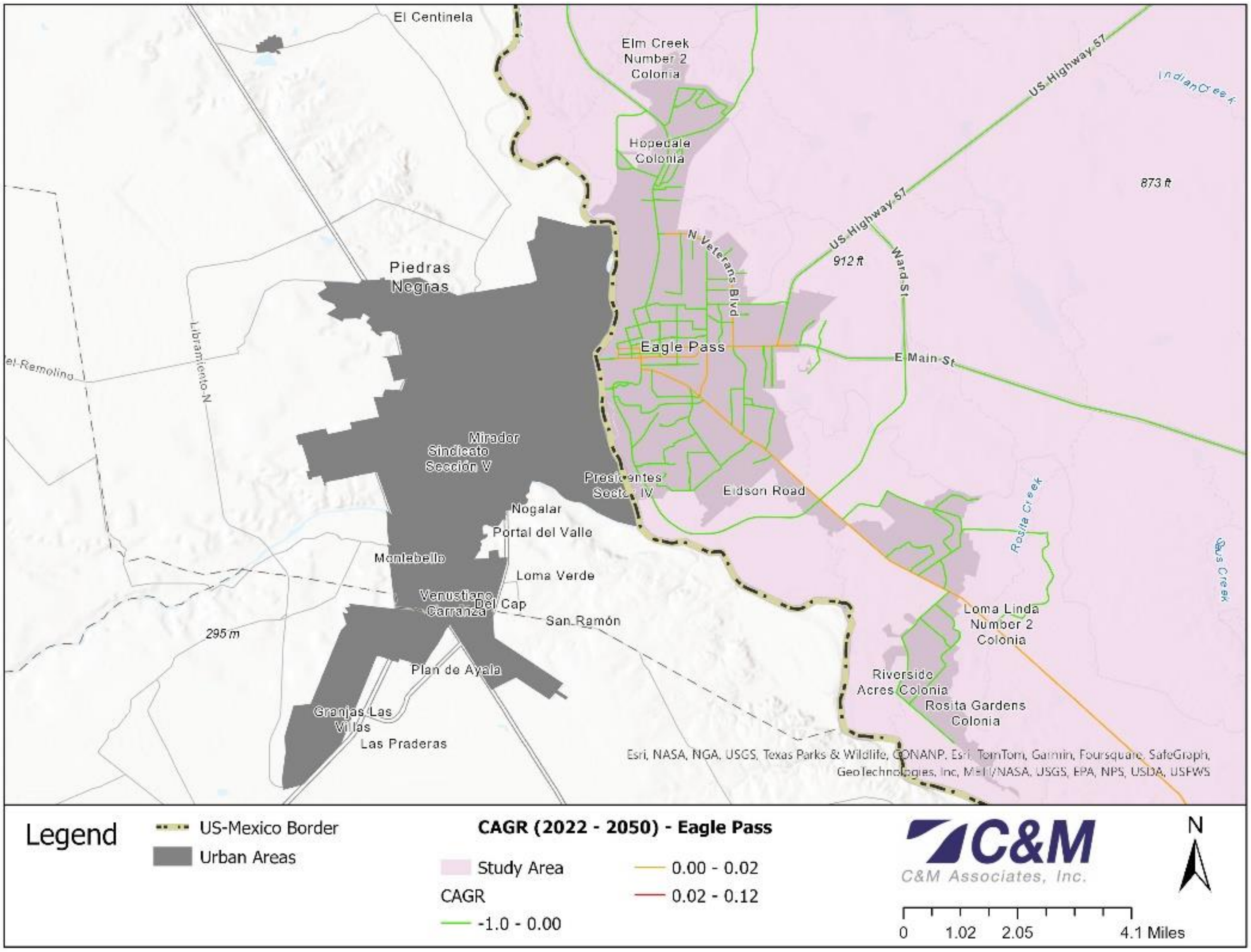


Figure 4-35. Eagle Pass CAGR, 2022–2050

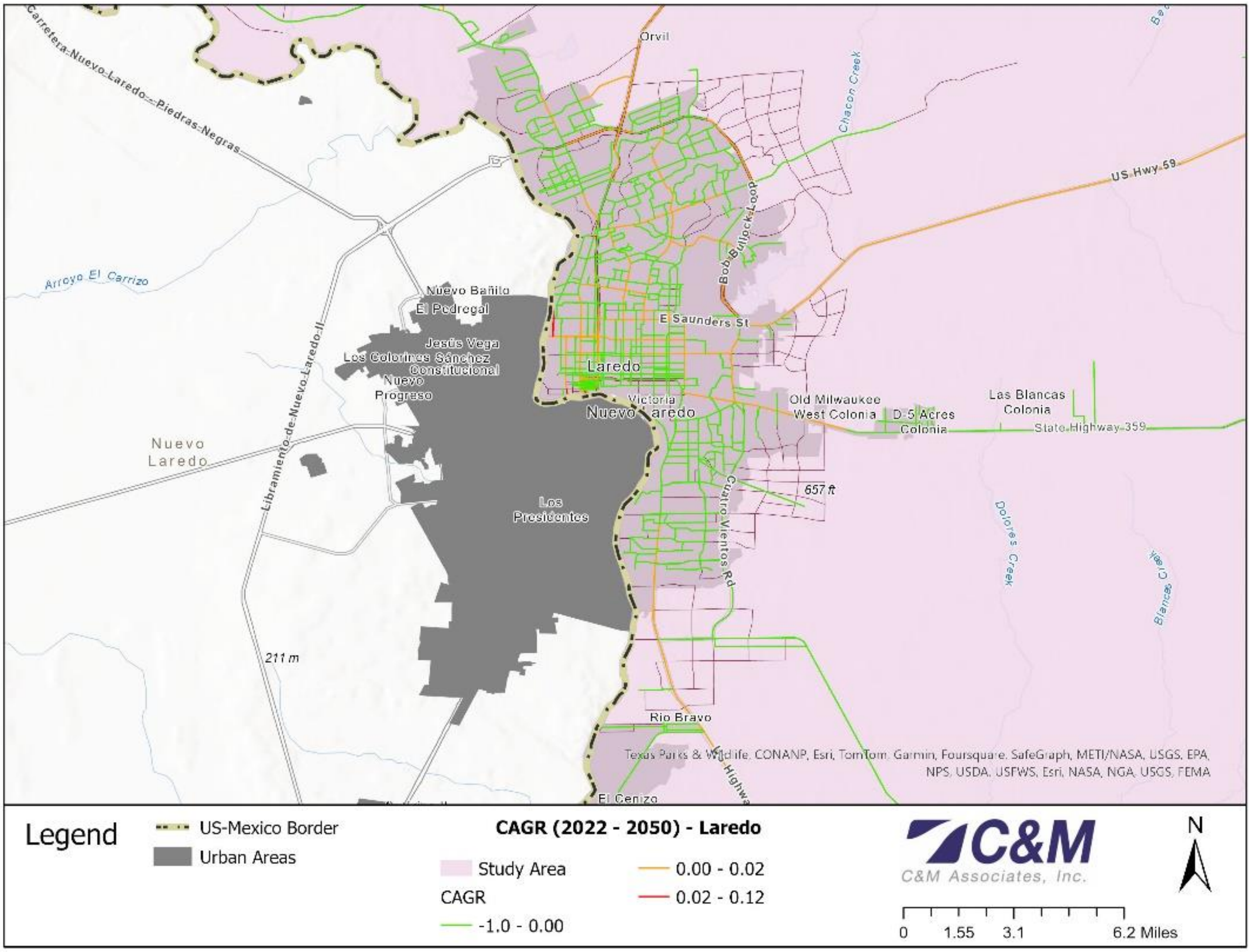


Figure 4-36. Laredo CAGR, 2022–2050

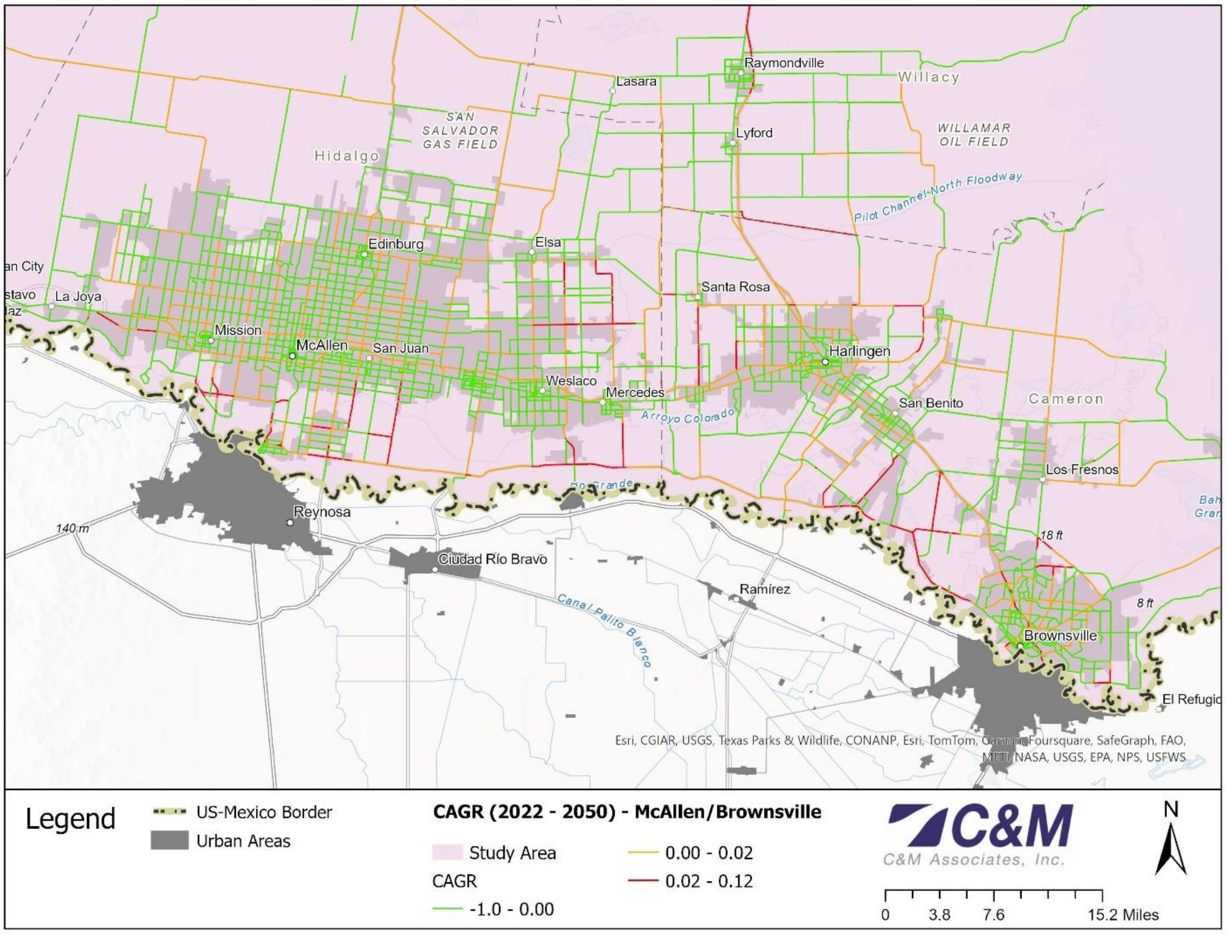


Figure 4-37. McAllen and Brownsville CAGR, 2022–2050

[1] U.S. Census (2023). Texas Population Estimates Program retrieved Mar 28, 2024, from https://demographics.texas.gov/Estimates/2022/

[2] Woods & Poole Economics, Inc. (2023). Complete Economic and Demographic Data Source (CEDDS), (*Purchased data).*

[3] Texas Water Development Board (n.d.). 2022 State Water Plan Water User Group Population Projections for 2020-2070 Feb 14, 2024 from https://txwaterdatahub.org/dataset/2022-state-water-plan-wug-projections-for-2020-2070

[4] Texas Workforce Commission (n.d.). Texas Labor Market Information (TexasLMI) retrieved Feb 15, 2024, from https://texaslmi.com/LMIbyCategory/Projections

[5] Moody's Analytics retrieved (*Purchased data*).