PERMIAN BASIN
FREIGHT AND ENERGY SECTOR TRANSPORTATION PLAN

NOVEMBER 2020

Texas Department of Transportation

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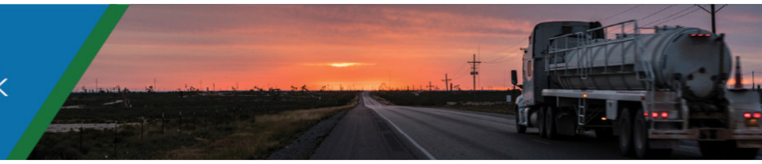

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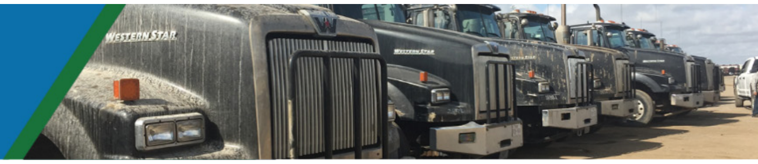


LIST OF EXHIBITS

ACRONYMS

/b	per barrel
AADT	Annual Average Daily Traffic
AADTT	Annual Average Daily Truck Traffic
ATRI	American Transportation Research Institute
BEA	Bureau of Economic Analysis
BNSF	BNSF Railway Company
BTI	Buffer Time Index
BTS	Bureau of Transportation Statistics
CAGR	Compound Annual Growth Rate
CCTV	Closed-Circuit Television
CR	County Road
CRIS	Crash Record Information System
CTT	Comparative Travel Time
DMS	Dynamic Message Signs
DMV	Department of Motor Vehicles
DPS	Department of Public Safety
EIA	U.S. Energy Information Administration
FAA	Federal Aviation Administration
FedEx	Federal Express
FHWA	Federal Highway Administration
FM	Farm to Market Road
FY	Fiscal Year
GIS	Geographic Information System
GPS	Global Positioning System
GRP	Gross Regional Product
GSP	Gross State Product
GW	Gas Well
HOS	Hours of Service
IMPLAN	Impact Analysis for Planning
IRI	International Roughness Index
ITS	Intelligent Transportation System
IVMS	In-Vehicle Monitoring System
kWh	Kilowatt hour

LEP	Limited English Proficiency
MAF	Midland International Air and Space Port
MMbbl/d	Million barrels per day
MMbbl	Million barrels
Mbbl/d	Thousand barrels per day
Mbbl	Thousand barrels
Mcf	Thousand cubic feet
MMcf	Million cubic feet
MMcf/d	Million cubic feet per day
MOTRAN	Midland-Odessa Transportation Alliance
MPO	Metropolitan Planning Organization
NAICS	North American Industry Classification System
NGL	Natural Gas Liquid
NHS	National Highway System
NMDOT	New Mexico Department of Transportation
NPMRDS	National Performance Management Research Data Set
OS/OW	Oversize/Overweight
PBFP	Permian Basin Freight Plan
PBHFN	Permian Basin Highway Freight Network
PBMFN	Permian Basin Multimodal Freight Network
PBPA	Permian Basin Petroleum Association
PRSC	Permian Road Safety Coalition
PSF	Permanent School Fund
PSP	Permian Strategic Partnership
PUF	Permanent University Fund
QCEW	Quarterly Census of Employment and Wages
RM	Ranch to Market Road
ROW	Right-of-Way
RRC	Railroad Commission of Texas
RWY	Runway
SAM	Statewide Analysis Model
SH	State Highway
SOI	Sphere of Influence
SR	State Route
SRA	State Rest Area
STB	U.S. Surface Transportation Board

TDM	Transportation Demand Management
TFMP	Texas Freight Mobility Plan
THFN	Texas Highway Freight Network
TMC	Traffic Management Center
TPAS	Truck Parking Availability Systems
TREDIS	Transportation Economic Development Impact System
TSM	Transportation Systems Management
TSM&O	Transportation Systems Management and Operations
TTI	Texas Transportation Institute
TTTR	Truck Travel Time Reliability
TxDMV	Texas Department of Motor Vehicles
TxDOT	Texas Department of Transportation
TxPROS	Texas Permitting and Routing Optimization System
UP	Union Pacific Railroad
UPS	United Parcel Service
UTP	Unified Transportation Program
VC	Vehicle Classification
WIM	Weigh-In-Motion

SECTION 1 Planning for Freight and Energy Sector Transportation in the Permian Basin

The 2018 Texas Freight Mobility Plan (TFMP) identified the need for a regional Freight and Energy Sector Transportation Plan for the Permian Basin region to1) Better capture data describing local and regional energy sector freight activity; 2) Identify energy sector-related freight transportation challenges; and 3) Identify and develop regional freight strategies.

Section 1 introduces the Permian Basin Regional Freight and Energy Sector Transportation Plan (Permian Basin Freight Plan). **Chapter 1** describes the Plan's **motivation, goals, and objectives**, and the approach used to develop the Plan. **Chapter 2** discusses how the **energy industry and freight transportation system in the Permian Basin are connected** to the state, national, and global economies.

The Plan is organized into three main sections that set the stage for why freight in the Permian Basin matters, provides data, analysis, and identification of needs, and identifies strategies and recommendations. Specifically:

- **Section 1** introduces the study;
- **Section 2** examines the Permian Basin's freight transportation network, condition, and needs.
- **Section 3** presents strategies, recommendations, and an implementation plan.

CHAPTER 1 Introduction

1.1 PLAN MOTIVATION

The Permian Basin, located in west Texas and southeastern New Mexico, covers approximately 75,000 square miles with more than 7,000 oil/gas fields and is the 2nd largest oil and gas producing area in the world. The energy boom has led to an increased economic importance of the region's oil and gas industry and an increased demand for freight transportation to support the industry. The resulting level of freight activity in the Permian Basin has far out-paced investment in the region's transportation system.

The region, depicted in **Exhibit 1,** has experienced unprecedented growth over the last decade due to growth in the energy sector. In 2019, Texas produced over 1.75 billion barrels of oil while the U.S. produced over 4.46 billion barrels in total. [1,2] The Texas portion of the Permian Basin produced over 2.8 million barrels of oil per day in 2019,[3] accounting for nearly 60% of Texas' total production. The New Mexico portion of the region produced 4.2 million barrels of oil per day in 2019.[4] The Permian Basin accounted for over 30% of the nation's total oil production. Though the 2020 global coronavirus pandemic and oversupply of oil on the world market has drastically impacted the production of oil and gas in the Permian Basin, long-term projections suggest the Permian Basin will rebound and continue to increase oil and gas production over the next several decades,[5] suggesting the need for investment in the region's transportation system continues to exist.

The 2018 TFMP recommended the development of a regional freight and energy sector transportation plan for the Permian Basin due to the lack of data and limited understanding of current and future freight movement activity. The intensity of the oil and gas industry throughout the region creates regional movements that are difficult to track including movement of equipment between storage yards and oil fields and the movement of sand and water used and produced in hydraulic fracturing (fracing), none of which are accurately represented in the statewide and national commodity flow databases or other planning data and tools for numerous reasons. First, water is not included in the U.S. Commodity Flow Survey (CFS) and thus it is not included in the other commonly used public and private sector databases modeled from the CFS such as the Federal Highway Administration's (FHWA) Freight Analysis Framework (FAF) or IHS Market TRANSEARCH (TRANSEARCH). Second, the sourcing of regional sand is a relatively new development and was not captured in the 2015 TRANSEARCH database, which is the latest version acquired by TxDOT. Third, wells in the oilfields are continuously being added, causing the pattern of equipment movements to

1 Railroad Commission of Texas, Monthly Oil and Gas Production by Year, https://www.rrc.state.tx.us/oil-gas/research-and-statistics/production-data/texas-monthly-oil-gas-production/, Accessed May 14, 2020.

2 U.S. Energy Information Administration, https://www.eia.gov/dnav/pet/pet_crd_crpdn_adc_mbbl_a.htm, Accessed May 14, 2020.

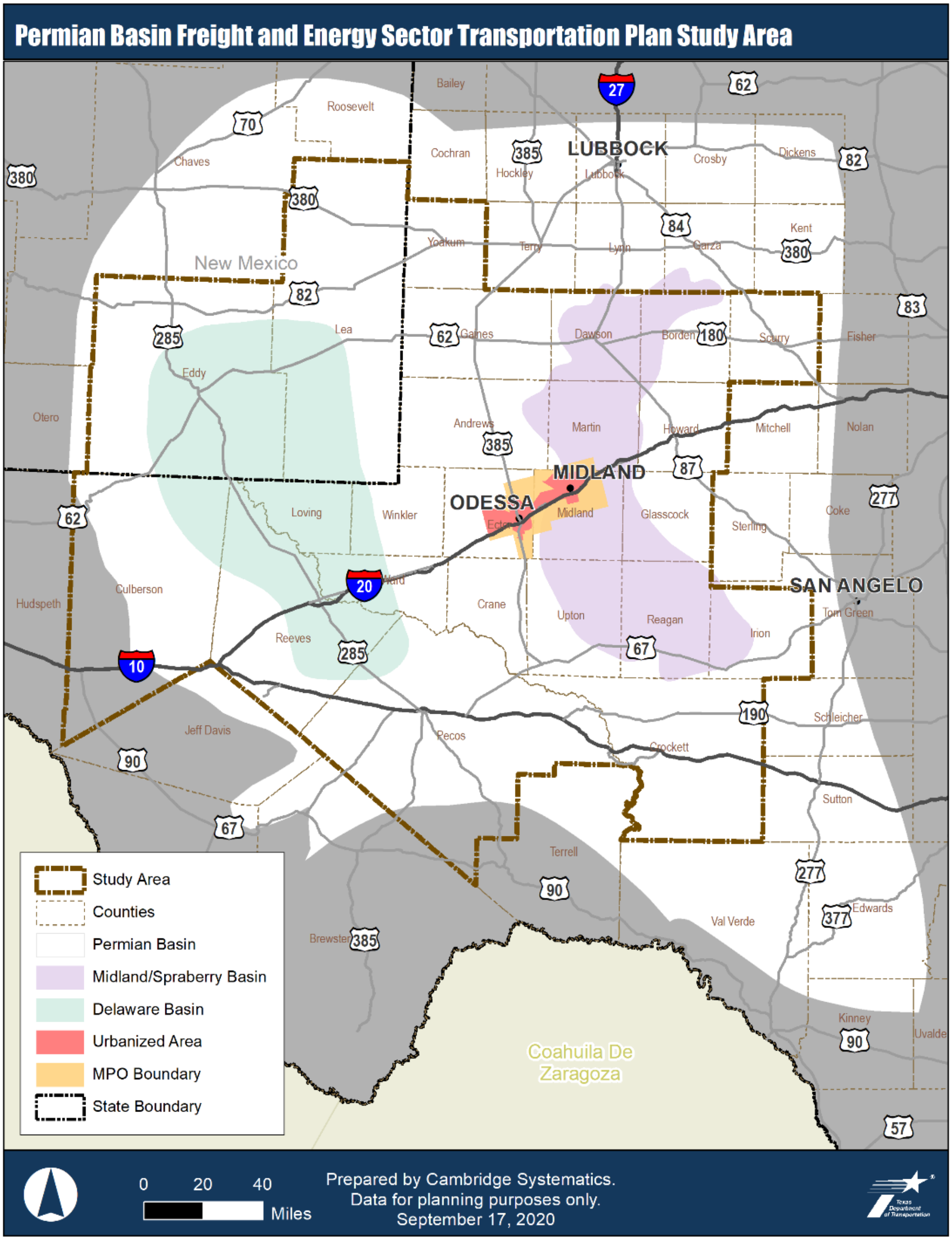
3 Railroad Commission of Texas, Texas Permian Basin Oil Production 2008 through February 2020, https://www.rrc.state.tx.us/media/57800/permian-basin-oil.pdf, Accessed May 14, 2020.

4 New Mexico Energy, Minerals and Natural Resources Department - Oil and Conservation Division, County Production and Injection by Month, http://www.emnrd.state.nm.us/OCD/statistics.html.

5 U.S. Energy Information Administration, https://www.eia.gov/outlooks/aeo/, Accessed July 17, 2020.

constantly change. Since the commodity flow databases are static, meaning they capture a point in time, these moves are not identified.

Exhibit 1. Permian Basin Freight and Energy Sector Transportation Plan Study Area



1.2 PURPOSE, GOALS AND OBJECTIVES

The Permian Basin Freight and Energy Sector Transportation Plan Purpose

Develop a multimodal regional freight plan to improve safety and mobility throughout the Permian Basin by identifying local and regional freight challenges and opportunities, and identifying and prioritizing improvements, including recommendations for policy and programmatic strategies.

The 2018 TFMP recognized the need for a regional study to examine the unique and fast-growing freight industry throughout the Permian Basin.

The goals of the Plan include:

Safety – Improve the safety of the Permian Basin region's multimodal freight system.

Economic Competitiveness – Enhance the economic competitiveness, productivity, and development of the Permian Basin region by ensuring the region's freight transportation network is adequate to support the energy sector and inform decision-makers of the importance of the region's freight activity at the state, national, and international levels.

Mobility and Reliability – Enhance mobility and improve system efficiency and performance of the Permian Basin region's transportation system by expanding capacity, improving operations and addressing freight bottlenecks.

Connectivity – Improve urban and rural system connectivity between all freight modes within the Permian Basin region and all industry sectors to regional, statewide, national, and international markets.

Sustainable Funding – Identify sustainable funding sources for the Permian Basin region's freight transportation system, which is critical to Texas' ability to serve the energy sector.

Stewardship – Manage environmental and agency resources responsibly and foster accountability and transparency in decision-making.

Customer Service – Encourage local ownership of and coordination in the development of the Permian Basin Freight Plan by engaging public and private sector stakeholders in transparent dialogue to determine consistent and comprehensive regional transportation planning needs, strategies and recommendations.

Asset Preservation – Maintain and preserve the Permian Basin's transportation infrastructure as it supports multimodal movement of people and goods.

The objectives of the Plan include:

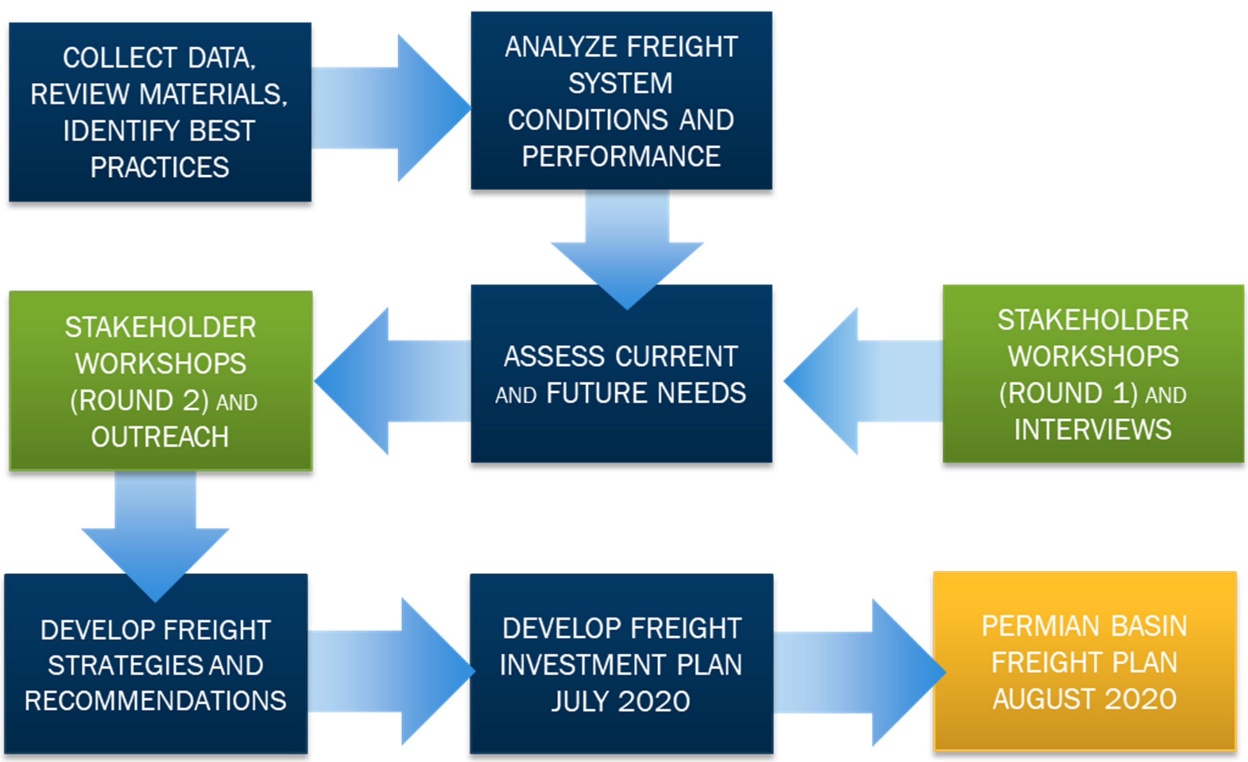
- Supplement state freight data with local and regional freight and traffic data collection specific to energy sector activity.

- Identify and assess the critical regional transportation network serving current and future energy sector needs.
- Enhance regional freight forecasts and the travel demand model by better accounting for future energy sector traffic, trends, and activity.
- Identify policies, programs, and projects to address energy sector freight activity for inclusion in the Plan.
- Document energy sector freight movement and its economic and operational impacts to local communities, the state, and the nation; and effectively communicate that impact to state and federal officials to inform policy and investment decisions.
- Improve multimodal connectivity and mobility between urban and rural areas and from the Permian Basin to the rest of the state and nation.
- Develop short- and long-term actionable strategies for enhancing regional freight mobility, connectivity, and safety on the local and regional transportation system.
- Seek formal adoption of the Regional Freight Plan by the Texas Transportation Commission and support regular updates to the Plan.

1.3 APPROACH TO DEVELOPING THE PLAN

The Permian Basin Freight Plan draws upon the 2018 TFMP which incorporated multimodal freight planning at the statewide, regional, and local levels. Developing the Permian Basin Freight Plan required a combination of localized data collection, modeling, and analysis, as well as local, regional, and statewide stakeholder outreach. An overview of the Plan development approach is provided in **Exhibit 2**.

Exhibit 2. Approach for Developing the Permian Basin Freight and Energy Sector Transportation Plan



Source: Cambridge Systematics.

The Permian Basin Freight Plan draws upon several technical reports including:

- **Goals and Objectives** – Discusses the process for developing the Plan's goals and objectives, presents the final goals and objectives, and summarizes how the goals and objectives align with the 2018 TFMP and TxDOT's overall mission.
- **Permian Basin Multimodal Freight Network Designation** – Discusses the process, criteria, data, and outcome for designating the Permian Basin Multimodal Freight Network (PBMFN).
- **Regional Freight Profile, Issues, Challenges and Opportunities** – Presents an inventory of the region's freight transportation assets, and modal demand, analyzes the conditions and performance of the network, and discusses the network issues, challenges, and opportunities.
- **Land Use and Freight** – Examines the freight intensive land uses throughout the region and the potential conflicts and environmental justice impacts of freight transportation and land use on communities across the Permian Basin.
- **Regional Freight Transportation Trends, Forecasts, and Needs Assessment** – Presents the key economic and energy sector trends impacting freight flows in the Permian Basin, provides a summary of current and future commodity flows, and provides an assessment of freight needs.
- **Economic Role of Permian Basin Freight and Energy Sector Transportation** – Provides an economic profile of the Permian Basin, quantifies the economic impact of the freight and energy sector activity in the region, and presents the Permian Basin's sphere of influence (SOI).
- **Strategies, Recommendations and Implementation Plan** – Puts forth a comprehensive set of policy, program, operational and technology, and infrastructure strategies and developed recommendations and implementation plan to address current and future freight needs in the Permian Basin.
- **Stakeholder Outreach and Engagement Summary** – Summarizes the various stakeholder outreach activities, input, and feedback gathered throughout the development of the Plan.

1.3.1 KEY DATA SOURCES

Exhibit 3 summarizes the key data sources used in the Plan. While the list is not exhaustive of all the data used, it represents the most critical and unique data. The table is organized by data use and provides the source and type of data. In addition to traditional state and regional planning data, several specialized data sources were utilized that provided critical data unique to the Permian Basin, including: the Enverus DrillingInfo data, a third party oil and gas drilling activity market analysis and data science firm, which supported the estimation of sand and water movements within the region; in-vehicle monitoring system (IVMS) data provided be local truck fleets, which tracks the movement and operational characteristics, such as hard braking, speed, and lane departures for trucks in the region; Railroad Commission of Texas (RRC) data, which tracks well permits and status; and Texas Department of Motor Vehicle (DMV) Oversize/Overweight (OS/OW) permitting data.

Exhibit 3. Key Data Sources Used in the Development of the Permian Basin Freight Plan

Source	Data Item	Description
American Transportation Research Institute (ATRI) truck global positioning system (GPS) data	Truck GPS data	Location based data for trucks over time to track movements, speeds, and parking
BTS Transtats Database FAA T-100 Data Series	Air Cargo Data	Total tonnage and landings of air cargo
Enverus Drillinginfo Database; FracFocus Database; New Mexico Energy, Minerals, and Natural Resources Department, County Production and Injection Summary by Month for Eddy and Lea Counties; Texas Water Development Board, Groundwater Database. Texas Water Development Board, Submitted Drillers Report Database; New Mexico Office of the State Engineer, Points of Diversion Geospatial File; Texas Railroad Commission, H-10 Reports	Oilfield Commodity Flows and Truck Movements	County-level estimates of the production, attraction, and generation of movements for oilfield commodities including sand, fresh water, and produced water
Federal Railroad Administration Highway Rail Crossing Inventory Database	At-Grade Highway -Rail Crossings	The location of at-grade Highway-rail crossings
FHWA Office of Planning	Intermodal Connectors Roadway Data	Freight-related intermodal Connectors
IHS Market TRANSEARCH	Freight Equipment Data	Freight equipment in Texas
	Commodity Flows by Mode	County-level commodity flows
National Bridge Inventory	Bridge Data	Bridge heights, widths, and weight limits

Source	Data Item	Description
National Performance Management Research Data Set (NPMRDS)	Truck Travel Times	Link-level truck travel time data for the National Highway System
National Transportation Atlas Database, TxDOT Open GIS Portal	State Rail Network	The extent and ownership of the state's rail network
GEOFORCE	In-Vehicle Monitoring System (IVMS) Data	Truck probe data that provides information on hard braking events and other events that imply unsafe driving conditions
Texas Department of Motor Vehicles (DMV)	OS/OW Permit Information	Permit data used to estimate daily OS/OW energy and/or construction related truck volumes
TxDOT Crash Record Information System (CRIS)	Crashes by Severity and Vehicle Type	Crashes over the most recent 5-year period
TxDOT, U.S. Energy Information Administration, U.S. DOT Pipelines and Hazardous Materials Safety Administration	Pipelines	Pipeline locations, current capacity, and planned expansions across the state
TxDOT Open GIS Portal, Energy Sector Corridors, Roadway Inventory, Texas Highway Freight Network, TxDOT Annuals, Texas Airports, Permanent Count Stations, Weigh-in Motion, TxDOT Speed Limits	Energy Sector Corridors Highway Network for State and Off-System Roadways Highway Freight Network Traffic Counts Airports Weigh Stattions Posted Speed Limits	Extent of the Energy Sector Corridors network, state highway system, Texas Highway Freight Network, truck volumes, location of cargo-handling airports, location of weigh stations, and speed limits
TxDOT and NMDOT Highway Performance Monitoring System Submittal	Pavement Conditions	Pavement conditions on the extent of the state highway system
TxDOT Statewide Analysis Model (SAM)	TxDOT Statewide Analysis Model	Statewide travel demand model

Source: Cambridge Systematics.

1.3.2 STAKEHOLDER INPUT

Stakeholder input was critical throughout the development of the freight plan. Perhaps the most critical input provided by stakeholders was helping to identify freight transportation challenges and needs and providing input on strategies to address those needs. The Permian Basin Freight Plan Stakeholder Outreach and Engagement Summary Report details the outreach activities and findings. Below is a summary of key stakeholder events held throughout the Plan development process.

Steering Committee – The Permian Basin Freight Plan Steering Committee was comprised of more than 30 public and private sector stakeholders from across the region. The committee met six times during the development of the Plan and provided input on all major milestones, including setting the Plan's goals and objectives, designation of the PBMFN, estimation of commodity flows, definition of spheres of influence, identification of needs and challenges, and development and prioritization of strategies.

Interviews – More than 25 interviews were conducted throughout the development of the Plan with public officials, industry stakeholders, planning partners, and modal representatives. Interviewees provided input on desired plan outcomes, data sources, and needs and challenges.

Surveys – A web-based survey aimed at private sector stakeholders was conducted during the early tasks of the study to gather input on needs and challenges. A survey of Gulf Coast ports was also conducted to gather input on the role of the ports in supporting the Permian Basin energy sector.

Industry and Stakeholder Forums – Two rounds of industry and stakeholder forums were held during the development of the Plan. The first round of forums was held July-August 2019 and focused on defining the PBMFN and identifying issues and challenges. The second round was held in June 2020 and focused on soliciting input on needs and strategies and recommendations.

Webinars and Meetings – Multiple webinars and meetings were held with stakeholder groups throughout Plan development including with TxDOT Odessa District, Permian Basin Metropolitan Planning Organization (MPO), Midland-Odessa Transportation Alliance (MOTRAN), Permian Strategic Partnership (PSP), Permian Basin Petroleum Association (PBPA), Permian Road Safety Coalition (PRSC), Permian Basin Regional Planning Commission, and the Texas Port Authority Advisory Committee (PAAC).

Industry tours – Members of the study team conducted field tours to gain direct insight into key freight and energy sector generation activities including oilfield and rig, sand mine and equipment yard tours.

Chapter 1 provides an overview of the Plan including the purpose, goals, and objectives, the approach, key data sources and stakeholder engagement events. **Chapter 2** provides additional detail on why freight movement in the Permian Basin is important and summarizes the primary trends impacting current and future freight movements in the region.

CHAPTER 2 Connecting the Permian Basin Region to the State, National, and Global Economies

2.1 THE ROLE OF THE PERMIAN BASIN

Permian Basin's Importance to Energy Production

Produces more than **4 million barrels** of **oil per day**

Produces **50%** of **all natural gas** in **Texas**, **15%** in the **U.S.**

The **Permian Basin** is the **number 1 wind energy producer** in the U.S.

The Permian Basin is the most significant oil and gas producing region in the U.S., producing over 30% of the nation's oil and about 15% of the nation's natural gas[6]. The importance of the region has increased significantly since 2010. In addition to oil and gas, the region is also the nation's largest supplier of alternative energy, including wind and solar energy. The U.S. Energy Information Administration (EIA) projects that the Permian Basin will continue to dominate domestic energy production for the next several decades. The growth in energy sector activity is driving rapid economic and population growth. On average, population in the Permian Basin has expanded by more than 12% between 2010 and 2017, with some counties witnessing as much as 21% growth. The growing population has resulted in significant growth in non-energy sector related freight movements in the region.

The energy sector activity and the energy and non-energy related freight movements in the region have impacts that extend far beyond the Permian Basin. Businesses and residents in the region rely upon raw materials, supplies, and consumer goods from all over the world to keep businesses operating and residents fed and clothed. Given the growing level of activity in the region's economy, the Permian Basin is a major market for inbound supplies, often arriving in the region through major east and west coast ports via distribution hubs in Houston and Dallas. Businesses also depend on access to global markets to export the oil, gas, and other products produced in the region. As the leading exporter of domestically produced oil and gas, the Permian Basin influences national and global energy markets and depends on efficient linkages to Texas' ports and international border crossings.

The following sections explore these connections in more detail by providing an overview of oil and gas activity and non-energy sector freight movements in the Permian Basin, defining the region's Spheres of Influence (SOI), and presenting the economic impact of the freight and energy sector activity in the Permian Basin.

2.2 OVERVIEW OF PERMIAN BASIN ENERGY SECTOR ACTIVITY

The energy sector in the Permian Basin is the underlying catalyst for the majority of the growth in freight movements into, out of, within, and through the region. The rapidly growing and changing industry has far-reaching implications for every aspect of infrastructure and services, including profound implications for the region's and state's transportation network. This section provides an overview of the Permian Basin's oil and gas sector as well as the broader supply chain impacts across Texas. Additional details can be found in the Trends, Forecasts, and Needs Assessment Report.

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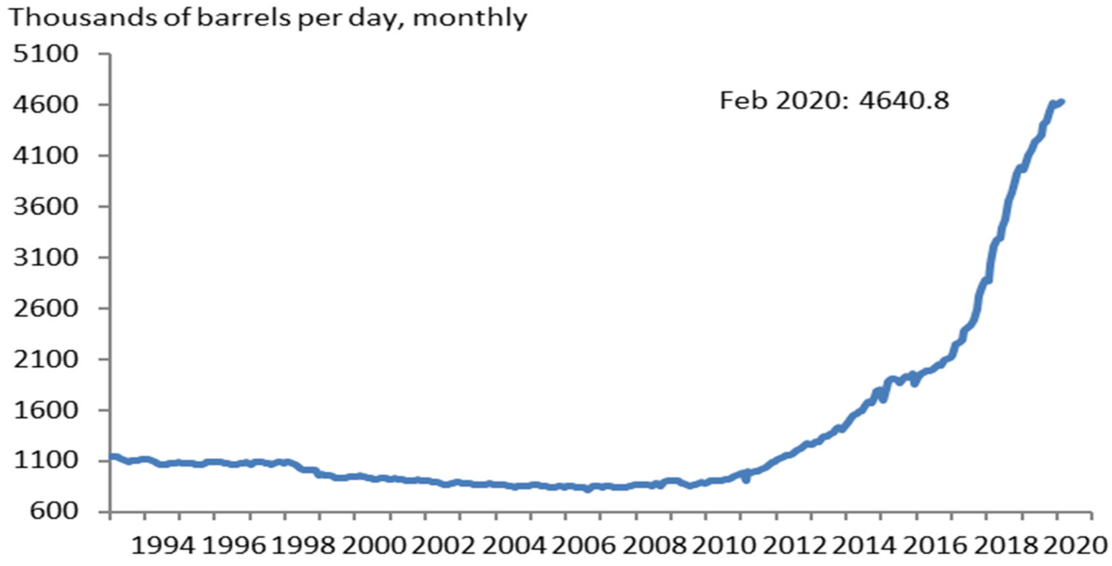
6 U.S. Energy Information Administration.

2.2.1 OIL PRODUCTION IN THE PERMIAN BASIN

After ten years of decline, oil production in the Permian Basin began climbing at the start of 2010. Since then, production increases have averaged 17.8% per year. The share of U.S. oil produced in the Permian Basin has also increased since 2010. In February 2020, the Permian Basin accounted for 36.2% of U.S. oil, up from 18.1% in 2013.[7] This trend is expected to continue over the next couple of decades.

The Texas portion of the Permian Basin produced over 3 million barrels per day in third quarter 2019.[8] In New Mexico, the Permian Basin dominates the state's oil production, accounting for more than 90% of state supply, translating into 850,000 barrels per day. In February of 2020, the Permian Basin region, as a whole, produced over 4.6 million barrels per day (see **Exhibit 4**).[9] With the recent investment in pipeline takeaway capacity, local sand mines and advanced drilling technology, the Permian Basin is poised to continue to dominate domestic energy production and be a major global oil and gas exporter for decades to come.

Exhibit 4. Total Oil Production in the Permian Basin



Source: U.S. Energy Information Administration, calculations by Dallas Federal Reserve Bank.

The EIA's energy outlook through 2050 predicts rising oil prices. By 2025, the average West Texas oil price is projected to increase to $75 per barrel (/b) (2019$).[10] After that, world demand is expected to drive oil prices to the equivalent of $214/b in 2050. It should be noted that these forecasts do not consider the effects of climate change and other policy changes that may occur in this timeframe.[11]

Active rig counts are an important measure for the drilling industry, its suppliers and freight transportation demand. When drilling rigs are active they consume products and services produced by the oil service

7 Ibid.

8 Railroad Commission of Texas

9 Federal Reserve Bank of Dallas.

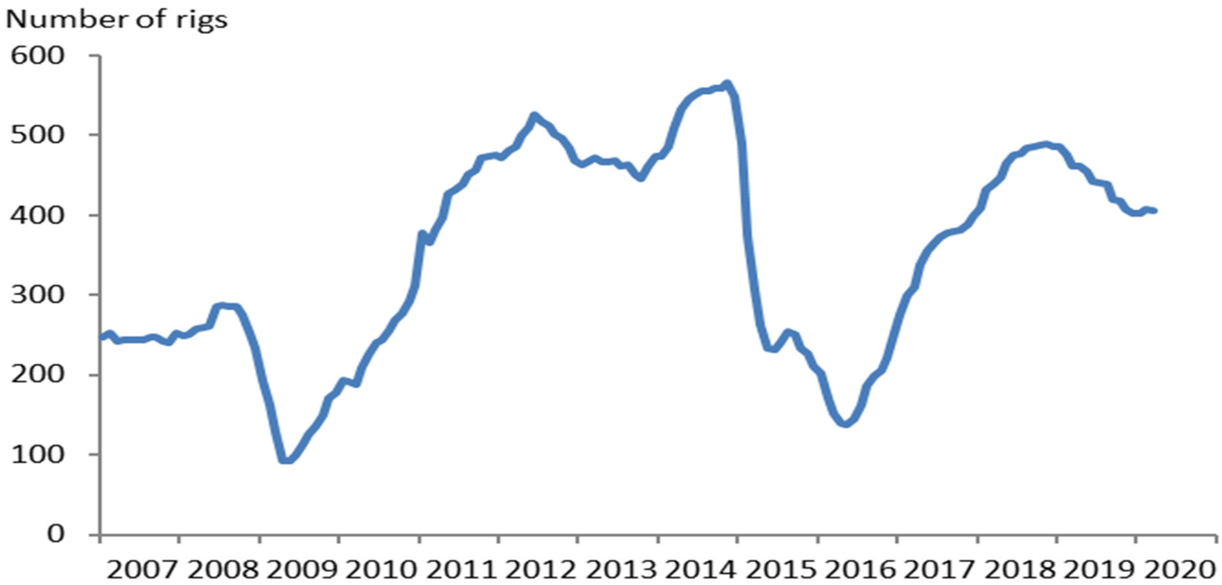
10 https://www.eia.gov/outlooks/aeo/, accessed June 14, 2020.

11 U.S. Energy Information Administration.

industry. The active rig count acts as a leading indicator of demand for products used in drilling, completing, producing and processing oil and gas. Active rig count in the Permian Basin, shown in **Exhibit 5**, increased steadily from mid-2009 to mid-2012. In May 2009, just 92 rigs operated in the Permian Basin; by June 2012, there were 525 rigs in the region. The rig count declined in the second half of 2012, leveling off in 2013 at around 465 rigs. The Permian rig count increased steadily for most of 2014, reaching 565 in October 2014 before falling oil prices began to drive the rig count down. Rig count started to rebound quickly from 2015 to 2018 before starting to decline again. As of March 2020, the number of rigs in the Permian Basin was 405, representing a 12.1% decline compared to the prior year (March 2019).[12]

This decline in rigs is driven by a business practice known as "high-grading", or shifting to higher-quality resources and technology, and operating only the most productive rigs and crews. As methods such as hydraulic fracturing and horizontal drilling improve, it is projected that rig productivity will continue to increase, meaning that fewer rigs will be required even as production levels increase. Greater rig productivity means that while total rig count will continue to grow in the long-term, it will do so at a slower rate. This translates into slower growth in demand for some of the heavy equipment transportation in the region.

Exhibit 5. Active Rig Count in the Permian Basin



Source: U.S. Energy Information Administration.

2.2.2 NATURAL GAS PRODUCTION IN THE PERMIAN BASIN

Since mid-2011, natural gas production in the region has increased by over 250%. The share of U.S. natural gas produced in the Permian Basin has also ticked up since 2011. In February 2019, the region accounted for 14.7% of U.S. production, up from 5.4% in 2011.[13] Total natural gas production in the Permian Basin is displayed in **Exhibit 6**.

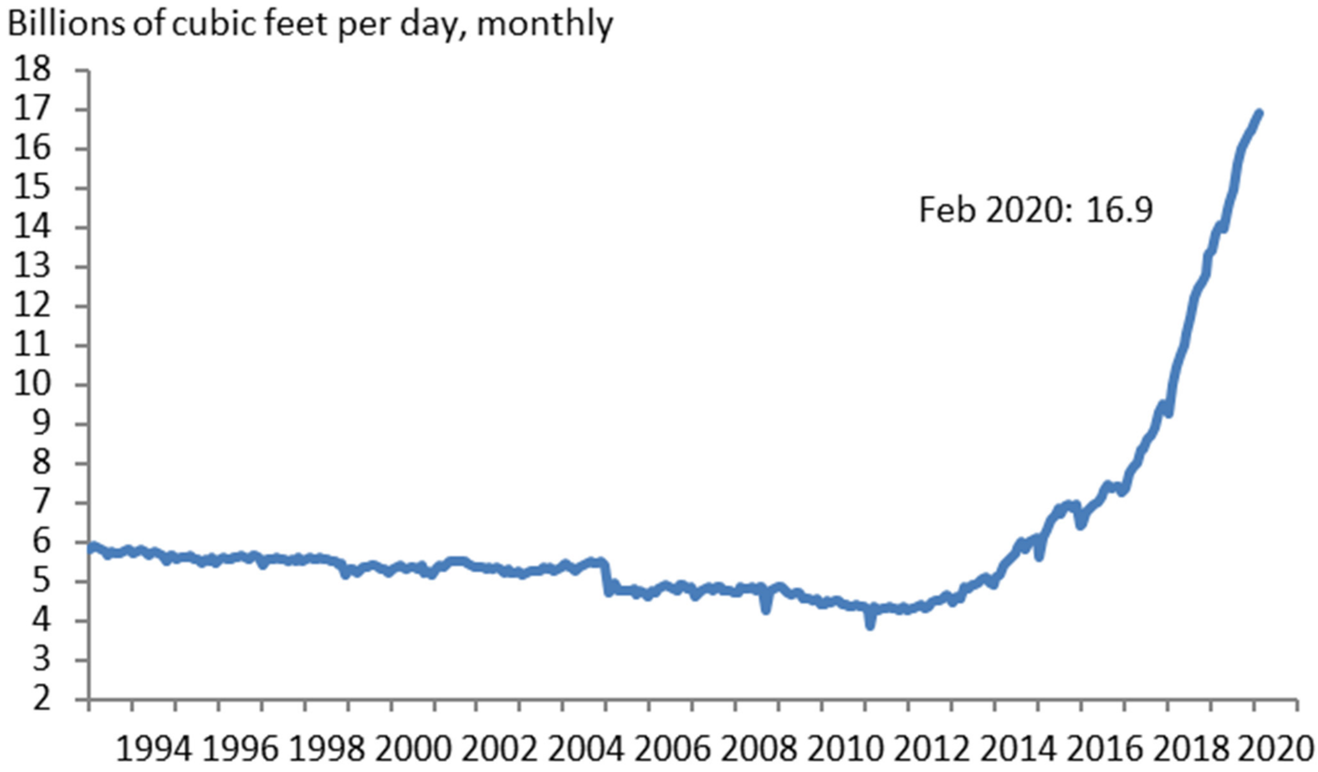
12 Ibid.

13 U.S. Energy Information Administration

The Texas portion of the Permian Basin produces the majority of the region's natural gas, and these counties have recorded strong production increases from 2012 to 2019. Production in third quarter 2019 was over 200% higher than production in first quarter 2011.[14]

Similarly, the New Mexico portion of the Permian Basin also has experienced growth in natural gas production. Production in third quarter 2019 was 226% higher than production in first quarter 2011.[15]

Exhibit 6. Natural Gas Production in the Permian Basin



Source: Railroad Commission of Texas; New Mexico Oil Conservation Division, U.S. Energy Information Administration; analysis by Dallas Federal Reserve Bank.

2.2.3 OIL AND GAS SUPPLY CHAIN AND LOGISTICS

There are four key industry components that comprise the global petroleum refining and petrochemicals supply chain that are critical to Texas and the Permian Basin:

- **Production**: Oil and gas wells and supporting systems that extract crude oil and natural gas from the land and from beneath the seas.
- **Conversion**: Refineries, gas processors, and crackers that convert crude oil into finished petroleum products such as fuels, and crude oil and natural gas into petrochemicals.

[14] Railroad Commission of Texas

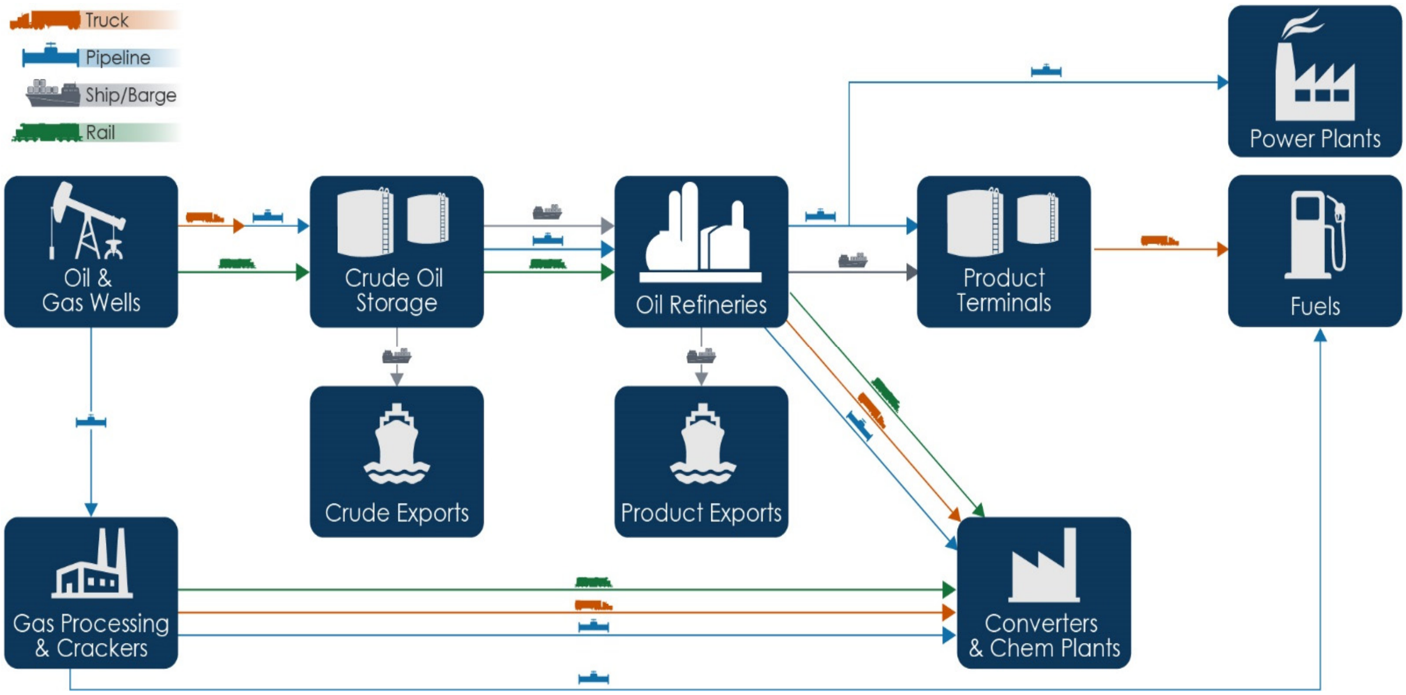
[15] New Mexico Oil Conservation Division

- **Consumption**: Intermediate and final consumers that use petroleum products as fuels for transportation and to produce other downstream products.
- **Transportation and Storage**: Transportation and storage of crude oil and petroleum products encompass most modes of transportation including pipelines, rail, trucking, and water, and storage facilities such as crude oil tank farms and bulk petroleum product terminals. Transportation of natural gas and derived products largely occurs through pipelines.

Exhibit 7 presents a schematic diagram of how these components work together in the supply chain and how goods are transported across the stages of production:

- Step 1: Oil fields on land produce crude oil that is shipped by truck to injection points on pipeline gathering networks.
- Step 2: Crude oil is received and held in short-term storage facilities, then transported chiefly by pipeline, but also by rail, to refineries primarily on the Gulf Coast.
- Step 3: Refineries manufacture a variety of products, some of which are exported by ship through the Gulf Coast ports. The largest domestic products are fuels and associated blending components. Fuels, including natural gas, bound for power plants move directly by pipeline. Fuels used in transportation are sent to product terminals by product pipelines or via coastal and inland waterways. Ethanol (not shown in the diagram) is brought in by rail, truck, and to a lesser extent, by water, and added to the fuel mix at the terminal.
- Step 4: Gasoline, diesel fuel, fuel oils, jet fuel, and manufacturing feed stocks are trucked from petroleum product terminals to establishments serving final users including motor vehicle fuel outlets such as service stations, truck stops, convenience stores, and airports. Petrochemicals move from refineries to chemical plants and plastic converters by pipeline, truck, and rail.
- Step 5: Natural gas is transported by pipeline to gas processing plants and crackers where it is broken down into constituent products. These include gas brought by pipeline to fueling stations and petrochemicals brought by pipeline, rail and truck to plastic converters and chemical plants to make plastics, synthetic rubber, and other products.

Exhibit 7. Major Oil and Gas Supply Chain Components



Source: Industry stakeholders, Cambridge Systematics and WSP.

The oil and gas activities in the Permian Basin are concentrated in the production of crude oil and gas, crude oil storage, and oil refineries. Pipelines are used to transport most crude oil from Texas oilfields to refineries in Texas or other states; and to port terminals, before being exported by ship or moved by barge to U.S. domestic destinations.

The major regional freight movements related to the energy sector are generated from the drilling, fracing, and on-going production of crude oil and gas in the Midland and Delaware Basins. Insights into the freight transportation requirements of the Permian Basin's oil and gas activities were obtained through stakeholder interviews, industry reports, research completed by the Texas Transportation Institute (TTI), and Enverus.

Exhibit 8 presents a general logistics flowchart for shale development with the Permian Basin activities concentrated on the inputs to well development and direct outputs. This is represented by the first box in **Exhibit 8**. Direct outputs, including crude, gas, and natural gas liquids (NGLs), must then be transported to storage, refineries and ports and international border crossings for export. Freight movement in the Permian Basin begins well before production commences. It begins with exploration and assembly and drilling of the wellhead. All these stages require the movement of

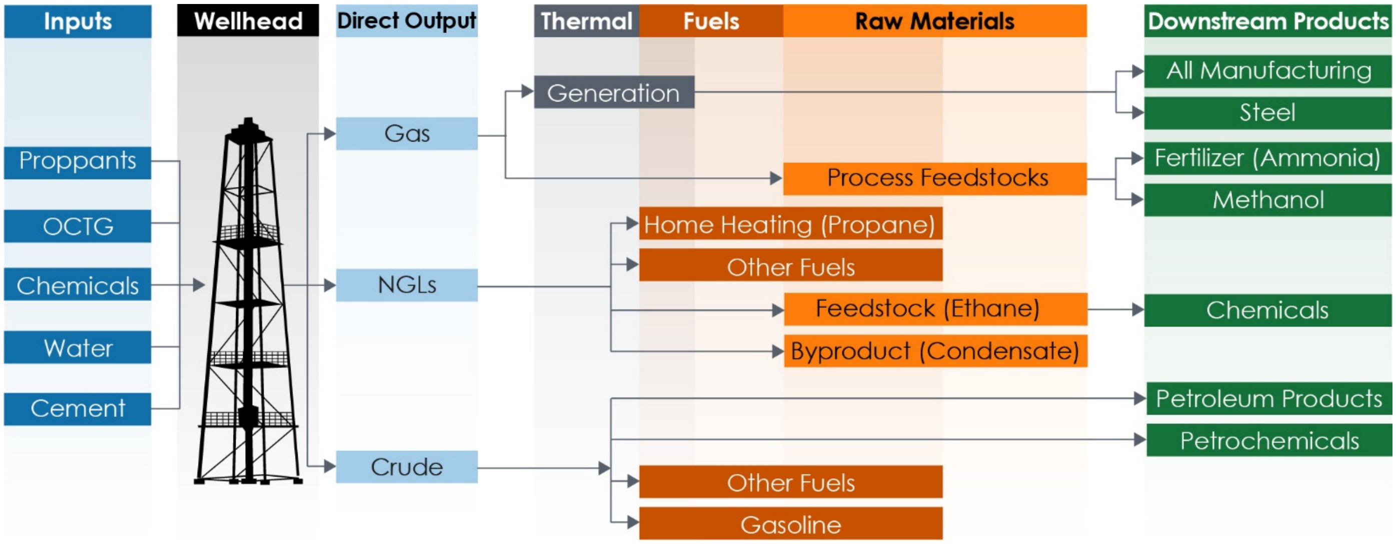
Critical Permian Basin Oil and Gas Drilling Input Commodities

Oil Country Tubular Goods **(**OCTG**)** refers to the piping products that are applied in oil and gas production (drilling activities). It is a collective name used to refer to Drill pipe, Steel Casing Pipe and Tubing pipe, Couplings, Connections, and Accessories.

Proppants are solid material, typically sand, treated sand or man-made ceramic materials, designed to keep an induced hydraulic fracture open, during or following a fracturing treatment.

heavy equipment from the staging yards to the oilfields. The refining of the output produced in the Permian Basin and the development of downstream products requires connections from the production in the Permian Basin to the domestic and international markets for these commodities, as illustrated above in **Exhibit 7**.

Exhibit 8. Overview of Shale Development and Logistics Patterns



Source: Adapted from PLG Consulting.

2.2.4 ALTERNATIVE ENERGY PRODUCTION IN THE PERMIAN BASIN

While rich in fossil fuel energy resources, the region also has abundant solar and wind energy capacity. Texas ranks first among states in solar energy potential and seventh in installed solar capacity.[16] In addition, in 2019 Texas was the fifth highest producer of utility-scale (i.e., produced by a power plant) solar electricity at 4.321 billion kilowatt-hours (kWh).[17] For wind energy, Texas ranks first in the country for both installed and under construction wind capacity, while supporting over 25,000 wind energy related jobs.[18] Texas generates more utility-scale wind electricity than any other state and the Permian Basin produces more than any other region in the state. In 2019, Texas produced 84.429 billion kWh of utility-scale wind electricity – nearly 3 times more than the second highest state.[19] **Exhibit 9** and **Exhibit 10** depict Texas' solar and wind energy generation compared to the rest of the country.

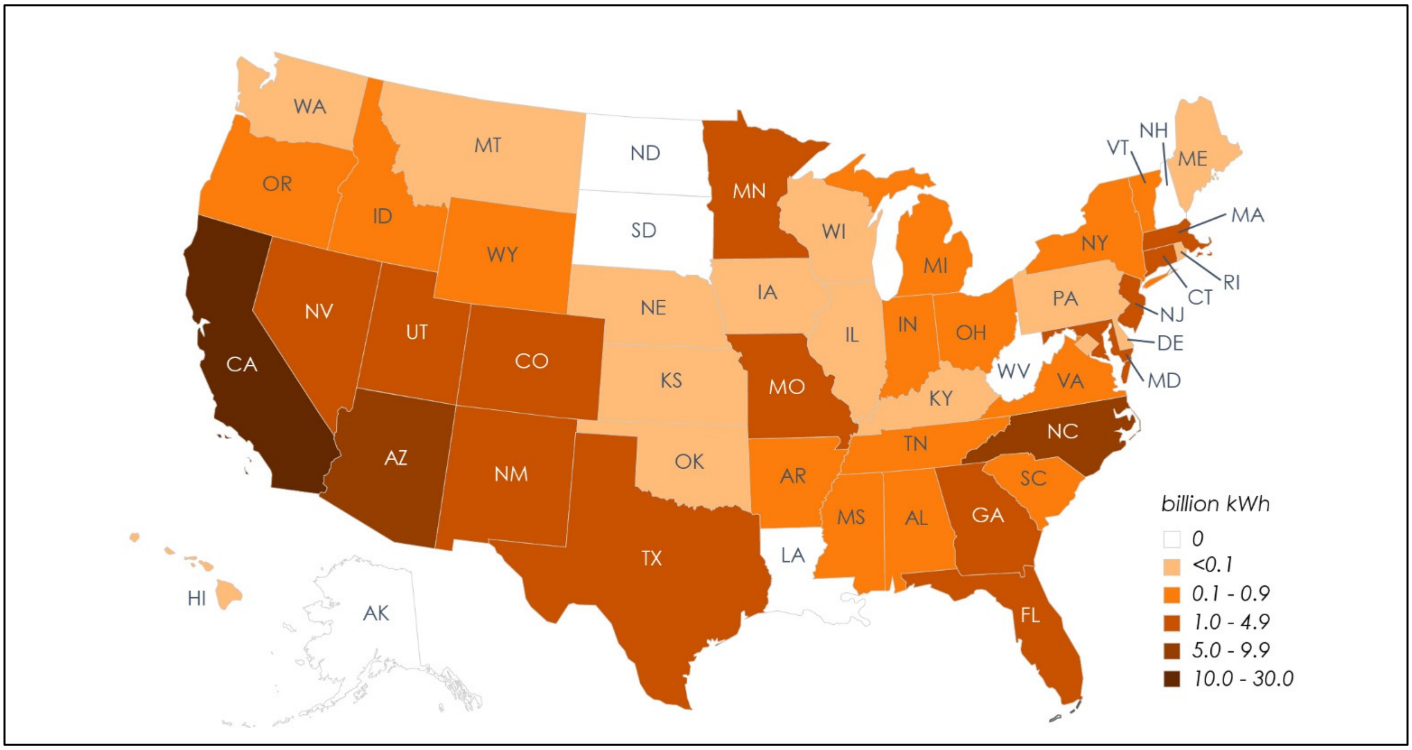
16 Federal Reserve Bank of Dallas, Texas Economic Outlook, 2019.

17 U.S. Energy Information Administration, Electric Power Monthly, February 2020.

18 American Wind Energy Association, Wind Energy in Texas State Fact Sheet, 2019.

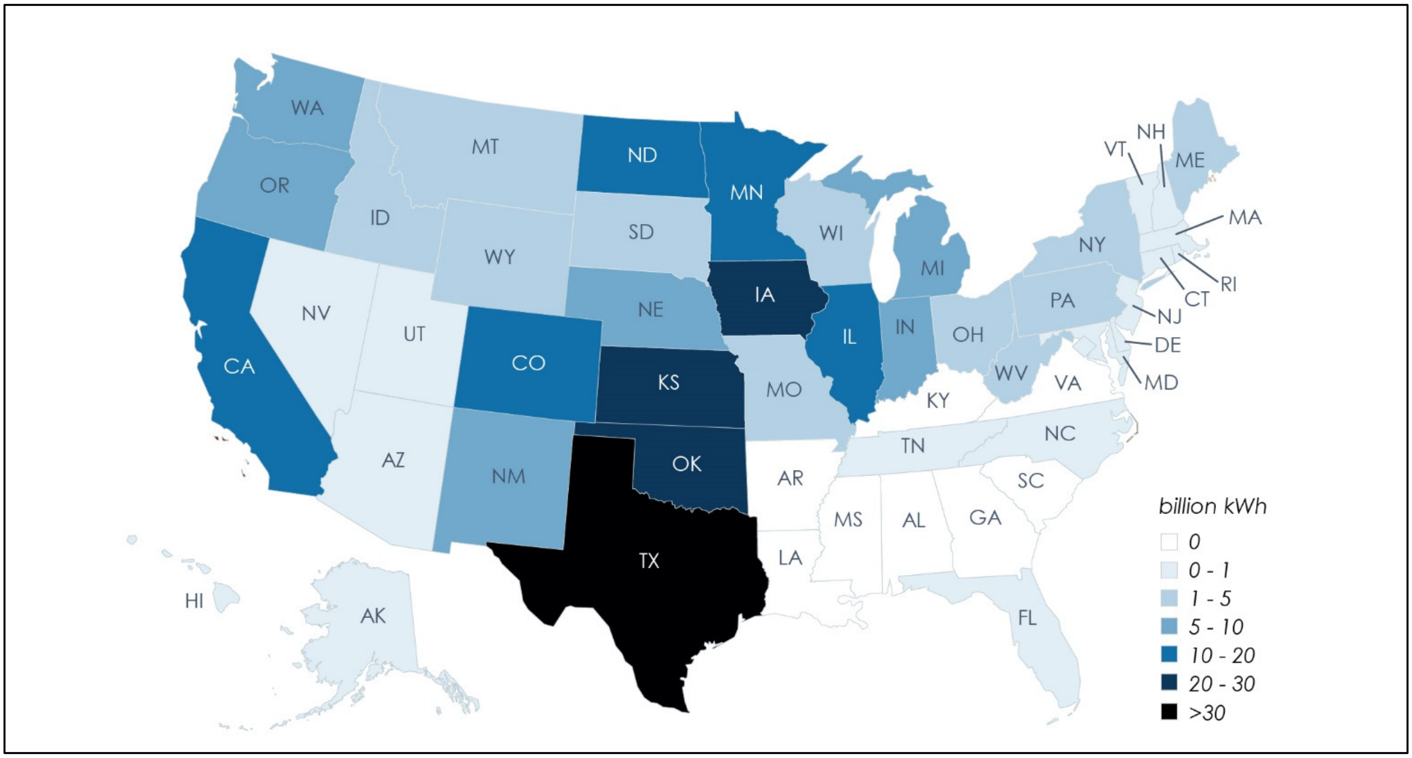
19 U.S. Energy Information Administration, Electric Power Monthly, Table 1.14B, February 2020.

Exhibit 9. Utility-Scale Solar Electricity Generation by State, 2019



Source: U.S. Energy Information Administration, Electric Power Monthly, February 2020.

Exhibit 10. Utility-Scale Wind Electricity Generation by State, 2019



Source: U.S. Energy Information Administration, Electric Power Monthly, February 2020.

Like the fossil fuel sector, growth in both solar and wind energy production are expected to continue in the coming years. In its Annual Energy Outlook 2020 report, the EIA predicted that electricity generation from solar and wind energy would continue to grow through 2050 due to declining capital costs, making those sources more competitive with nuclear and coal. In its reference forecast scenario, the EIA estimated that the U.S. would add 481 gigawatts of new wind and solar capacity between 2020 and 2050.[20] Within Texas, stakeholders indicated that much of the anticipated growth in solar and wind energy is expected in the Permian Basin.

A major factor driving the alternative energy growth in Texas is the fossil fuel energy sector's demand for electricity. Drilling, pumping, and transporting oil and gas production in the Permian Basin requires electric power. Major oil and gas producers are pursuing alternative energy in the Permian Basin to meet this demand.

Oil and gas production in the Permian Basin, along with the economic growth it has sparked, is increasing the demand for electricity. [21] Existing power plants are struggling to keep up, and alternative energy farms are being built in the region to meet the demand for electricity. In 2019, there were 53 wind farms in the region with 3,940 turbines installed.[22] Sites where renewable and non-renewable energy production are side-by-side are not uncommon today in the region, and may provide land owners an additional source of revenue.

Co-Located Wind and Petroleum Energy Assets

The basic phases of freight movement of a typical wind or solar construction project include mobilizing equipment to the job site (pickups, trailers, mobile field offices, tools, etc.), mobilizing the specific wind (turbines, etc.) or solar (panels, etc.) equipment to the wind/solar farm, building access roads to the installation sites on the wind/solar farm, building the foundations (excavate, build/pour pad, backfill), erecting the equipment, reclaiming and re-seeding disturbed construction areas, and finally packing and moving installation equipment out.

Typically, turbine construction requires 300 to 500 yards of concrete, 10 to 20 truckloads of rebar, and 12 to15 truckloads of equipment (tower, blades, gearbox). In addition, heavy equipment is required for the wind/solar farm road building, site preparation and repair, and construction. For example, 600-ton crawler cranes are used to erect wind turbines. The crane itself requires 30 to 40 truckloads to deliver, and the same to remove it from the site when finished. Many of the shipments are oversize and/or overweight so specific

20 U.S. Energy Information Administration, Annual Energy Outlook 2020.

21 Bloomberg.com, Solar is-Going to Keep Oil Flowing in the Texas Shale Patch, April 4, 2019.

22 Hoen, B.D., Diffendorfer, J.E., Rand, J.T., Kramer, L.A., Garrity, C.P., and Hunt, H.E., 2018, United States Wind Turbine Database (ver. 3.1, July 2020): U.S. Geological Survey, American Wind Energy Association, and Lawrence Berkeley National Laboratory data release

Example OS/OW Loads associated with Wind Energy in the Permian Basin

routing is critical. Haulers must account for bridge vertical and horizontal clearances, lane, and shoulder widths, turning radii, and pavement and bridge strength. In addition, OS/OW loads require escorts and planning around construction work zones.

Commodity movements that support alternative energy production include but are not limited to rubber and plastics, fabricated metal products, machinery, electrical equipment, and instruments, photography, and optical equipment. Specific products in these categories that are representative of the alternative energy industry sector include turbines and electrical transformers.

In addition to California, Mexico is a major supplier of the types of goods that support this industry sector and border states such as Nuevo Leon, Chihuahua, and Coahuila de Zaragoza are prominent.

2.3 OVERVIEW OF NON-ENERGY SECTOR FREIGHT INTENSIVE INDUSTRIES

Rapid growth in oil and gas production in the Permian Basin has resulted in a sharp and sustained increase in population as workers relocate to the region for jobs in the energy sector. The demand for goods and services associated with this growing industry, increasing population base, and other related and unrelated industries is significantly increasing the demand for transportation system capacity for freight, service, and personal travel. Though the energy sector is fundamental to the region's economy and is the primary driver of freight activity, it is important to also account for non-energy sector industries that generate notable volumes of freight and will continue to grow as the region's economy and population grow. These include transportation, warehousing, and distribution; food, beverage, and retail; healthcare and medical services; construction; and agriculture.

2.3.1 TRANSPORTATION, WAREHOUSING, AND DISTRIBUTION IN THE PERMIAN BASIN

Distribution and materials handling are integrated into most supply chains and industry sectors in the region. Goods demanded by households and businesses in the region are produced by domestic and international sources and enter the region via established supply chains that maneuver the state's

Non-Energy Related Freight Stakeholders

The information included in this analysis was obtained through one-on-one interviews with regional industry representatives from the following companies and agencies:

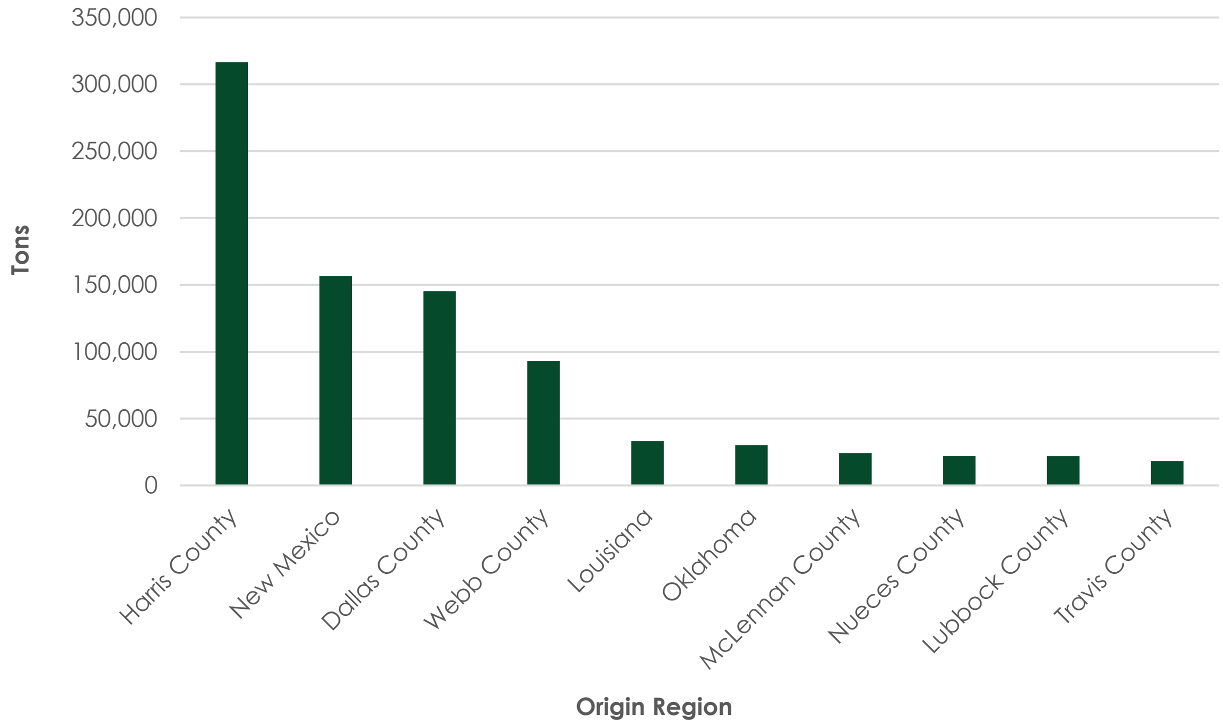
- Ben E. Keith Company
- Warren CAT
- Midland Health
- Family Dollar
- Shamrock Steel Sales
- J.B. Hunt Dedicated Contract Services
- Midland International Air and Space Port
- Parkway Transport
- Truck Stop Operator
- Midland County Emergency Management

sea, air, or land ports of entry and domestic and international warehouse and distribution center networks. Products may be delivered to retailers and consumers from distribution centers outside the region, or they may pass through an additional local distribution center before final delivery. Final deliveries are predominantly made by truck to retail outlets or, increasingly, to the consumer's front door.

As the Permian Basin region does not contain any intermodal rail terminals and has minimal air cargo activity, nearly all of its warehousing and distribution-related traffic is to and from warehouses and distribution centers. The region's warehousing and distribution center assets are primarily located in Midland and Ector Counties. Thus, these counties represent the primary destinations of inbound warehouse/distribution center-related truck traffic.

Exhibit 11 depicts the top ten origins for inbound shipments to the Permian Basin of warehousing/distribution center-related commodities by tons. The results indicate that warehouses and distribution centers in Texas' major metropolitan areas – namely Dallas County (home to Dallas), Harris County (home to Houston), and Travis County (home to Austin) – as well as New Mexico (exclusive of Eddy and Lea Counties) are important for delivering goods to the Permian Basin. The results also show that Texas' international gateways are major suppliers to the Permian Basin. Webb County, which contains the international border crossing at Laredo, and Nueces County, which contains the Port of Corpus Christi, account for significant volumes of warehousing and distribution-related commodities that are shipped into the Permian Basin.

Exhibit 11. Permian Basin Inbound Tons of Transportation, Warehousing, and Distribution Sector Commodities, 2018



Source: TRANSEARCH; WSP and Cambridge Systematics analysis.

Note: All counties in Texas unless otherwise noted.

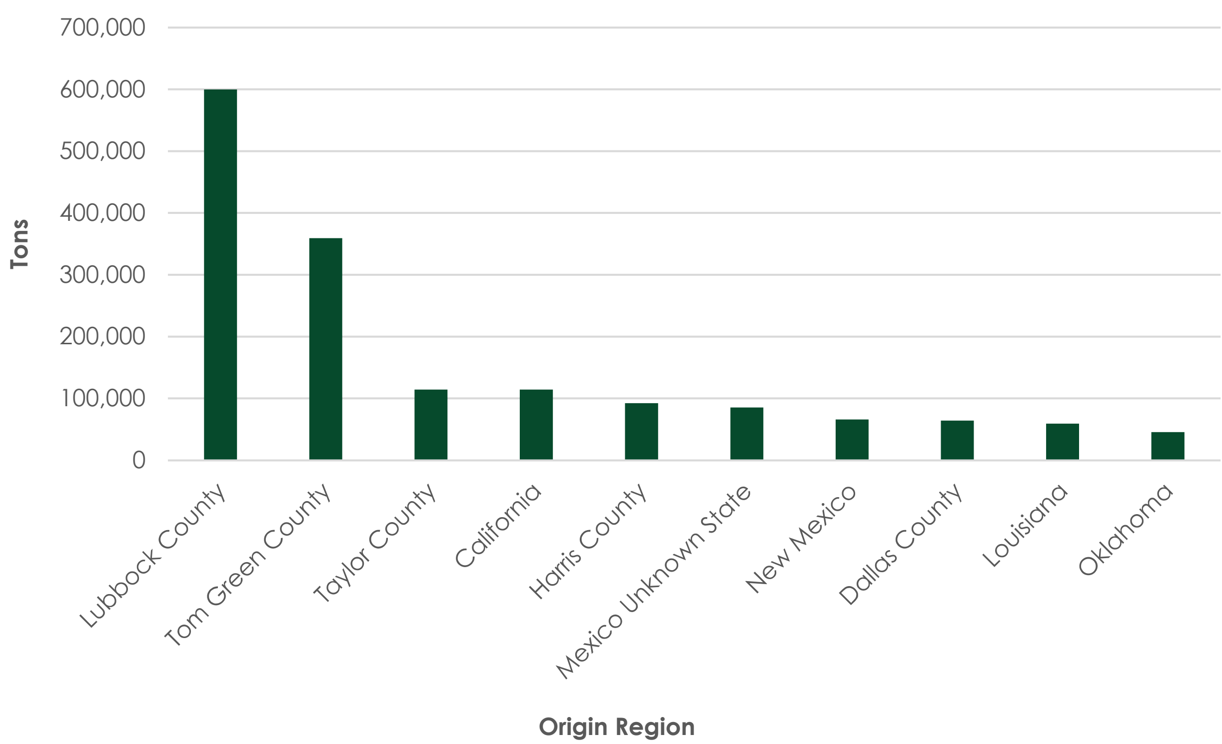
2.3.2 CONSUMER GOODS IN THE PERMIAN BASIN

Consumer goods are products bought for consumption by the average consumer. Alternatively called final goods, consumer goods are the end result of production and manufacturing, and are what a consumer will see stocked on the store shelf. Clothing, food, and appliances are all examples of consumer goods. These commodities represent the goods necessary to meet the everyday consumer demands of the region. The Permian Basin region is unique in this regard due to its transient workforce and the demand for these goods generated by the presence of workers in staff camps, extended stay hotels, and short-term rental units.

Food and beverage distribution are critical components of regional logistics patterns. Providers supply the staff camps and lodging facilities where workers are housed along with the hotels and restaurants accommodating the many travelers to the region. They also supply the needs of the population through restaurants, grocery, and convenience stores, and public entities such as schools and hospitals.

Exhibit 12 depicts the top ten origins for inbound shipments to the Permian Basin of commodities associated with consumer goods by tons. The commodity flow data indicates that the demand for consumer goods, in terms of total tonnage, is served out of the Lubbock and San Angelo regions, with Lubbock and Tom Green Counties being the top two origins for inbound shipments to the Permian Basin region. These two counties are estimated to have shipped over 950,000 tons of food, beverage, and retail sector related commodities into the Permian Basin region in 2018. Houston in Harris County and Dallas in Dallas County are also important in-state origins for consumer products. Outside of Texas, California, Mexico, New Mexico, and Louisiana are top origins for Permian Basin-bound consumer goods.

Exhibit 12. Permian Basin Inbound Tons of Consumer Goods, 2018



Source: TRANSEARCH; WSP and Cambridge Systematics analysis.

Note All counties are in Texas unless otherwise noted.

2.3.3 HEALTHCARE SERVICE COMMODITIES IN THE PERMIAN BASIN

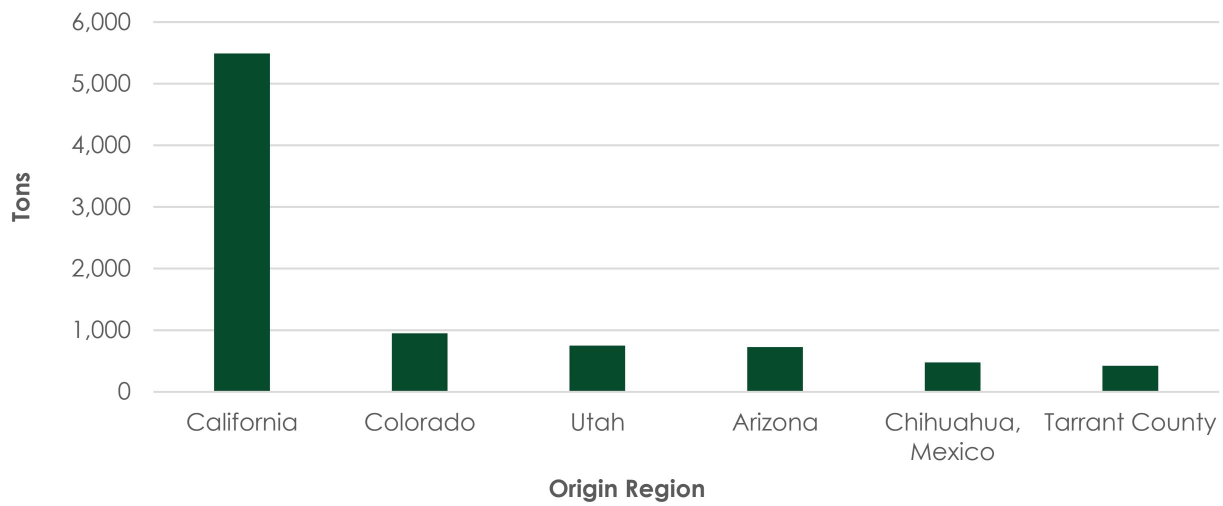
Healthcare services are available broadly throughout the region but are clustered within the primary cities and towns where the medical facilities are located. The largest clusters of healthcare service providers are in Midland and Ector Counties. This includes the three major hospitals in Midland and Odessa – Midland Memorial Hospital, Odessa Regional Medical Center, and Medical Center Hospital. The bulk of the distribution activities relative to healthcare services are associated with these hospitals.

Midland Memorial Hospital's medical and surgical supplies are managed by a third-party medical logistics provider, Cardinal Logistics. Cardinal Logistics serves Midland Memorial from a facility in Grand Prairie, which is located within the Dallas-Fort Worth metropolitan area. In partnership with the Odessa Regional Medical Center and the Abilene Regional Medical Center, Midland Memorial Hospital owns Texas Health Care Linen. The linen service covers the three owner facilities as well as others in west Texas. Food service is provided by regional distributors for food products and beverages.

Commodity movements that support healthcare-related businesses are identified using the following commodity groups: chemicals or allied products; instruments, photo equipment, optical equipment; and electrical equipment. Specific products in these categories that are representative of the healthcare industry include drugs, X-ray equipment, surgical equipment, and dental supplies.

As shown in **Exhibit 13**, commodities associated with the healthcare industry are primarily shipped into the Permian Basin region from California. California alone accounts for nearly two-thirds of healthcare associated commodities inbound to the region. Other states that feature prominently include Colorado, Utah, and Arizona. Tarrant County (Fort Worth, TX) is also shown as generating substantial volumes of healthcare-related commodities for the Permian Basin region. While the shipments do not weigh much, they are often transported in small batches requiring hundreds of truck and van deliveries weekly. As indicated by stakeholder feedback, the region's hospitals have major suppliers in the Dallas-Fort Worth region.

Exhibit 13. Permian Basin Inbound Tons of Healthcare Service Commodities, 2018



Source: TRANSEARCH; WSP and Cambridge Systematics analysis.

Note: All counties in Texas unless other noted.

2.3.4 CONSTRUCTION COMMODITIES IN THE PERMIAN BASIN

Construction activities in the Permian Basin region have surged as both population and industry have grown. The demand for industrial and commercial buildings as well as residential housing is high. Between 2010 and 2017, population in the Permian Basin region increased by 12.1%,[23] leading to an increased demand for housing, retail, and commercial establishments. Much of the region-wide population growth has been centered in Andrews, Ector, Gaines, Martin, Midland, and Reeves Counties. Individually, these counties experienced population growth ranging from 11.4% to 21.6% over the 2010-2017 timeframe. There has also been increased demand for industrial construction as more oilfield service providers move into and expand throughout the region. Thus, the movement of construction materials and equipment into and across the region to meet this demand contributes to its transportation challenges. Much like freight activity associated with the development of a new site for oil and gas production, freight activity spurred by the construction industry periodically shifts from site to site across the region, as residential and commercial projects are completed and new ones begin.

Commodities represented in the inbound supply chain for the construction sector include gravel, sand, stone, and other non-metallic minerals including construction sand and gravel; lumber and wood products; furniture; asphalt and other petroleum products; cement and other clay, concrete, glass, or stone products; and lighting and other electrical equipment. Pipes are included in the energy sector commodities discussion given the intensive use of this commodity for drilling as opposed to residential and other commercial and industrial construction.

Exhibit 14 shows the regions in which construction materials for the Permian Basin are sourced as indicated by the TRANSEARCH commodity flow data. New Mexico (exclusive of Eddy and Lea Counties), McCulloch County (TX), and Callahan County (TX) are among the biggest suppliers to the region. Multiple construction sand and gravel mines are in the southeastern portion of McCulloch County (TX) near the unincorporated Voca community. One sand mine operator in McCulloch County (TX), PFS Aggregates, specifically lists the construction and industrial sectors as two industry sectors served by the sand and gravel extracted from their mine.[24] Vulcan Materials, a major supplier of aggregates to the construction sector, has a quarry located in Callahan County (TX), north of Baird on U.S. 283.

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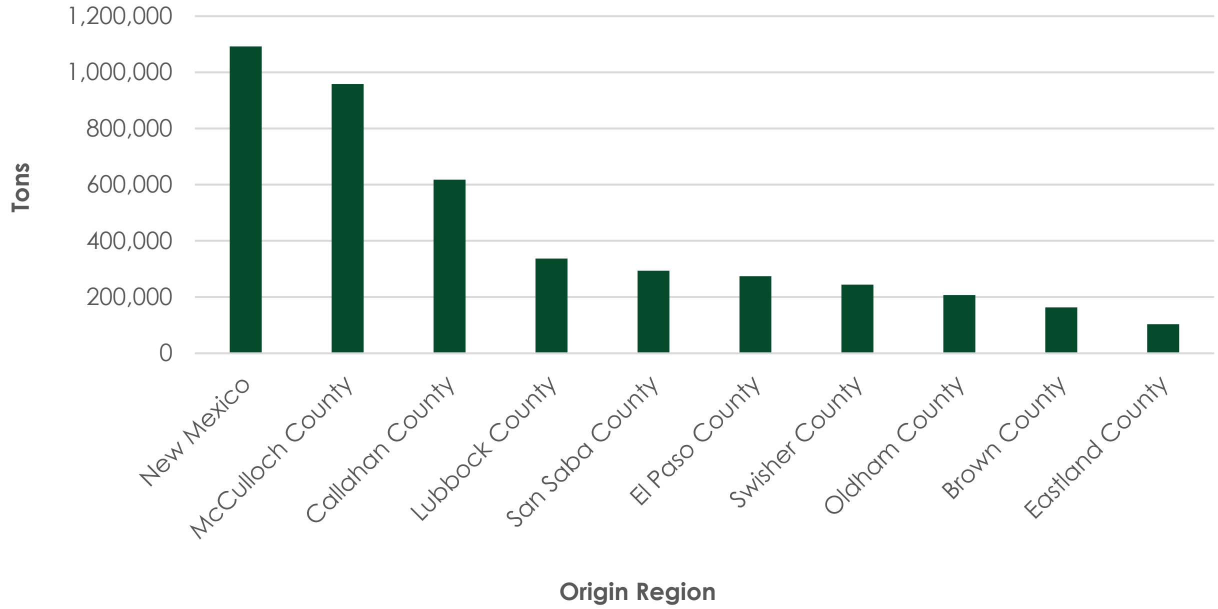
23 Texas Demographic Center, 2019; The University of New Mexico, 2019. Geospatial and Population Studies. https://gps.unm.edu/pru/estimates

24 https://pfsaggregates.com/services/building-and-industrial-sands/, Accessed March 29, 2020.

Exhibit 14. Permian Basin Inbound Tons of Construction Sector Commodities, 2018



Source: TRANSEARCH; WSP and Cambridge Systematics analysis.

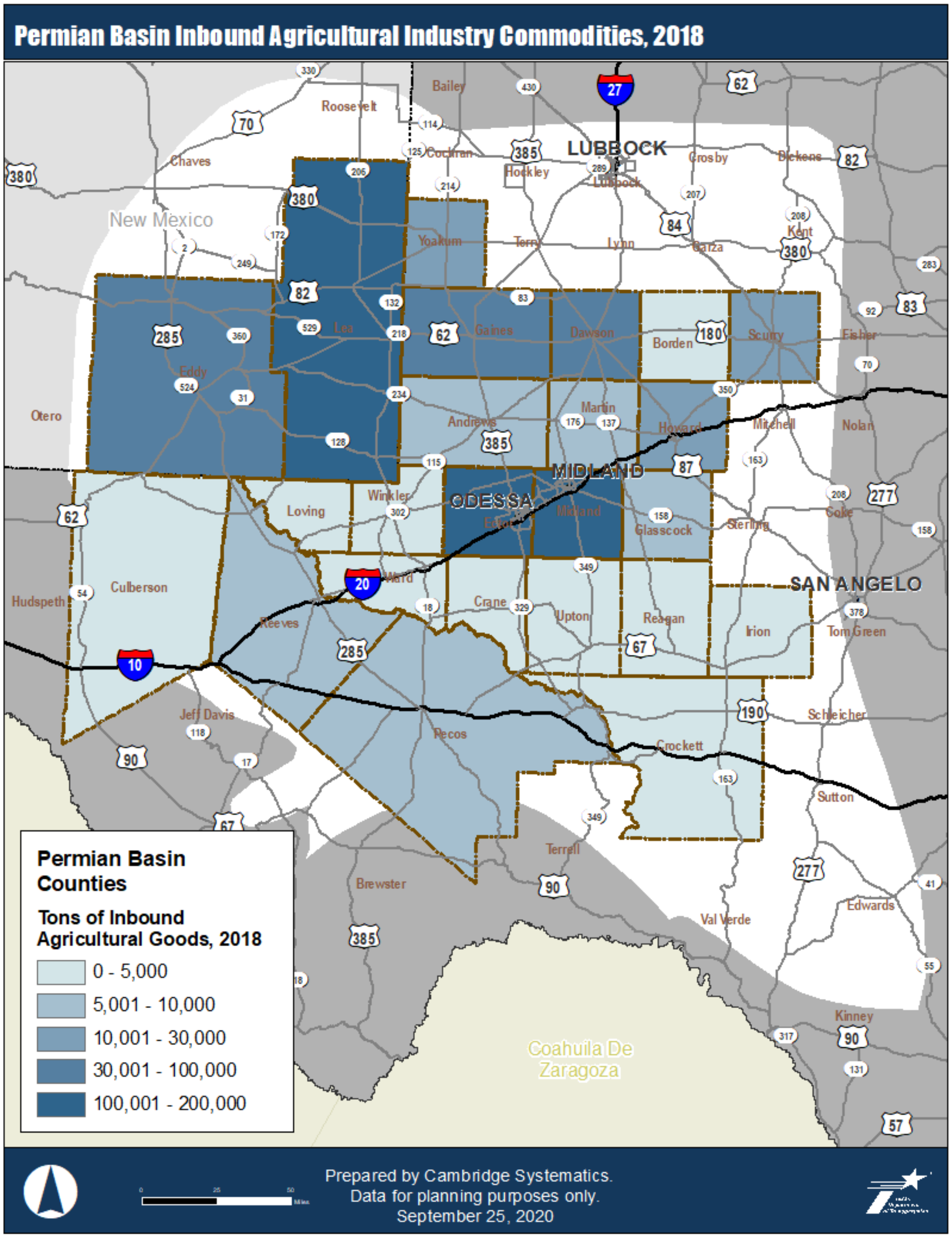
Note: All counties are in Texas unless otherwise noted.

2.3.5 Agricultural Commodities in the Permian Basin

Farm commodity group flows are predominantly outbound with 4.3 million tons in 2018 compared to 0.8 million tons inbound and 0.3 million tons transported within the Permian Basin. The principal agricultural industry commodities include farm products, chemicals, non-metallic minerals and machinery. Farm products include dairy farm products, cotton, miscellaneous field crops, oil kernels, nuts or seeds, and grain. Chemicals or allied products are comprised almost entirely of fertilizers, non-metallic minerals include crude fertilizer minerals and machinery includes tractors and other farm equipment.

Top destinations for inbound agricultural products into the Permian Basin, shown in **Exhibit 15**, include Midland (TX), Lea (NM), Ector (TX) and Eddy (NM) Counties.

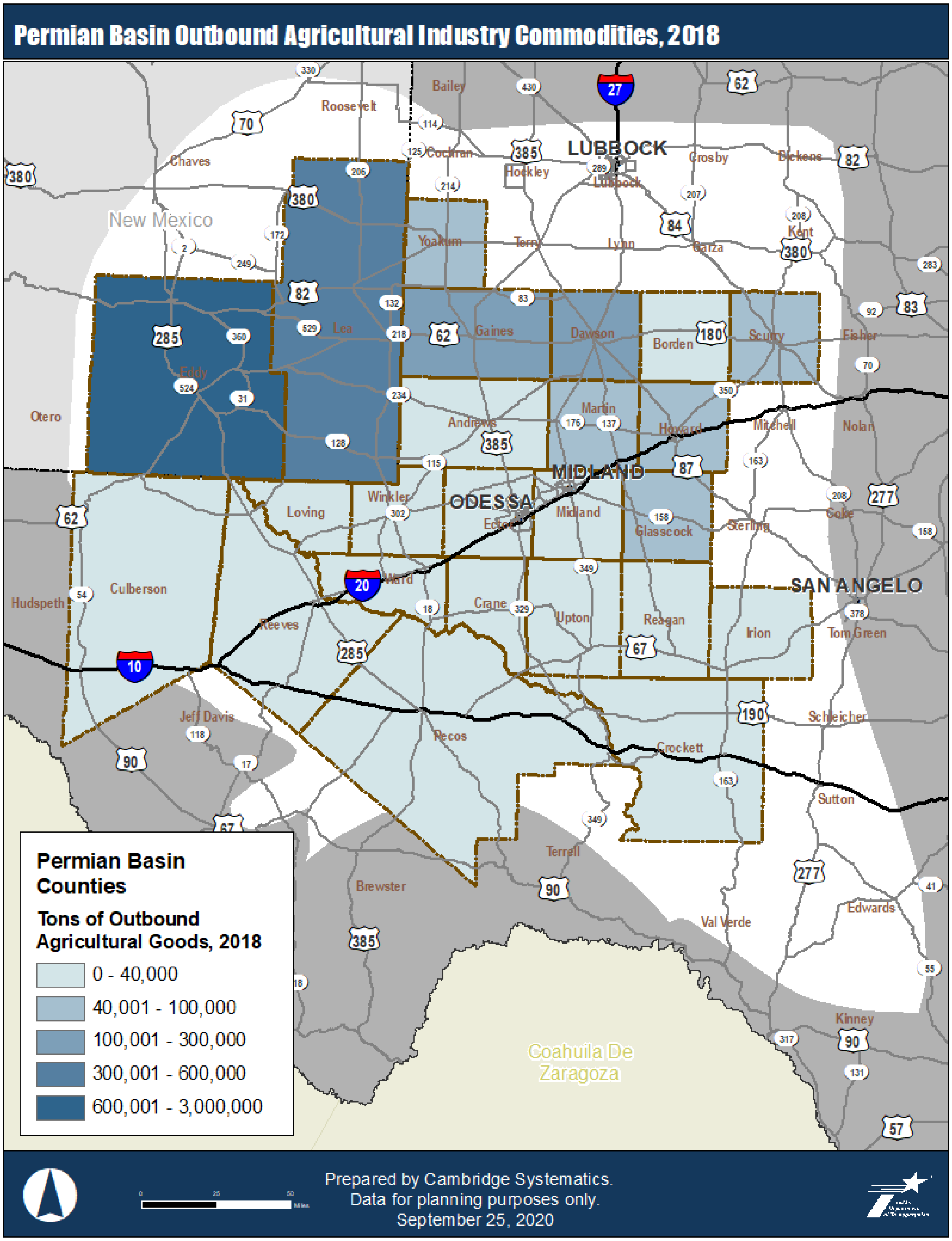
Exhibit 15. Permian Basin Inbound Agricultural Industry Commodities, 2018



Source: TRANSEARCH; WSP and Cambridge Systematics analysis.

Top origin counties for outbound agricultural commodities from the Permian Basin are displayed in **Exhibit 16**. Eddy and Lea Counties (NM) are the predominant origin of outbound agricultural commodity flows from the Permian Basin with the northern Texas Permian Basin counties rounding out the top ten originating counties.

Exhibit 16. Origin Counties of Permian Basin Outbound Agricultural Commodities, 2018



Source: TRANSEARCH; WSP and Cambridge Systematics analysis.

As shown in **Exhibit 17**, Jefferson County, TX, California, and New Mexico together accounted for one-third of total outbound tons of Permian Basin agricultural commodities in 2018, with Jefferson County (TX) and California volumes projected to grow more rapidly than other top destinations.

Exhibit 17. Top Desinations for Permian Basin Outbound Agricultural Commodities, 2018 & 2050

Destination	Tons 2018	Tons 2050	Tons Growth	Trucks 2018	Trucks 2050	Trucks Growth	Value 2018 (millions)	Value 2050 (millions)	Value Growth
Total	**4,289,719**	**4,663,176**	**9%**	**219,848**	**230,435**	**5%**	**1,312**	**1,778**	**36%**
Jefferson County, TX	534,775	1,178,825	120%	22,038	48,611	121%	41	91	123%
California	480,328	807,004	68%	25,300	44,543	76%	218	463	113%
New Mexico	424,761	409,354	-4%	21,640	18,032	-17%	101	81	-20%
Georgia	162,065	162,530	0%	8,986	11,310	26%	87	170	96%
Dallas County, TX	160,696	92,260	-43%	9,042	4,976	-45%	39	34	-13%
El Paso County, TX	139,848	124,431	-11%	6,759	6,006	-11%	21	22	4%
Colorado	114,261	77,945	-32%	6,019	3,357	-44%	32	35	12%
Harris County, TX	103,365	111,236	8%	6,328	6,624	5%	65	87	33%
Bexar County, TX	85,836	104,863	22%	4,956	6,075	23%	32	48	49%
Tarrant Cunty, TX	84,324	83,116	-1%	4,787	4,980	4%	29	37	29%
Other	1,999,457	1,511,612	-24%	103,994	75,923	-27%	648	712	10%

Source: TRANSEARCH; Cambridge Systematics and WSP analysis

2.4 PERMIAN BASIN SPHERES OF INFLUENCE

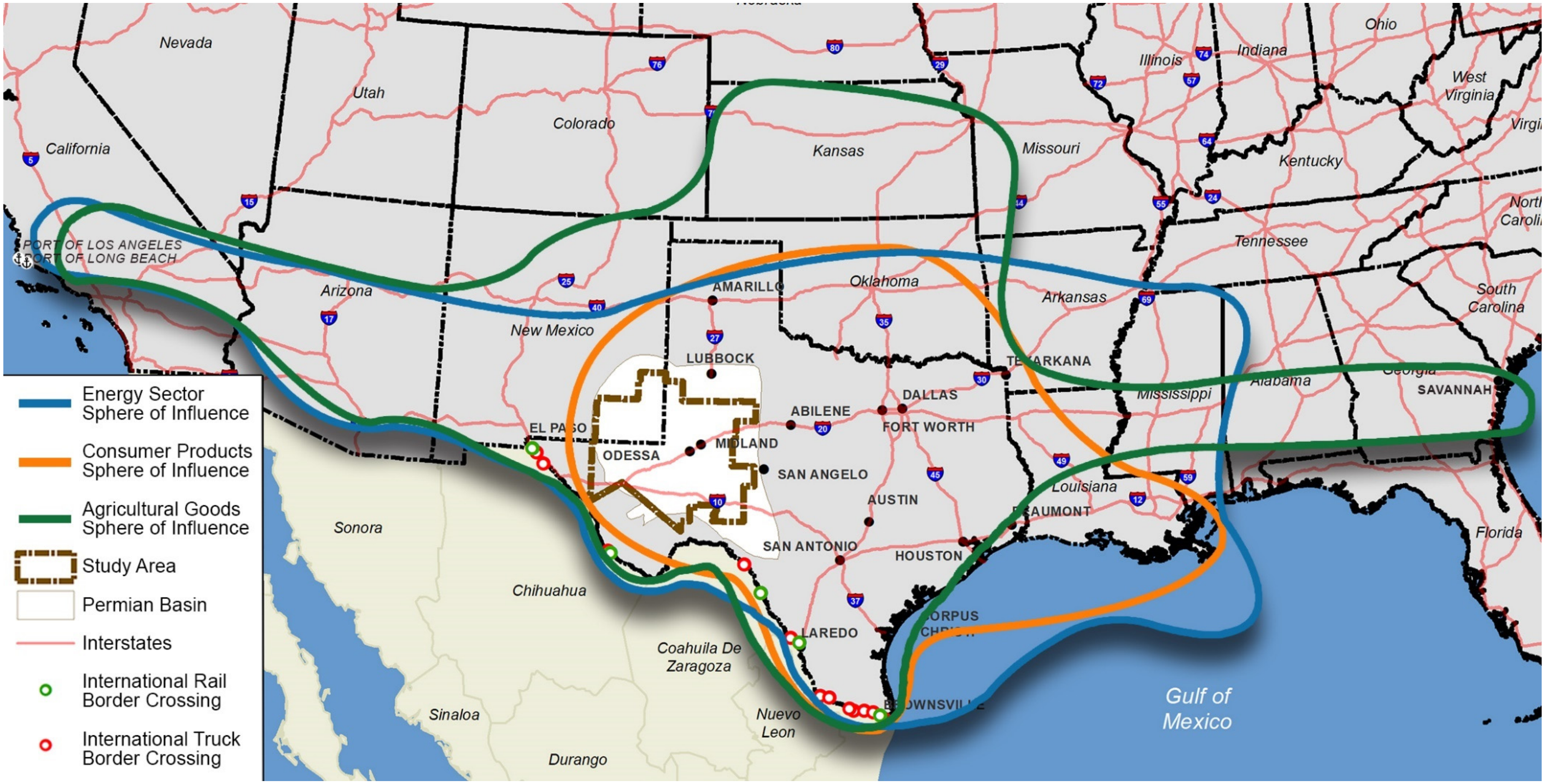
The Permian Basin Spheres of Influence (SOI) are defined as regions, states, and countries whose development both affect and are affected by unique and notable freight activity in the Permian Basin. Defining the SOIs is important in assessing the role of transportation in connecting and providing access to trading partners, markets, economies, and resources critical to the Permian Basin's economy. The SOIs are defined by examining commodity flows into and out of the region for three key industry supply chains, as identified by the stakeholders, based on the most significant commodity flows discussed in **Sections 2.2 and 2.3** above, and on economic, supply chain, and transportation connections for the region's key freight intensive industries. The SOIs are defined for the energy sector, consumer trade, and agricultural goods, as these are the industries most dependent on economic and transportation connections to the rest of the state, nation, and world. The process used to define the SOIs, displayed in **Exhibit 18**, includes examining commodity flows to determine key trading partners and identifying the transportation network facilities and gateways critical to connecting the region to those key partners. Other, non-energy sector industries discussed in **Section 2.3,** including construction, warehousing and distribution, and healthcare services are important in terms of intraregional movement of goods but have a relatively nominal impact on national and global supply chains, and were not identified by stakeholders for inclusion in the SOI designations.

Exhibit 18. Process for Defining Permian Basin Spheres of Influence

Source: Cambridge Systematics.

The resulting SOIs are depicted in **Exhibit 19**. As shown, there is significant overlap between the three, although the agricultural and energy sector SOIs are more far-reaching than the consumer goods SOI. All of the SOIs are discussed in more detail below.

Exhibit 19. Permian Basin Spheres of Influence



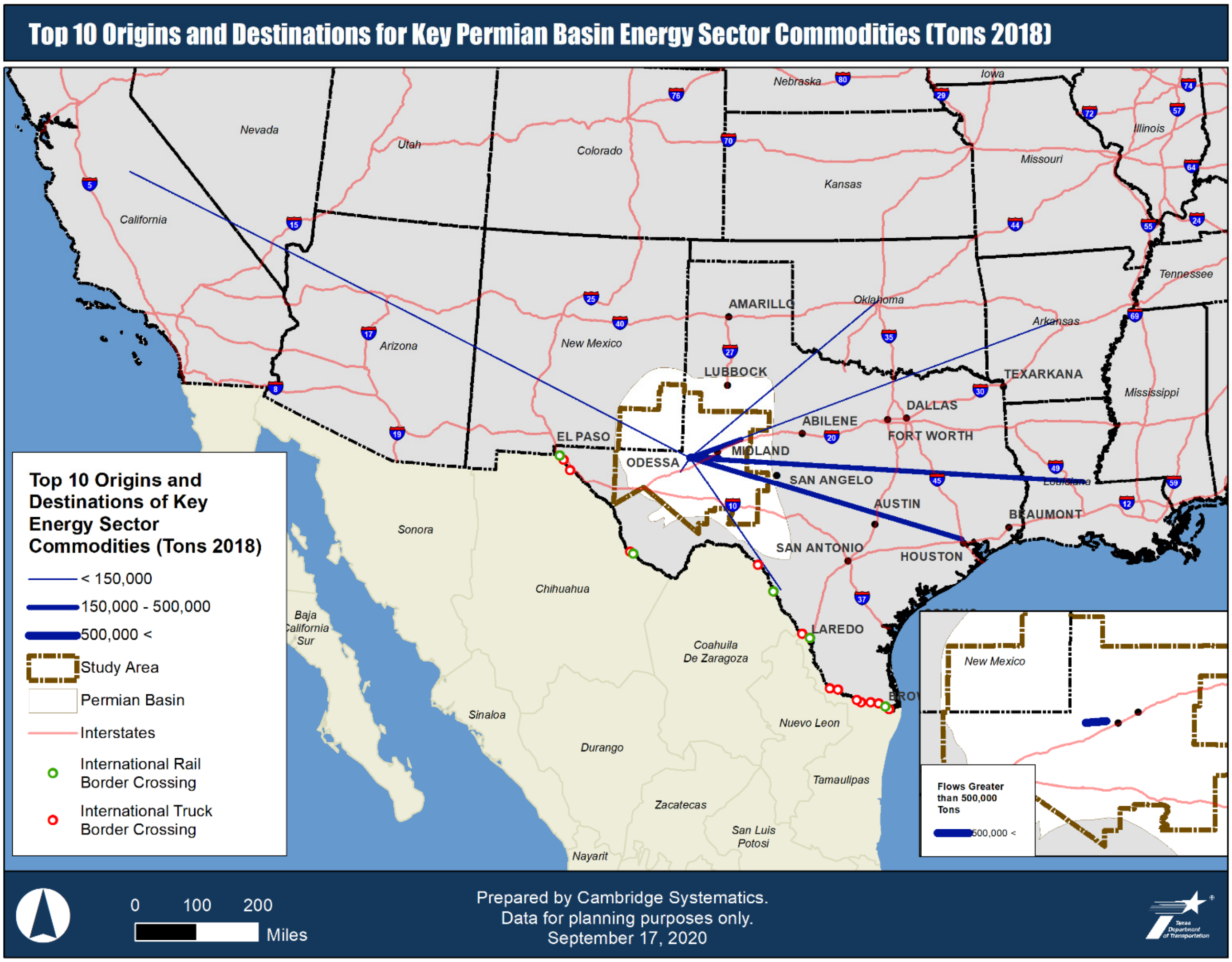
Source: TRANSEARCH; Cambridge Systematics analysis and Steering Committee input.

2.4.1 PERMIAN BASIN ENERGY SECTOR SPHERE OF INFLUENCE

The commodities included in the definition of the energy sector SOI include petroleum, crude petroleum and natural gas, chemical and allied products, non-electrical machinery (examples include boilers, wind turbines, solar panels, and mechanical machinery such as pumps and milling equipment), and fabricated metal products including pipes. **Exhibit 20** displays the top ten origins and destinations into and out of the Permian Basin for these commodities by tons.

Using the information gleaned from the commodity flow analysis, combined with stakeholder feedback, the Energy Sector SOI, displayed in **Exhibit 21**, was defined as extending westward to the Ports of Los Angeles and Long Beach in California, and eastward to include the Texas Gulf Coast Ports and Port of New Orleans. The Energy Sector SOI also includes international land border ports of entry along the Texas/Mexico border. The connection to international gateways are critical to the Permian Basin, as the energy sector depends on gateways to Asia to export crude oil and gateways to Mexico to export natural gas to fuel manufacturing south of the border.

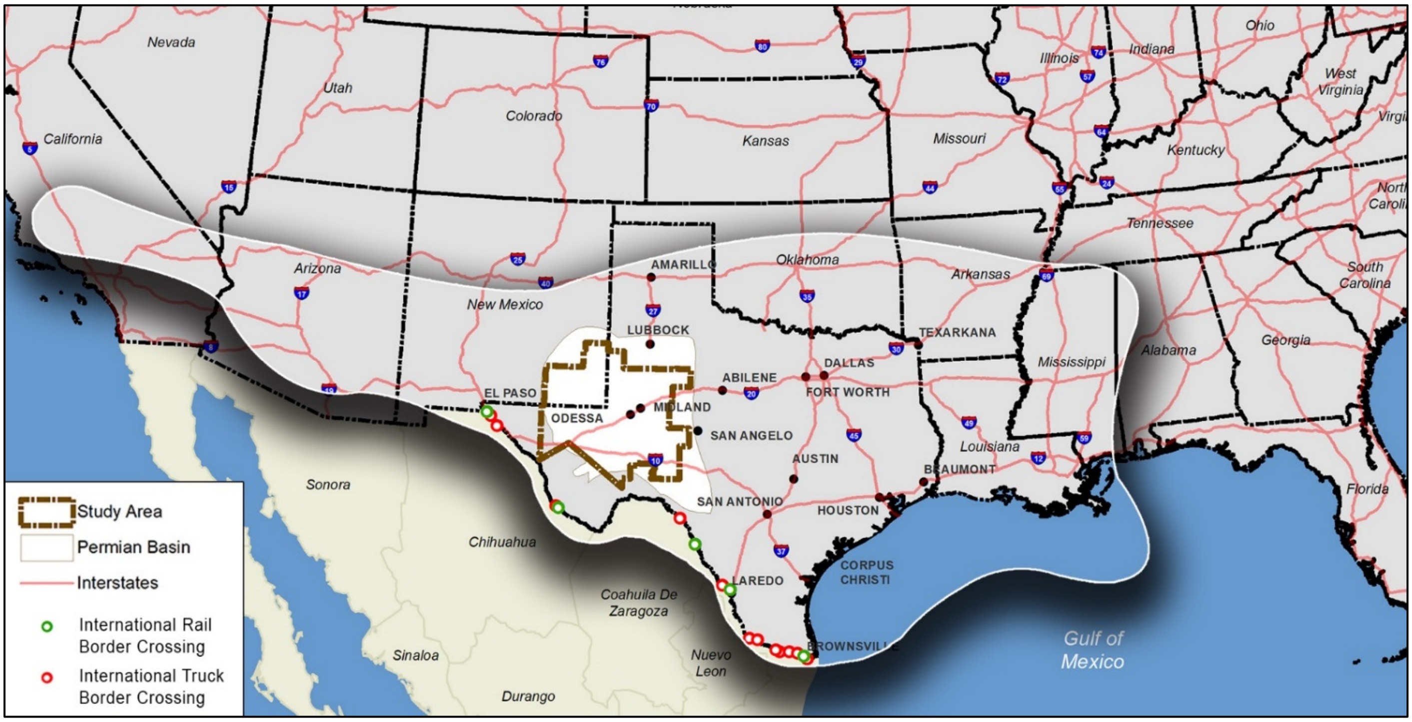
Exhibit 20. Top 10 Origins and Destinations for Permian Basin Energy Sector Commodities, (Tons 2018)



Origin/Destination	Inbound Tons 2018	Outbound Tons 2018	Total Tons 2018
Ector County, TX	503,158	205,365	708,523
Louisiana	427,942	67,328	495,270
Harris County, TX	267,924	98,955	366,879
Midland County, TX	34,271	254,055	288,326
Howard County, TX	176,482	11,063	187,545
Ward County, TX	100,747	15,117	115,865
Oklahoma	88,929	25,655	114,584
Arkansas	47,853	39,698	87,551
Maverick County, TX	N/A	77,200	77,200
California	26,030	43,768	69,798

Source: TRANSEARCH; Cambridge Systematics analysis.

Exhibit 21. Permian Basin Energy Sector Sphere of Influence

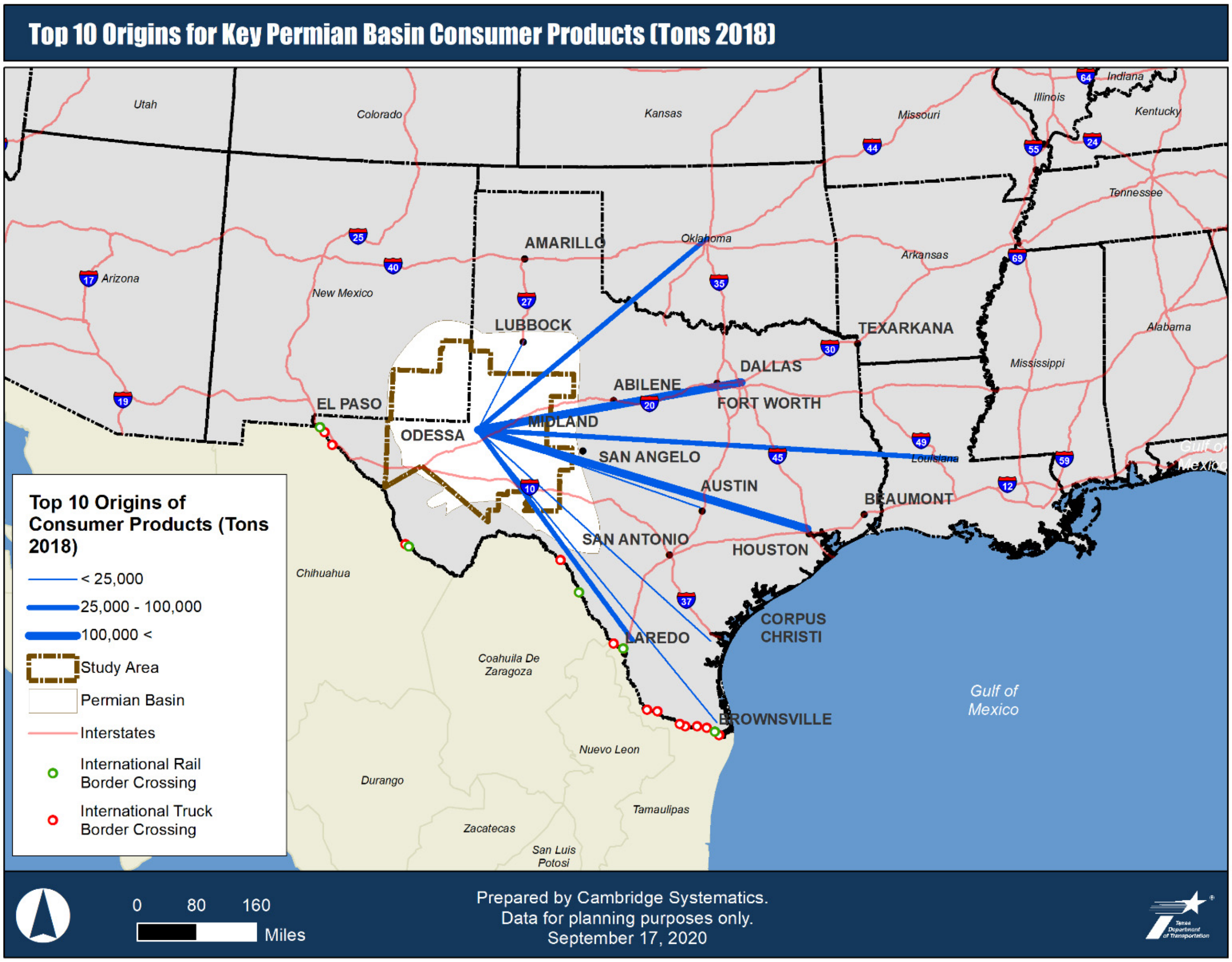


Source: TRANSEARCH; Cambridge Systematics analysis and stakeholder input.

2.4.2 PERMIAN BASIN CONSUMER PRODUCTS SPHERE OF INFLUENCE

The Permian Basin is an inbound market for consumer products meaning that the region imports as opposed to manufactures most of the goods consumed by residents and the transient workforce and local businesses. For the consumer products SOIs, consumer goods and warehousing and distribution commodities are combined as they both represent finished products for final consumption. **Exhibit 22** depicts the top origins for inbound shipments to the Permian Basin of consumer products commodities by tons. The results indicate that warehouses and distribution centers in Texas' major metropolitan areas – namely Dallas-Fort Worth, Houston and Austin-are important for delivering consumer products to the Permian Basin. The results also show that Texas' international gateways are major suppliers to the Permian Basin. Webb County, which contains the international border crossing at Laredo, and Nueces County, which contains the Port of Corpus Christi, account for significant volumes of warehousing and distribution-related commodities. Significant volumes of consumer goods coming into the region from the Dallas-Fort Worth area are entering the U.S. from Asia through the Ports of Los Angeles and Long Beach in southern California. The resulting consumer products SOI is displayed in **Exhibit 23**.

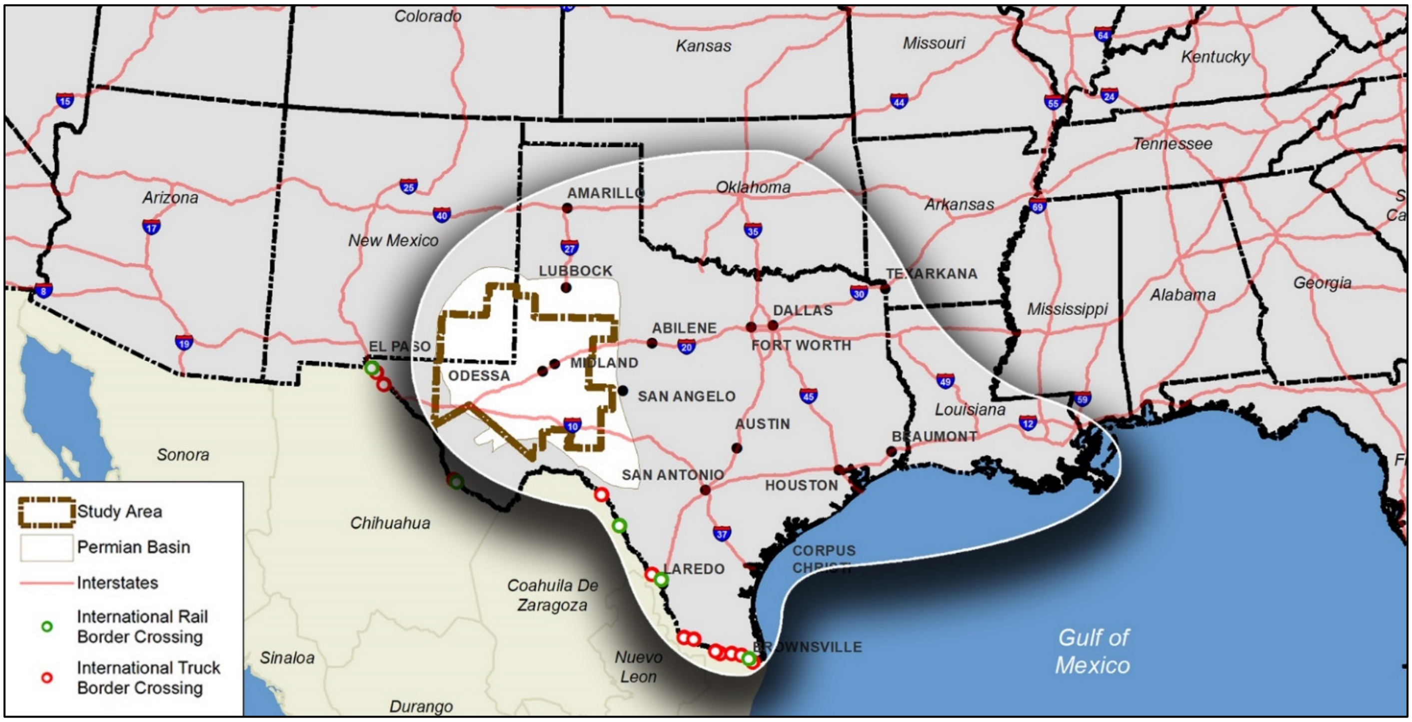
Exhibit 22. Top 10 Origins for Key Permian Basin Consumer Products, (Tons 2018)



Origin	Inbound Tons 2018
Harris County, TX	291,629
Dallas County, TX	129,094
Webb County, TX	85,448
Louisiana	30,415
Oklahoma	28,683
McLennan County, TX	22,439
Lubbock County, TX	20,940
Nueces County, TX	20,470
Travis County, TX	16,991
Cameron County, TX	15,039

Source: TRANSEARCH; Cambridge Systematics analysis.

Exhibit 23. Permian Basin Consumer Products Sphere of Influence

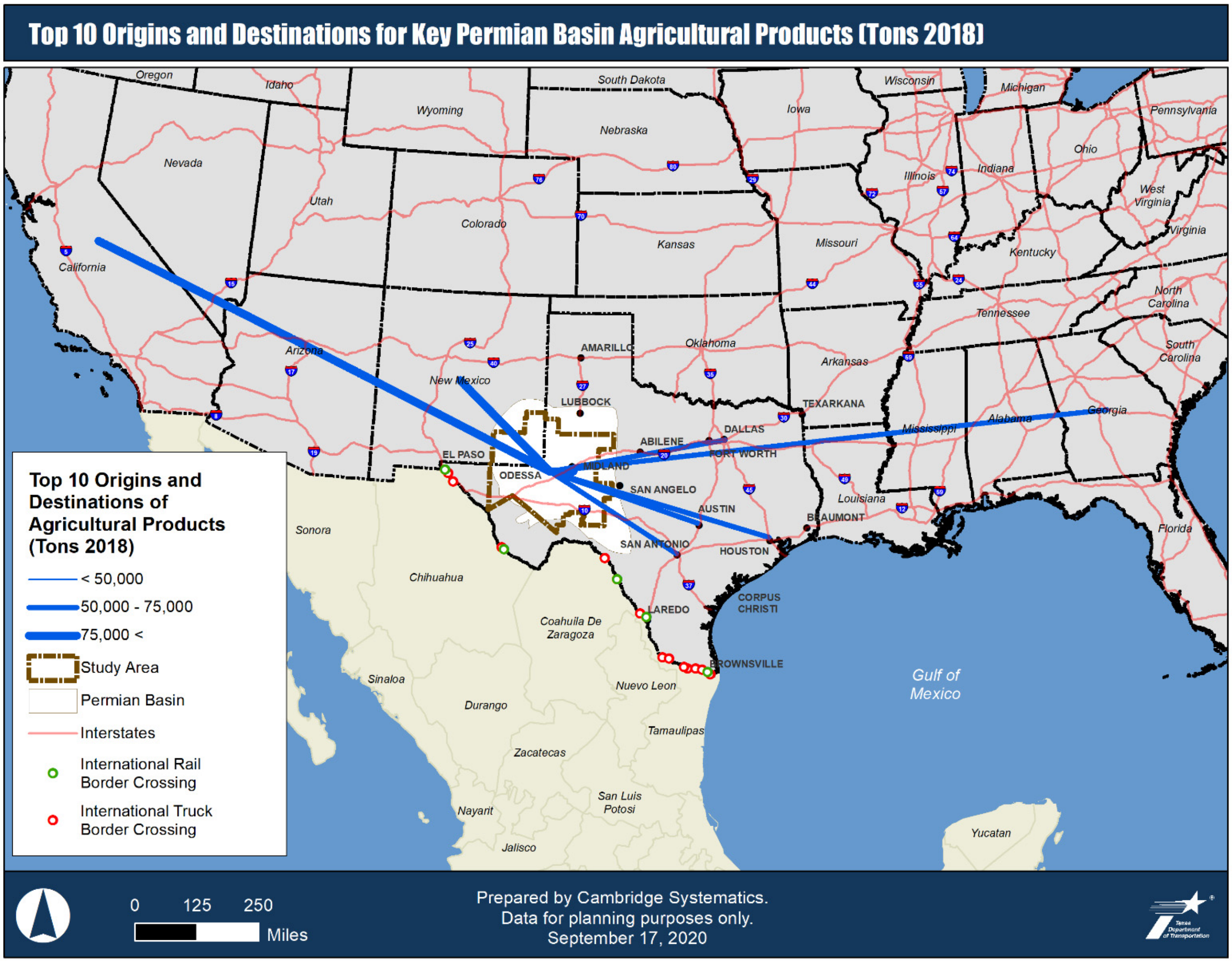


Source: TRANSEARCH; Cambridge Systematics analysis and stakeholder input.

2.4.3 PERMIAN BASIN AGRICULTURAL SECTOR SPHERE OF INFLUENCE

The agricultural sector SOI is defined by examining both inbound and outbound agricultural commodity movements. As noted in **Section 2.3.5**, the principal agricultural industry commodities include farm products, chemicals, non-metallic minerals, and machinery. Farm products include dairy farm products, cotton, miscellaneous field crops, oil kernels, nuts or seeds, and grain. Chemicals or allied products are comprised almost entirely of fertilizers, non-metallic minerals include crude fertilizer minerals and machinery includes tractors and other farm equipment. The top origins and destinations for Permian Basin agricultural commodities, shown in **Exhibit 24** include several Texas counties indicating the role of Texas' maritime and inland ports. They also include California and Georgia, indicating the international gateways of the Ports of Los Angeles and Long Beach and Port of Savannah are critical for Permian Basin agricultural exports, especially cotton.

Exhibit 24. Top 10 Origins and Destinations for Permian Basin Agricultural Products, (Tons 2018)

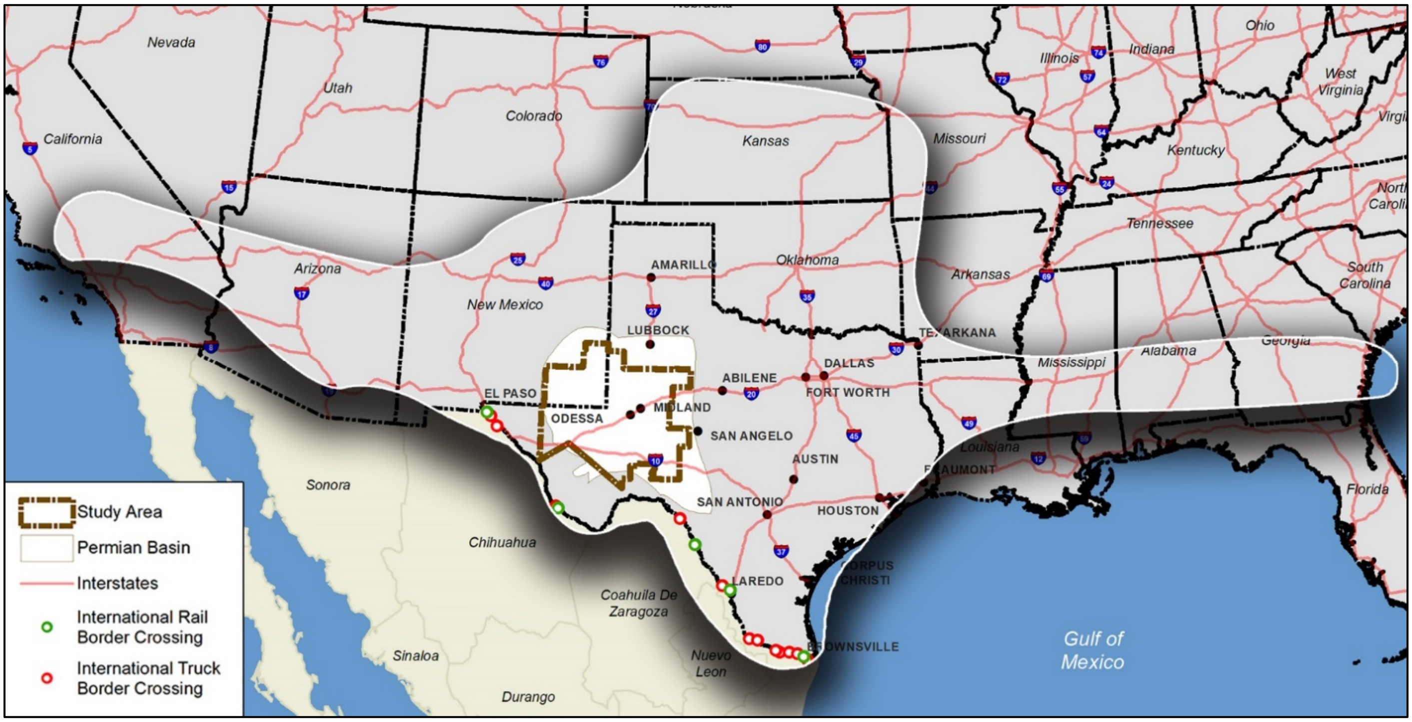


Origin/Destination	Inbound Tons 2018	Outbound Tons 2018	Total Tons 2018
New Mexico	132,529	62,469	194,997
California	--	129,500	129,500
Midland County, TX	22,832	52,284	75,116
Dallas County, TX	--	66,077	66,077
Georgia	--	60,642	60,642
Harris County, TX	--	56,028	56,028
Ector County, TX	--	52,609	52,609
Bexar County, TX	--	52,140	52,140
Travis County, TX	--	50,567	50,567
Tarrant County, TX	--	49,322	49,322

Source: TRANSEARCH; Cambridge Systematics analysis.

The resulting agricultural SOI, displayed in **Exhibit 25**, extends to much of the lower half of the U.S., extending westward to California and eastward to Georgia, indicating significant statewide, national, and global connections with the Permian Basin.

Exhibit 25. Permian Basin Agricultural Sphere of Influence



Source: TRANSEARCH; Cambridge Systematics analysis and stakeholder input.

2.5 ECONOMIC IMPORTANCE OF THE PERMIAN BASIN

As depicted in the SOIs in **Section 2.4**, the influence of the Permian Basin extends well beyond its borders. The previous section focused on commodity and trade flows; this section focuses on the economic importance of the Permian Basin to regional and state economies. The economic analysis includes only the Texas counties in the study area due to economic model availability.

In recent years, the Permian Basin has become the most important oil and gas producing area in the U.S., and is currently the nation's largest petroleum-producing basin. By 2018, the Permian Basin reported a current-dollar Gross Regional Product (GRP) of $97.6 million, including $7.6 billion from freight transportation and handling sectors, and $82.5 billion from freight-intensive sectors. This is discussed in more detail in the following sections. The growth in the oil and gas industry has fueled economic growth in the region. The Permian Basin GRP increased by 78% between 2008 and 2018 (**Exhibit 26**), a rate 55% higher than that of Texas as a whole.

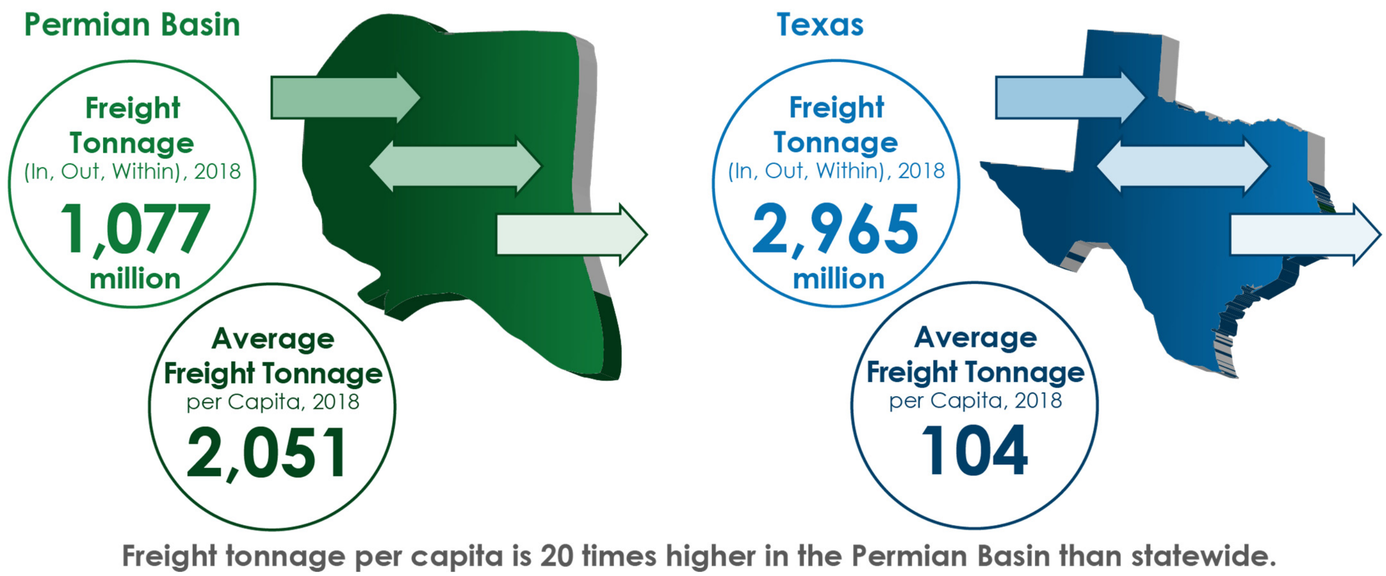
Exhibit 26. Gross Regional Product in the Permian Basin and Texas, 2008 and 2018

	2008 (Millions of Current Dollars)	2018 (Millions of Current Dollars)	Change 2008-2018	Cumulative Annual Growth Rate 2008-2018
Permian Basin	$54,926	$97,613	77.7%	5.9%
Texas	$1,237,395	$1,802,511	45.7%	3.8%

Source: Bureau of Economic Analysis (BEA).

Freight transportation plays a significant role in the Permian Basin's economy as evidenced by the fact that the freight tonnage per capita in the Permian Basin is nearly 20 times greater than the statewide average. As shown in **Exhibit 27**, it is estimated that over 1,700 tons of freight are moved per capita in the Permian Basin compared to 104 tons per capita statewide.

Exhibit 27. Freight Tonnage Per Capita in the Permian Basin and Texas, 2018



Source: TRANSEARCH; Cambridge Systematics analysis.

2.5.1 ECONOMIC IMPACTS OF ENERGY AND FREIGHT ACTIVITY IN THE PERMIAN BASIN

The economic contribution of freight transportation in the Permian Basin is estimated by assessing freight transportation jobs, labor income, value added (or GRP), and tax revenue arising from direct employment in freight transportation and handling industries (such as warehousing and distribution) and freight intensive industries. Freight intensive industries are defined as industries that spend a higher share of total cost on freight transportation for both inputs and outputs. These industries are typically producing, moving, or selling goods, and include manufacturing, construction, retail and wholesale trade, transportation (distribution) and warehousing, agriculture, and mining and extraction. Total economic impacts include:

- Direct Impact: Employment, income, value added, and tax revenue generated by the direct operations of the freight transportation sector and freight intensive industries.
- Indirect Impact: Employment, income, value added, and tax revenue generated as part of the intermediate consumption of the freight transportation sectors and freight intensive industries. Examples

include purchases from local businesses, such as office supplies, fuel, professional services, and real estate costs.

- Induced Impact: Impacts measured in terms of additional jobs, income, value added, and tax revenue as a result of the personal consumption patterns of direct employees. Examples include spending on education and health, entertainment, groceries, and rent.

This analysis relies on the 2018 TREDIS model for the Permian Basin and the 2018 IMPLAN model for Texas to estimate the impact of freight transportation and handling and freight intensive sectors at the regional and state levels. Economic impacts are measured in terms of the following categories:

- Employment – This is the estimate of the number of jobs (full and part time) by place of work supported by freight and industry activity. Full-time and part-time jobs were given equal weight in this analysis.
- Labor Income – This is a measure of wages and benefits associated with the direct, indirect, and induced employment generated.
- Gross State Product (GSP) – This captures the value-added created in the production of goods and provision of services, which includes employee compensation (labor income), proprietor income (i.e., payments received by self-employed individuals as income), other income types, and indirect business taxes.
- Tax Revenue – This is the increase in property and sales tax revenue to the local government, as well as changes in income tax revenues and taxes on production and imports for the federal and state government that are realized when local resident and business activity changes.

The direct employment in freight transportation and handling and freight intensive industries, categorized by North American Industrial Classification System (NAICS) code, are presented in **Exhibit 28 and 29**, respectively. In the Permian Basin in 2019, there were more than 25,000 direct jobs engaged in transporting or handling freight with NAICS code 484-Truck Transportation accounting for the largest share. There are over 265,000 direct jobs in freight intensive industries with NAICS code 21- Mining, Quarrying and Oil and Gas Extraction and 44-45- Retail accounting for nearly 50%.

Exhibit 28. Employment in the Freight Transportation and Handling Sectors in the Permian Basin, 2019

NAICS Code – Sector Name	Number of Establishments	Average Employment	Total Wages (Millions)
484 – Truck Transportation	1,478	18,112	$333.1
486 – Pipeline Transportation	206	3,024	$88.2
488 – Support Activities for Transportation	107	1,110	$22.3
492 – Courier and Messengers	28	1,036	$11.8
493 – Warehousing and Storage	19	875	$12.4
491 – Postal Services	54	633	$11.0
481 – Air Transportation	14	250	$5.5
483 – Water Transportation	6	10	$0.2
Total	**1,912**	**25,050**	**$484.4**

Source: Texas Labor Market Information, Quarterly Census of Employment and Wages (QCEW).

Exhibit 29. Employment in the Freight Intensive Sectors in the Permian Basin, 2019

NAICS Code – Sector Name	Number of Establishments	Average Employment	Total Wages (Millions)
21 – Mining, Quarrying, and Oil and Gas Extraction	4,134	113,716	$3,026.2
44-45 – Retail	3,081	52,909	$522.9
23 – Construction	2,591	42,954	$851.3
42 – Wholesale Trade	2,132	30,856	$720.8
31-33 – Manufacturing	1,128	22,382	$426.2
Total in Freight-Intensive Sectors	**13,066**	**197,047**	**$5,547.4**
Total in All Sectors	32,521	508,108	$9,012.3

Source: Texas Labor Market Information, Quarterly Census of Employment and Wages (QCEW).

[1] The employment in Sectors 481, 483, 484, 486, 488, 491, 492, and 493 from Exhibit 28 are not inlcuded in this figure to avoid double counting.

Exhibit 30 presents the economic contribution from direct employment in the freight transportation and handling sectors in the Permian Basin to the economies of the region and the rest of Texas. The results indicate that the freight transportation and handling sectors in the Permian Basin support 71,465 jobs statewide, which adds close to $7.0 billion in labor income and generates $7.6 billion in GSP. This yields almost $1.9 billion in tax revenues, which include $1.2 billion in federal taxes and $660 million in state/local taxes.

Exhibit 30. Total Economic Contribution from Employment in the Freight Transportation and Handling Sectors in the Permian Basin to the Economies of the Region and Texas, 2019

Economic Contribution to:	Employment Jobs	Labor Income (Millions)	GSP (Millions)
Permian Basin	43,235	$3,604	$3,181
Rest of the State	28,230	$3,386	$4,465
Total Contribution to Texas	**71,465**	**$6,990**	**$7,646**
Economic Contribution to:	**Federal Taxes (Millions)**	**State/Local Taxes (Millions)**	**Total (Millions)**
Permian Basin	$465	$425	$890
Rest of the State	$754	$234	$988
Total Contribution to Texas	**$1,219**	**$660**	**$1,879**

Source: 2018 TREDIS model for the Permian Basin and 2018 IMPLAN model for Texas.

Note: To perform the analysis, the total number of direct jobs generated by the freight transportation and handline sectors was used as the reference for the calculation of other economic impacts (labor income, GSP, and taxes), as well as the multiplier effects (indirect and induced impacts).

Exhibit 31 presents the economic contribution from direct employment in the freight-intensive sectors in the Permian Basin to the economies of the region and the state. The results indicate that the freight-intensive sectors in the Permian Basin support 694,270 jobs, which adds close to $45.1 billion in labor income and generates $82.5 billion in GSP. This yields $18 billion in tax revenues, which includes $9.4 billion in federal taxes and $8.6 billion in state/local taxes.

Exhibit 31. Economic Contribution from Employment in the Freight-Intensive Sectors in the Permian Basin to the Economies of the Region and the State, 2019

Economic Contribution to:	Employment Jobs	Labor Income (Millions)	GSP (Millions)
Permian Basin	354,520	$27,587	$44,373
Rest of the State	339,750	$17,495	$38,094
Total Contribution to Texas	**694,270**	**$45,082**	**$82,467**
Economic Contribution to:	**Federal Taxes (Millions)**	**State/Local Taxes (Millions)**	**Total (Millions)**
Permian Basin	$4,281	$5,193	$9,474
Rest of the State	$5,149	$3,416	$8,566
Total Contribution to Texas	**$9,430**	**$8,609**	**$18,040**

Source: 2018 TREDIS model for the Permian Basin and 2018 IMPLAN model for Texas.

Note: To perform the analysis, the total number of direct jobs generated by the freight intensive sectors was used as the reference for the calculation of other economic impacts (labor income, GSP, and taxes), as well as the multiplier effects.

2.5.2 ADDITIONAL STATE PUBLIC REVENUE CONTRIBUTIONS OF THE PERMIAN BASIN OIL AND GAS INDUSTRY

In fiscal year 2019, total Texas state and local taxes and Texas state royalties paid by the oil and gas industry in Texas represented $13.4 billion, up 14% from $11.8 billion in fiscal year 2018.[25] State and local taxes include state severance taxes on oil and gas, property taxes, sales taxes, and other special industry taxes such as the oil well serving tax and the oil and gas field cleanup regulatory fee. These funds directly support public education, universities, healthcare and infrastructure through the State Highway Fund, the Economic Stabilization Fund (commonly known as the Rainy-Day Fund), the Permanent School Fund (PSF), and the Permanent University Fund (PUF). As a result, the quality of life in Texas benefits from a robust oil and natural gas industry.

Severance Tax Paid by Permian Basin Oil and Gas Producers

This analysis focuses on taxes paid by oil and gas producers in the Permian Basin. It is estimated that oil and gas producers in the Permian Basin contributed nearly $3.6 billion to the state Treasury in 2019 (**Exhibit 32**) or 65% of the total severance taxes on oil and gas paid by the industry statewide.

[25] Permian Basin Petroleum Association (PBPA). The Permian Basin Enriching Texas (Spring 2020). PBPA Report Developed with the Texas Taxpayers and Research Association (TTARA) Research Foundation.

Exhibit 32. State Severance Taxes Paid by Permian Basin Oil and Gas Industry, FY 2019

Variable	Oil	Casinghead (Oil Well)	Gas (Gas Well)	Condensate (Natural Gas Liquids)	Total
Value of Production (Millions of Dollars)	$58,976	$7,647	$4,269	$4,648	$67,540
State Severance Tax Rate	4.6%	4.6%	7.5%	4.6%	N/A
State Severance Taxes Paid (Millions of Dollars)	$2,713	$352	$320	$214	$3,599

Source: Cambridge Systematics analysis based on data from the Railroad Commission of Texas and the U.S. Energy Information Administration.

Royalties Paid by Oil and Gas Producers in the Permian Basin

Private companies commonly lease public land and, in return, are obligated to repay (i.e. royalties) the public for the use of the land as well as the raw materials that are extracted (e.g., coal, oil, natural gas). In fiscal year 2019, the Texas oil and natural gas industry paid $2.1 billion in royalties to the state.[26] The majority of these royalties fund Texas public schools through the PSF and Texas universities through the PUF. Using the ratio of the number of producing wells in the Permian Basin and the number of producing wells statewide, this analysis estimates royalties of $945 million paid by the oil and gas industry in the Permian Basin in fiscal year 2019, as shown in **Exhibit 33**.

Exhibit 33. Estimated Royalties Paid by Permian Basin Oil and Natural Gas Industry, FY 2019

Region	Number of Oil Wells Regular Producing	Royalties (Millions)
Texas Statewide	186,841	$2,122.7
Permian Basin	83,597	$945
Permian Basin as Percent of State	45%	45%

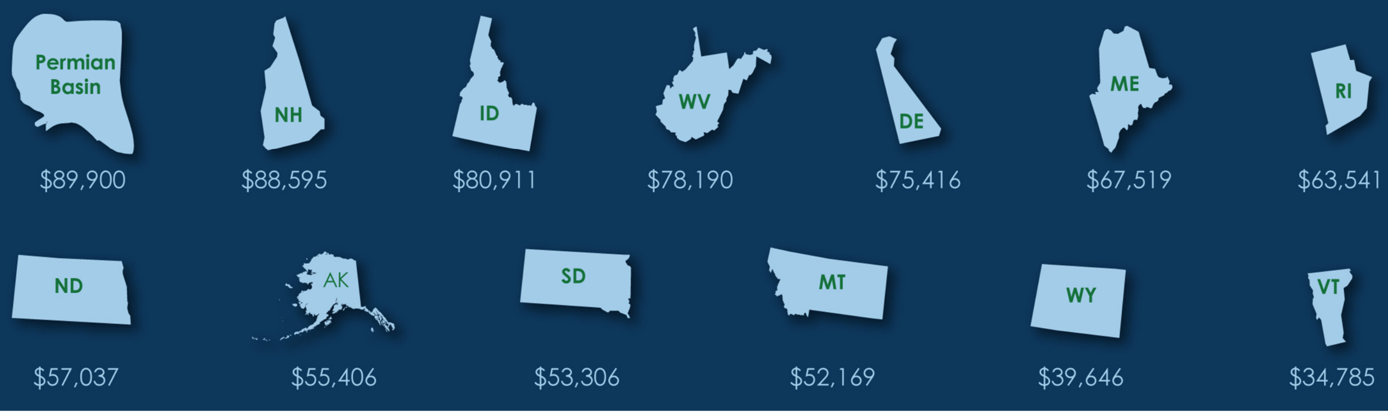
Source: Cambridge Systematics analysis based on data from the Railroad Commission of Texas and the U.S. Energy Information Administration.

[26] Permian Basin Petroleum Association (PBPA). The Permian Basin Enriching Texas (Spring 2020). PBPA Report Developed with the Texas Taxpayers and Research Association (TTARA) Research Foundation.

2.5.3 SUMMARY OF ECONOMIC IMPACT OF FREIGHT AND ENERGY SECTOR ACTIVITY IN THE PERMIAN BASIN

Exhibit 34 presents the total estimated economic impact of freight transportation and handling and freight intensive industries in the Permian Basin. In 2019, freight and energy sector activity in the Permian Basin supported nearly 766,000 jobs statewide, and $52 billion in income. At nearly $90 billion in GSP, the impact of the Permian Basin's freight transportation activity is larger than the economy of twelve states.[27]

Permian Basin's Economic Impact is Larger than the Economies of the Following 12 States



27 U.S. Bureau of Economic Analysis, 2019

Exhibit 34. Total Economic Impact of Freight Transportation in the Permian Basin, 2019

Source: TREDIS, IMPLAN; Cambridge Systematics analysis.

Exhibit 35 displays the total state and local tax revenue generated by the freight and energy sector transportation in the Permian Basin in 2019. In total, the region contributed more than $25 billion in local and state revenue in Texas.

Exhibit 35. Total State and Local Tax Revenue Generated by the Freight and Energy Sector Transportation in the Permian Basin, 2019

Region	Federal Taxes (Millions)	State /Local Taxes (Millions)	Total (Millions)
Permian Basin	$4,746	$5,618	$10,364
Rest of Texas	$5,903	$3,650	$9,554
Total Contribution to Texas	**$10,649**	**$9,268**	**$19,919**

Revenue Source	State Revenue (Millions)
State Severance Taxes	$3,599
Royalties	$945
Total	**$4,544**

Source: TREDIS, IMPLAN; Cambridge Systematics analysis.

Chapter 2 discussed why freight movement in the Permian Basin is important, the Permian Basin's Spheres of Influence, and the economic importance of the region. **Chapter 3** presents the freight and energy sector transportation network inventory and profile.

SECTION 2 Permian Basin Freight and Energy Sector Network Conditions, Challenges, and Opportunities

Section 2 of the Permian Basin Freight Plan describes the inventory, utilization, and needs of the region's multimodal freight transportation network. This analysis represents the compilation of data from public and private freight and energy sector data sources, truck GPS data from ATRI, crash data from TxDOT's CRIS, OS/OW permit data, TxDOT network inventory and conditions data, and stakeholder input. This section presents the designated Permian Basin Multimodal Freight Network and prioritized needs across the region that inform the development of strategies and recommendations.

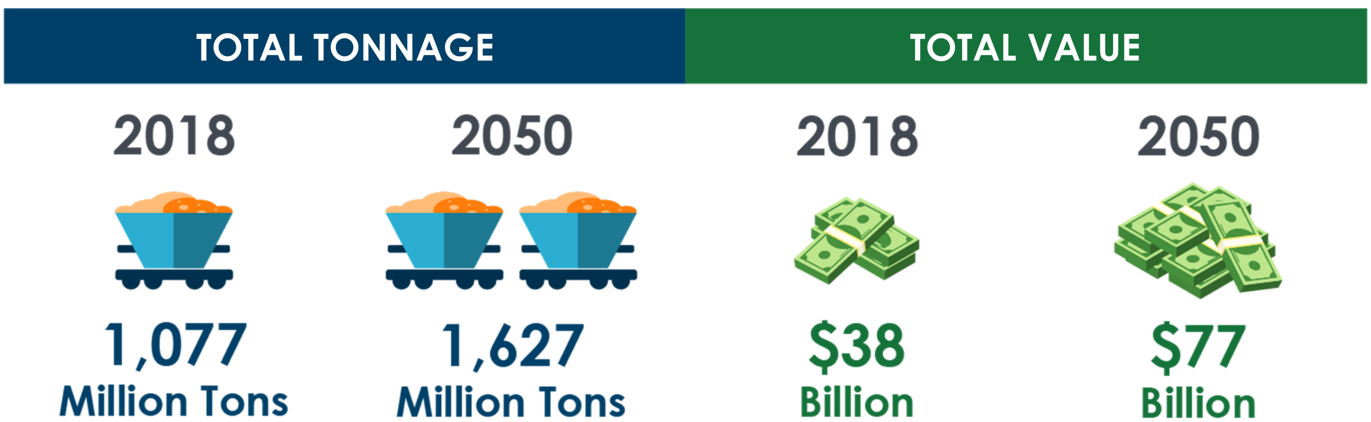
Chapter 3 provides a **profile of the region's freight infrastructure** including highway, rail, pipeline, and airports. **Chapter 4** assesses **freight network performance and conditions** and freight intensive land uses. **Chapter 5** examines the region's **freight and energy sector transportation needs and challenges**, and presents prioritized needs across the Permian Basin Highway Freight Network.

CHAPTER 3 Permian Basin Freight and Energy Sector Profile

3.1 PERMIAN BASIN FREIGHT MOVEMENT

In 2018, an estimated 1.1 billion tons of freight valued at $38.3 billion was transported into, out of and within the Permian Basin region. These volumes are expected to grow by 51% to 1.6 billion tons by 2050, with value expected to reach $76.9 billion. The greater increase in the value of freight indicates a faster growth in higher value commodities such as consumer goods. This also reflects projected slower growth in some energy sector goods in the outer years of the forecasts including sand, water, and pipes (see **Exhibit 36**). The following presents summary statistics of freight flows in the Permian Basin region. Additional detail on 2018 and 2050 freight flow volumes and value are provided in the Permian Basin Commodity Flow Profile.

Exhibit 36. Freight Demand in the Permian Basin



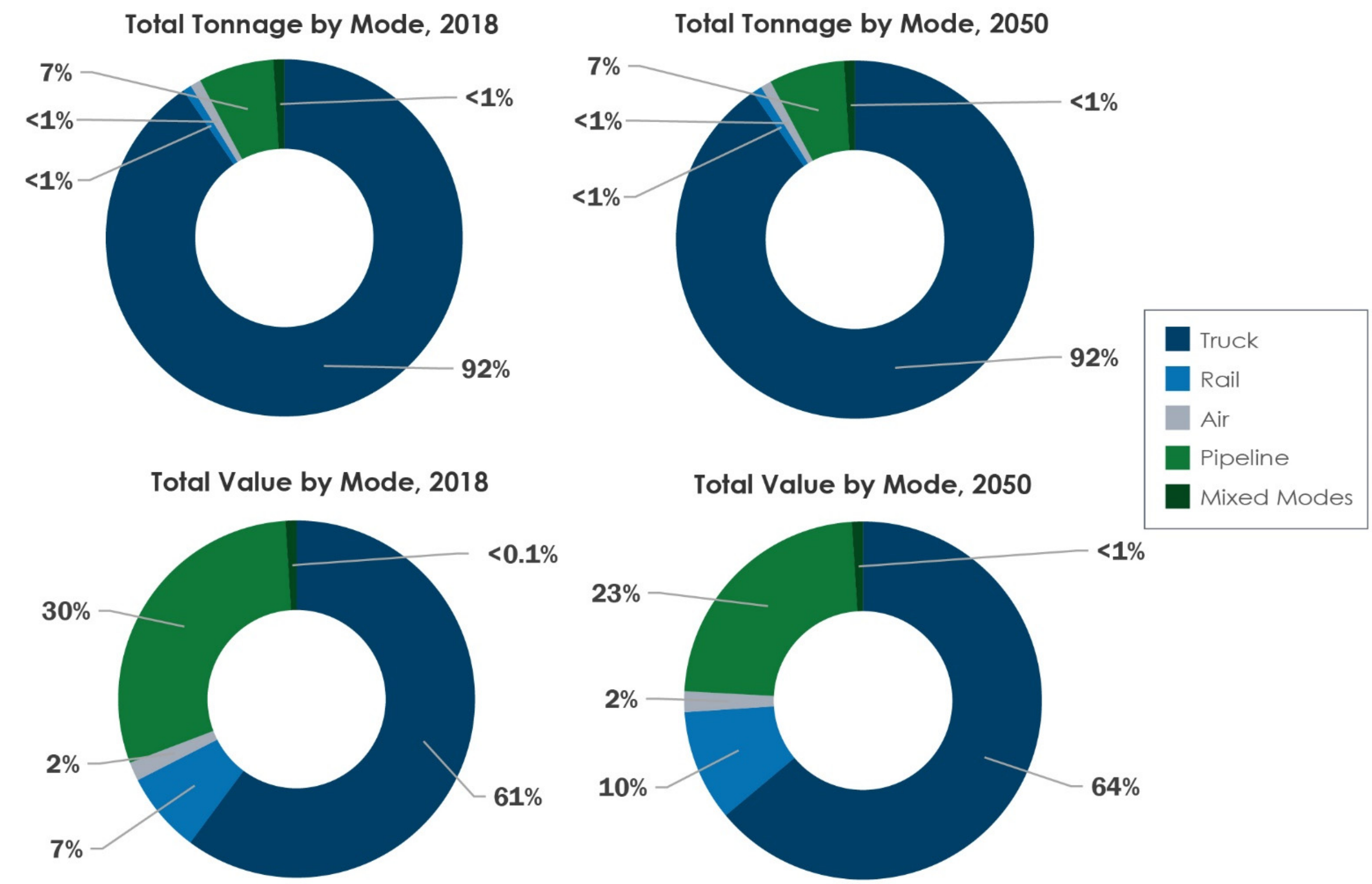
Source: Cambridge Systematics analysis of TRANSEARCH, Enverus DrillingInfo, and stakeholder input.

3.1.1 PERMIAN BASIN REGIONAL FREIGHT FLOWS BY MODE

Exhibit 37 displays the modal composition of the regional freight flows. When looking at the modal composition of the freight movements in the region, three findings are worth noting. First, trucking is the predominate mode used to move freight, accounting for 92% of the total tonnage and 61% of the total value of freight moved in 2018. This is not surprising in terms of tonnage as it is representative of the national pattern for inland freight movement. The corresponding value moved by truck is relatively low compared to national averages and this is driven by the huge amounts of sand and water being trucked throughout the region, both of which have relatively smaller market value per ton. Secondly, despite the region's dependency on commodities typically seen as rail compatible, the rail share of freight movement is relatively low in the region. This is a newer trend as the sand sourcing has become increasingly and almost totally locally sourced. The third notable finding is that pipelines comprise a significantly higher share of total volume and value than the national average. This is driven by the takeaway pipelines for crude oil and gas.

Modal share in terms of tonnage is projected to stay relatively constant between 2018 and 2050. The forecasts are based on the growth in commodities and assumes that commodities will move via the same mode in the future as they move today. Modal splits will be driven by infrastructure improvements, technology advancements, and customer service requirements. Additional details on freight movements by mode are discussed in the Permian Basin Regional Freight Profile Report and the Permian Basin Freight Plan Needs Assessment Report.

Exhibit 37. Permian Basin Freight Transportation by Mode, 2018 and 2050

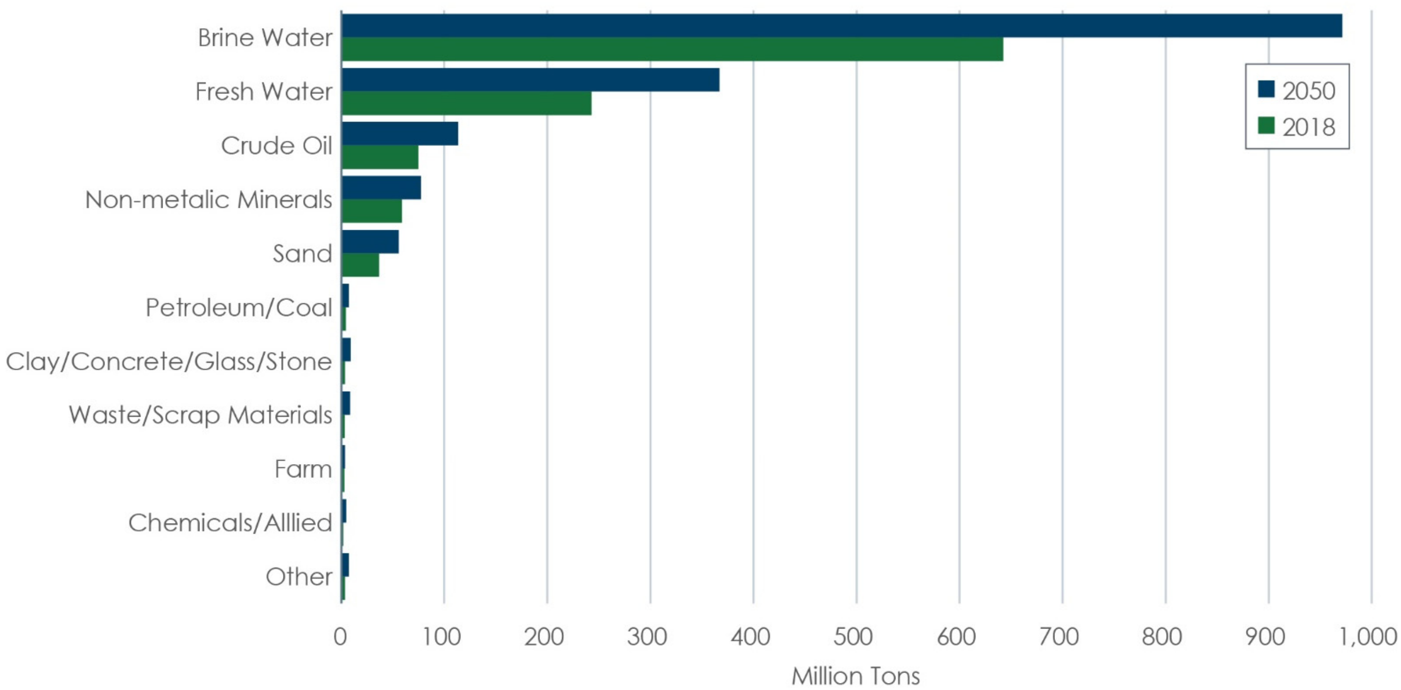


Source: Cambridge Systematics analysis of IHS Markit TRANSEARCH, Enverus DrillingInfo, and stakeholder input.

3.1.2 PERMIAN BASIN REGIONAL FREIGHT FLOWS BY COMMODITY

Freight flows in the Permian Basin are driven by the energy sector and most significantly, oil and gas activities. However, other commodities, most notably construction and consumer goods, are also significant. **Exhibit 38** displays the top commodities moving into, out of and within the region. As shown, produced water (sometimes referred to as brine) and fresh water dominated the total flows in the region, followed by crude oil, non-metallic minerals, and sand. The commodity mix is projected to remain relatively stable over the forecast horizon.

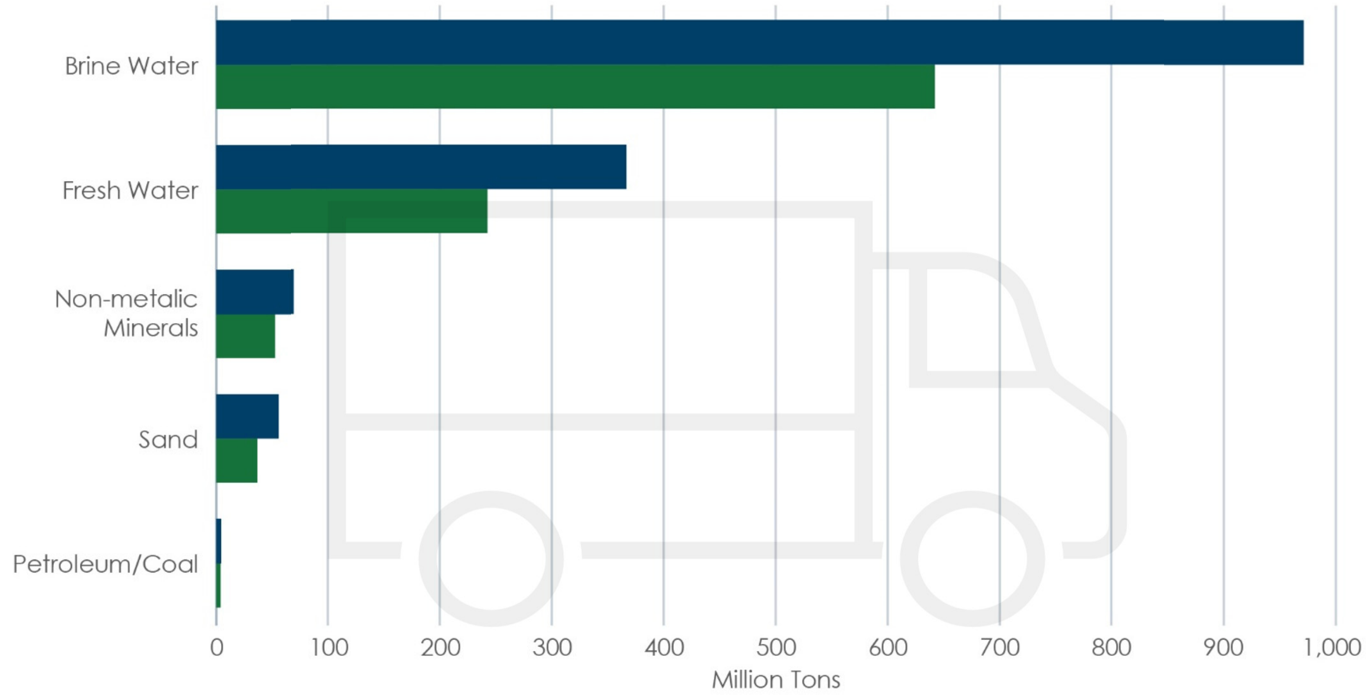
Exhibit 38. Top Ten Commodities Moving in the Permian Basin, 2018 and 2050



Source: Cambridge Systematics analysis of TRANSEARCH, Enverus DrillingInfo, and stakeholder input.

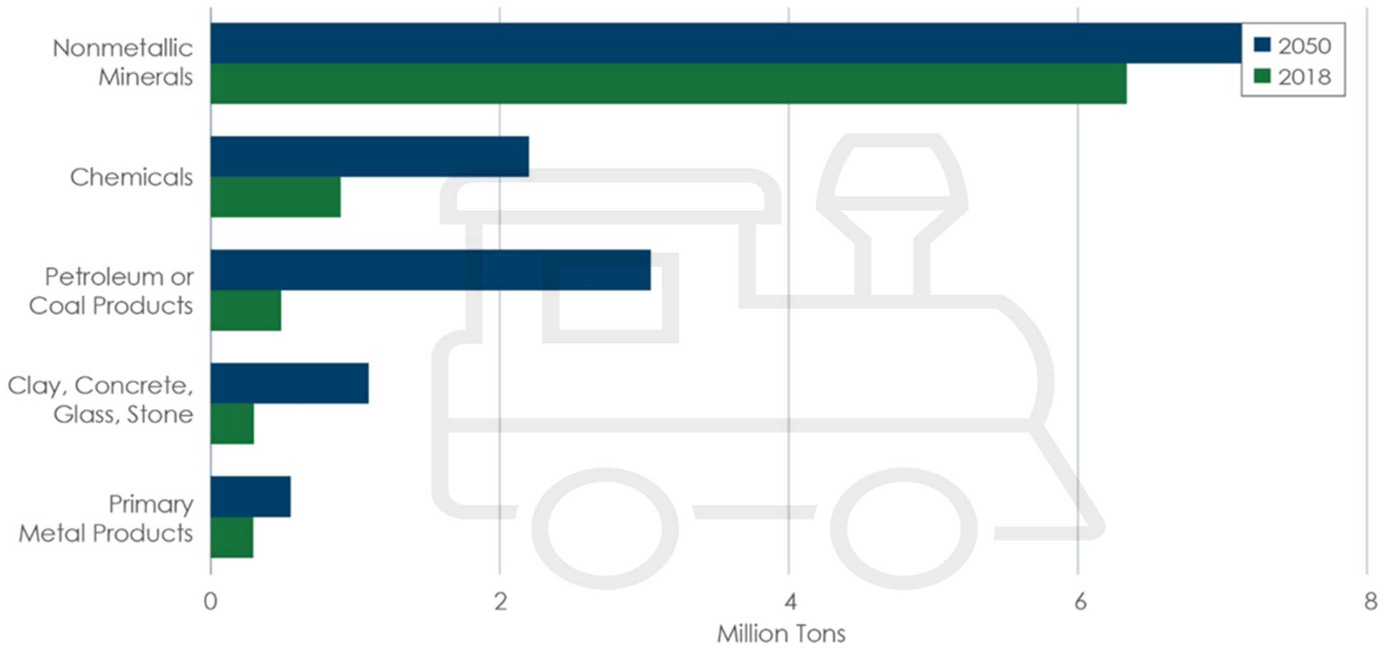
The top five commodities moved by truck, shown in **Exhibit 39**, are dominated by water and sand. Together, the top five commodities represent about 98% of total truck tonnage and have a value of $22.9 billion. The top five commodities moved by rail, shown in **Exhibit 40**, include a mix of energy sector and construction products, such as non-metallic minerals (includes non-energy sector sand), chemicals, crude, concrete, clay, and stone. In total the top five commodities represent about 95% of all rail tonnage moved in the region and have a value of $2.7 billion.

Exhibit 39. Top Five Commodities Moved by Truck in the Permian Basin, 2018 and 2050



Source: Cambridge Systematics analysis of TRANSEARCH, Enverus DrillingInfo, and stakeholder input.

Exhibit 40. Top Five Commodities Moved by Rail in the Permian Basin, 2018 and 2050

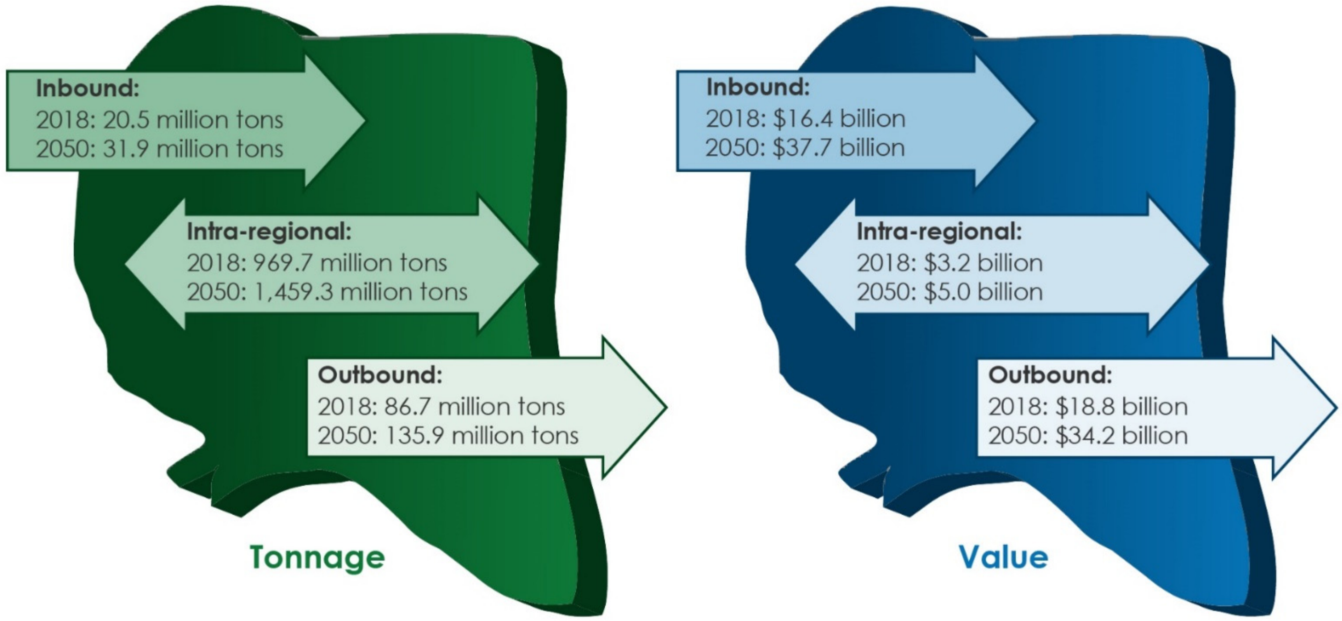


Source: Cambridge Systematics analysis of TRANSEARCH, Enverus DrillingInfo, and stakeholder input.

3.1.3 PERMIAN BASIN REGIONAL FREIGHT FLOWS BY DIRECTION

Understanding commodity flows by direction provides insight into the Permian Basin's regional economy in terms of imports (inbound commodities), exports (outbound commodities), and intraregional flows (goods traded within the region). As shown in **Exhibit 41**, intraregional freight movements dominate in terms of tonnage due to the large volumes of water and sand. However, in terms of value, both inbound and outbound overshadow the intraregional flows. This is due to the higher value of the pipes, equipment, and consumer goods being imported and the crude oil and natural gas being exported.

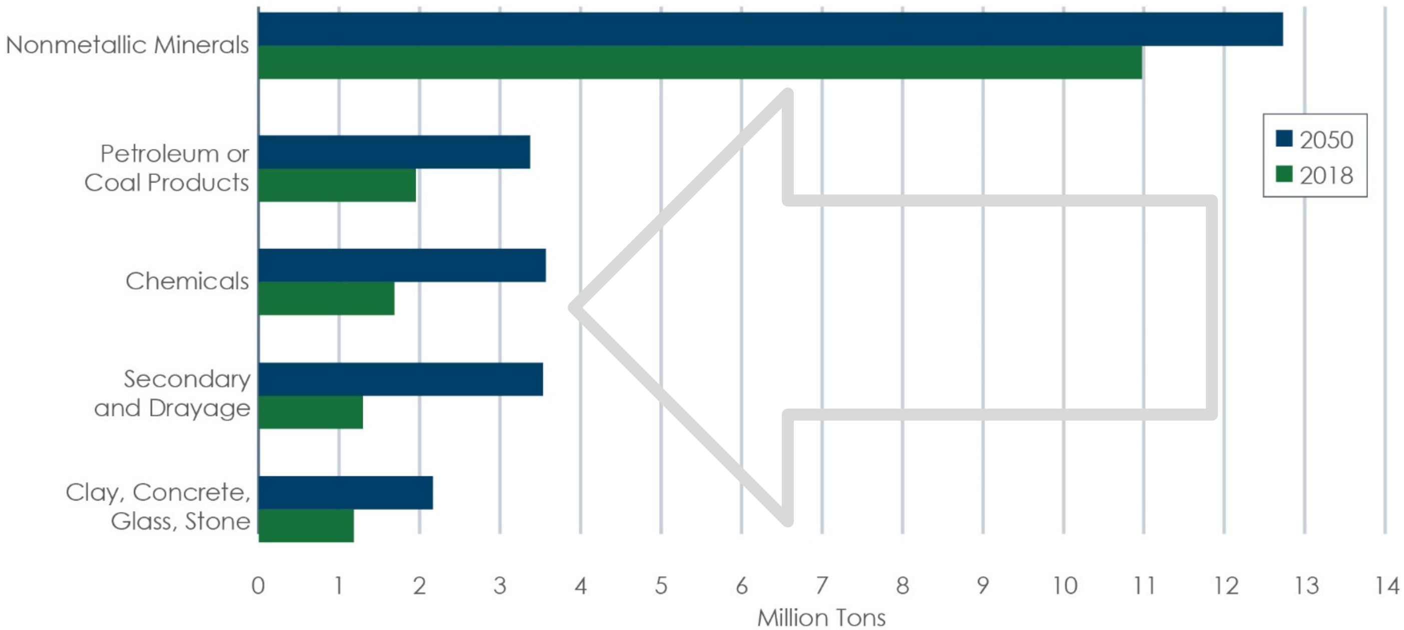
Exhibit 41. Direction of Permian Basin Regional Commodity Flows, 2018 and 2050



Source: Cambridge Systematics analysis of TRANSEARCH, Enverus DrillingInfo, and stakeholder input.

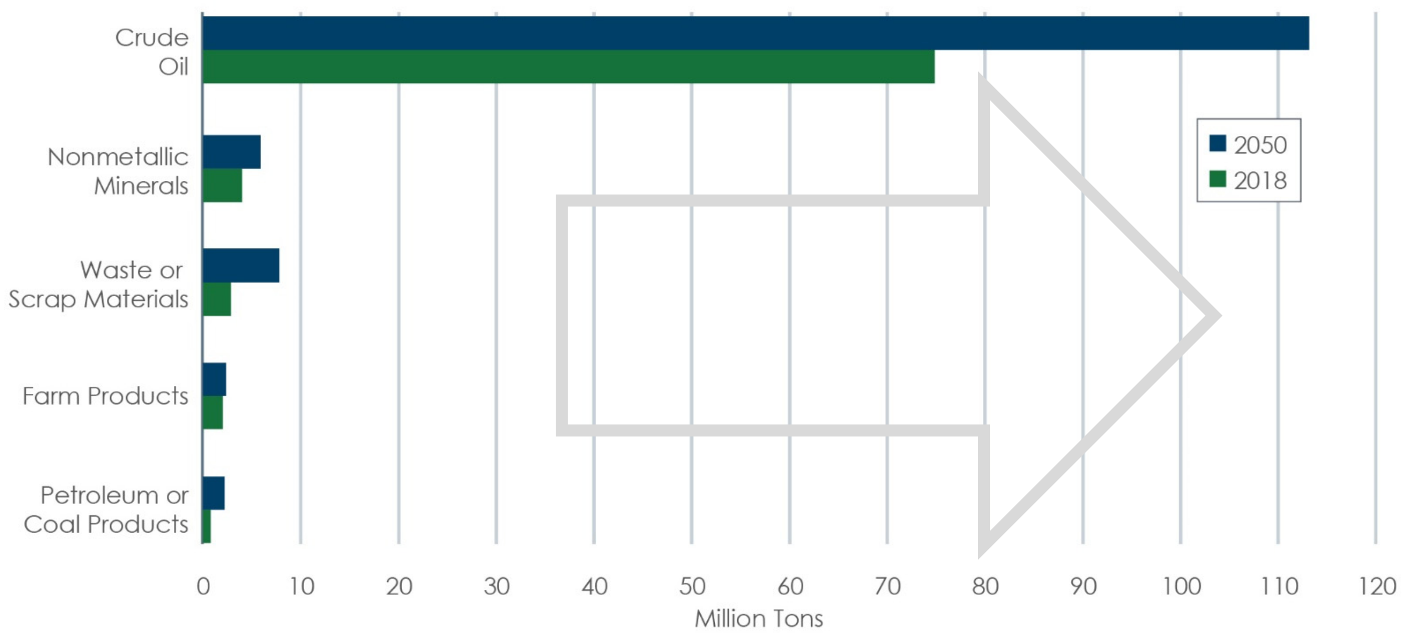
Exhibit 42, **Exhibit 43** and **Exhibit 44** display the top five commodities (by tons) by direction for 2018 and estimated for 2050. The top five inbound commodities, dominated by inputs for the fracing process including non-metallic minerals, petroleum and coal products, and chemicals, represent 83% of the total inbound tonnage and are valued at $13.7 billion. The top five outbound commodities represent 97% of total outbound tonnage valued at $18.3 billion and include crude oil, waste, and scrap. The top five intraregional commodities represent nearly 99.9% of all intraregional tonnage and value and are dominated by water and sand.

Exhibit 42. Top Five Inbound Commodities to the Permian Basin, 2018 and 2050



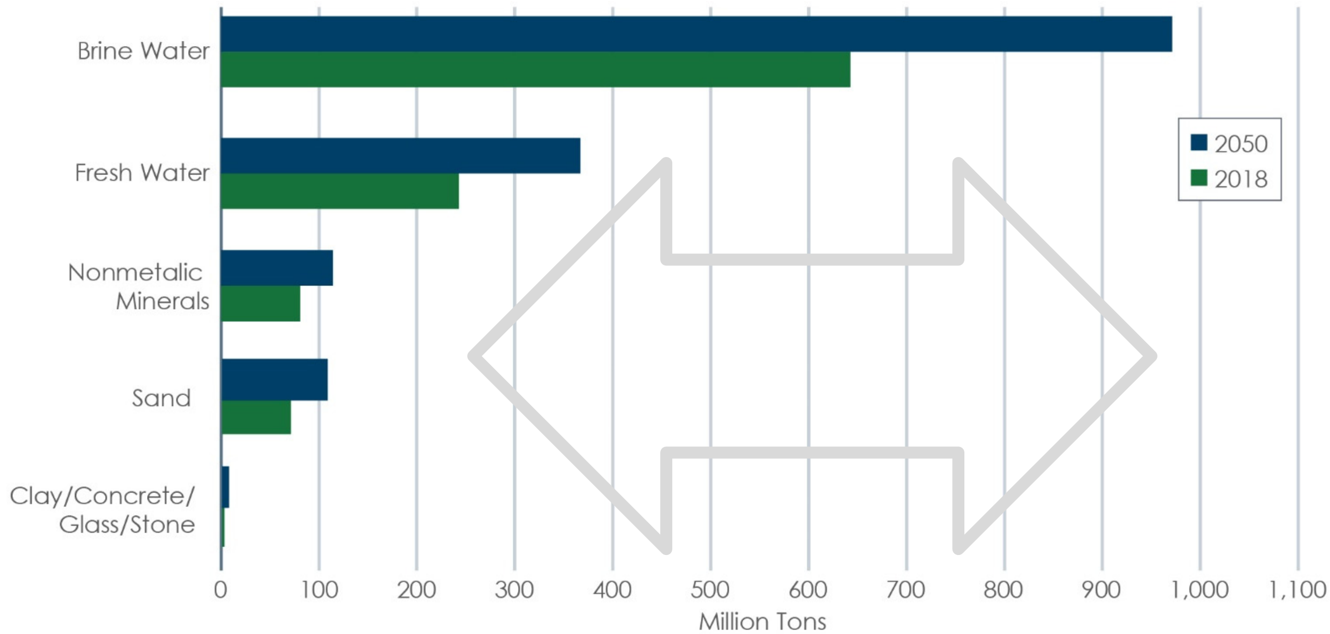
Source: Cambridge Systematics analysis of TRANSEARCH, Enverus DrillingInfo, and stakeholder input.

Exhibit 43. Top Five Outbound Commodities from the Permian Basin, 2018 and 2050



Source: Cambridge Systematics analysis of TRANSEARCH, Enverus DrillingInfo, and stakeholder input.

Exhibit 44. Top Five Intraregional Commodities in the Permian Basin, 2018 and 2050



Source: Cambridge Systematics analysis of TRANSEARCH, Enverus DrillingInfo, and stakeholder input.

3.2 PERMIAN BASIN FREIGHT NETWORK

The Permian Basin region has an extensive multimodal freight transportation system with assets including highways, rail lines, airports, and pipelines, as well as interchange points between the modes, such as airports, rail terminals, pipeline terminals, and warehouse/distribution centers. Additionally, international border gateways and Texas' Gulf Coast ports are critical for the Permian Basin's ability to deliver oil and gas to international markets. The Gulf Coast ports are also important for supplying the Permian Basin with pipes, machinery, chemicals, and other goods used in the production of oil and gas as well as consumer goods critical to both residents and the significant number of temporary workers.

These freight transportation assets support the region's economy with a GRP of nearly $98 billion in 2018. Over 1.1 billion tons of freight valued at $38.3 billion moves on these transportation assets annually.[28] The following sections summarize the Permian Basin Regional Freight Profile. Additional detail is available in the Regional Freight Profile, Issues, Challenges, and Opportunities Report.

3.2.1 PERMIAN BASIN HIGHWAY FREIGHT TRANSPORTATION ASSETS

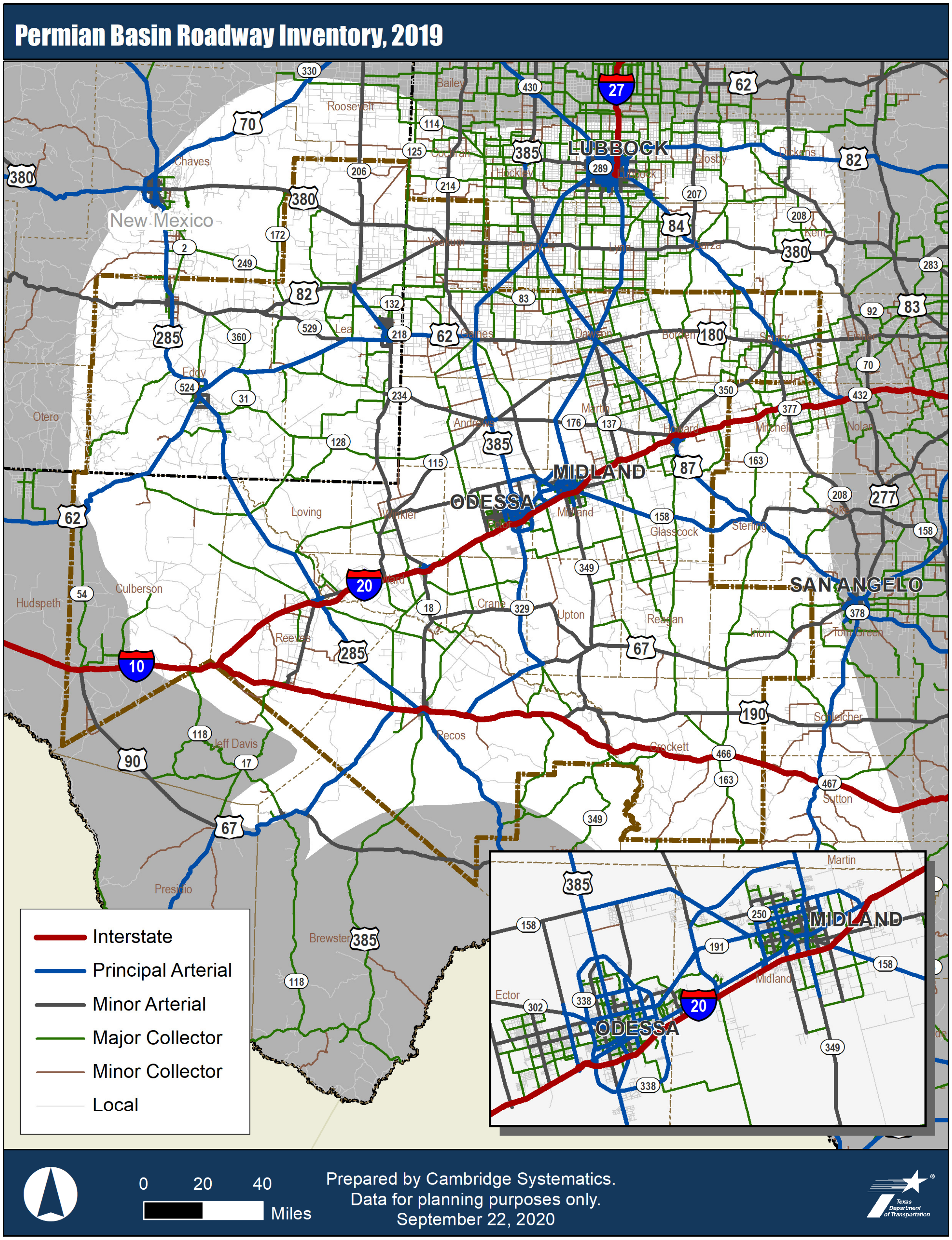
The Permian Basin region contains nearly 26,000 miles of public roadways with about 65% of the network (about 17,000 miles) being in Texas and the remainder in New Mexico. Nearly 62% of the roadway system is classified as local as depicted in **Exhibit 45**. Local roadways can be described as smaller roadways not intended for use for long distance travel, except at the origin or destination of a trip.[29] Collectors, both major and minor, are the next largest category of roadways by mileage in the Permian Basin, comprising

[28] Cambridge Systematics analysis of TRANSEARCH data supplemented with Enverus DrillingInfo data.

[29] Federal Highway Administration, *Highway Functional Classification Concepts, Criteria and Procedures*, 2013 Edition.

nearly 23% of the network. These roadways primarily facilitate intra-county travel and funnel traffic from local roads to the arterial network. Just over 13% of the region's roadways are classified as arterials, either minor or major. Arterials provide for travel over multiple counties at relatively high speeds. Approximately two percent of the region's roadways are Interstate, which provide for travel over much longer distances and at higher speeds. Goods movement relies primarily on the Interstate and arterial networks to move cargo over longer distances while collector and local roadways represent the first and last mile. Given the rural nature of the Permian Basin and the supply chain practices and geographic makeup of the energy sector, collector and local roadways are critically important to goods movement in the region. Furthermore, the Permian Basin is unique in the prevalence of sand and water being transported by truck – an activity that relies on collector and local roadways.

Exhibit 45. Permian Basin Roadway Inventory, 2019



Source: Texas Department of Transportation Open Data Portal, 2019.

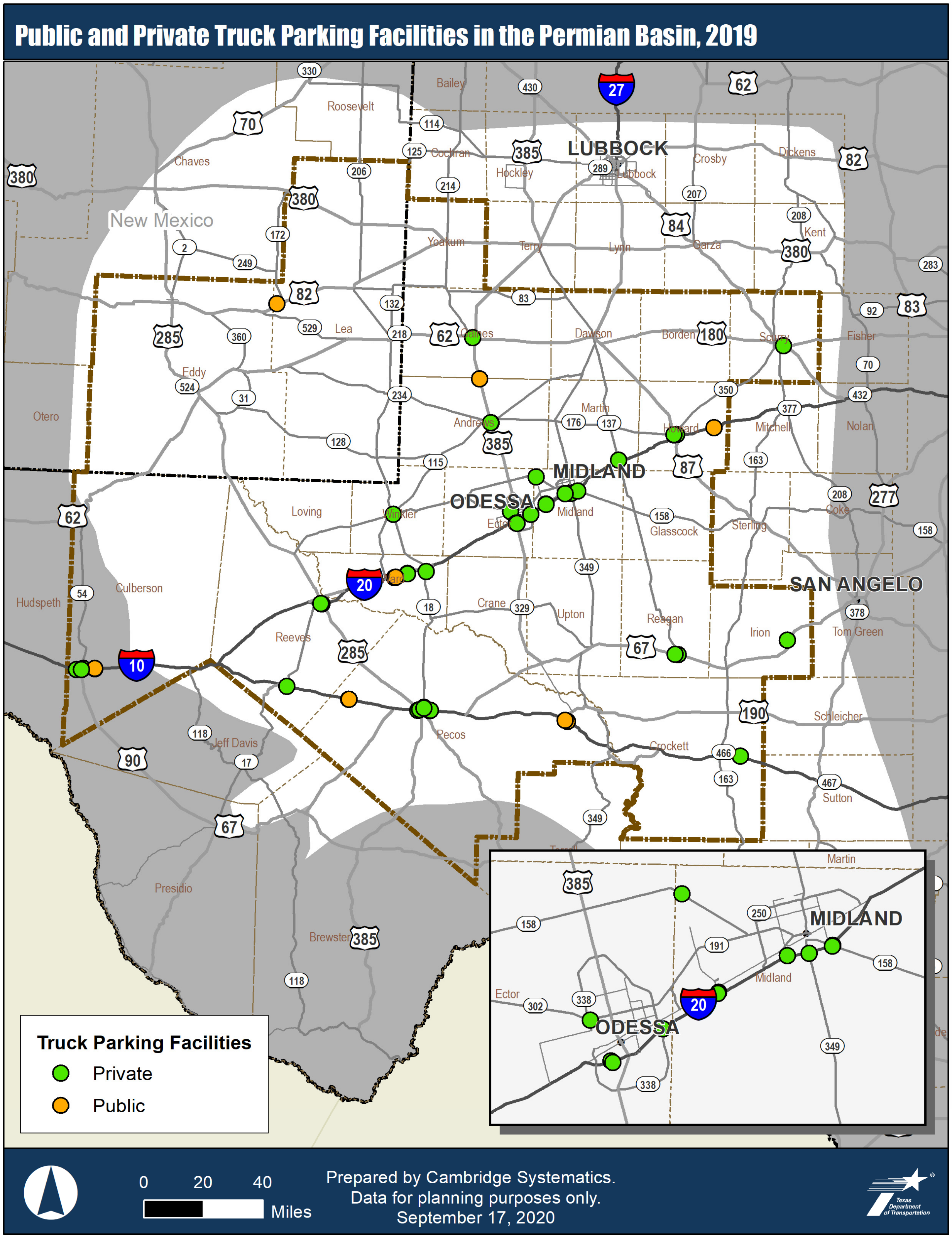
3.2.2 PERMIAN BASIN TRUCK PARKING FACILITIES

Truck parking facilities provide drivers with safe, authorized locations to park to meet federal regulations for hours-of-service (HOS), rest breaks, or staging ahead of delivery or pickup. The sufficient availability of safe spaces for rest is critical to overall highway safety. As highlighted in the 2020 Texas Truck Parking Study, most regions throughout the state lack adequate truck parking capacity and the Permian Basin leads the state in terms of rural truck parking shortages.[30]

Within the study area, there are 14 publicly owned and 40 privately owned truck parking facilities. The publicly owned facilities account for an estimated 292 truck parking spaces and the privately owned facilities provide about 2,249 truck parking spaces.[30] All but one of the publicly owned truck stops is in the Texas portion of the study area. The private facilities are clustered mainly around some of the larger cities while the public facilities are primarily located between cities. Most (42 of 54) of the region's truck stops (private and public) are located along Interstate routes. Both the public and private truck stops in the study area are shown in **Exhibit 46**.

30 Texas Department of Transportation, Truck Parking Study, 2020; New Mexico Department of Transportation, Public Rest Areas, 2019; American Truck Parking; http://www.americantruckparking.com.

Exhibit 46. Public and Private Truck Parking Facilities in the Permian Basin, 2019



Source: Texas Department of Transportation, Truck Parking Study, 2020; New Mexico Department of Transportation, Public Rest Areas, 2019; American Truck Parking; http://www.americantruckparking.com.

3.2.3 PERMIAN BASIN INTELLIGENT TRANSPORTATION SYSTEM ASSETS

Intelligent transportation systems (ITS) and technology programs along highways in the Permian Basin include devices, systems, and data used to enhance the safety and efficiency of the region's roadway network. This is accomplished by preventing and mitigating disruptions on the system due to crashes, bridge strikes, and other forms of non-recurring events. ITS device types present in the Permian Basin are summarized in **Exhibit 47**.

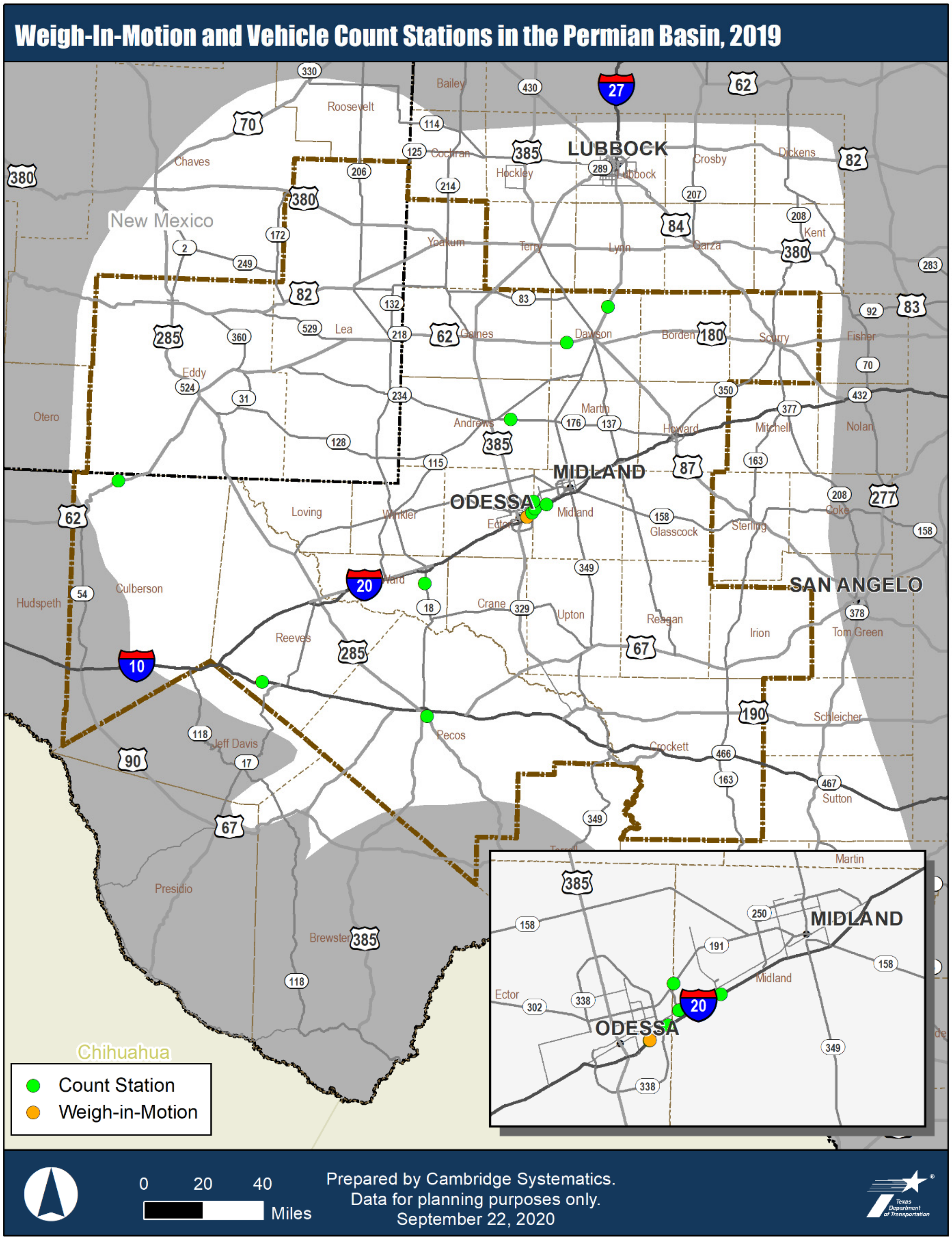
Exhibit 47. ITS Device Types in the Permian Basin

Device Type	Description	Number of Devices
Closed-Circuit Television (CCTV) Cameras	CCTV cameras provide coverage on high-traffic corridors. They feed back to DriveTexas, a web-based traffic management service that monitors roadway conditions. The DriveTexas.org website provides information on incidents, construction activity, and driving conditions.	21
Dynamic Message Signs (DMS)	Dynamic Message Signs display important messages to drivers on key corridors. They can also include Comparative Travel Time (CTT) signs.	20
Weigh in Motion/Vehicle Count Stations	Most weigh in motion (WIM) stations in Texas serve a dual purpose as vehicle count (VC) stations. They are useful for determining traffic counts and commercial vehicle weights.	17 (2 WIM and 15 VC)

Source: Texas Department of Transportation.

TxDOT owns and operates WIM and permanent VC stations around the state that are used to collect data for planning purposes on an on-going basis. WIM is a technology that estimates truck weights to (1) inventory the percentage of overweight vehicles at a given location, (2) collect and classify traffic data for planning activities, and (3) provide notification of a likely overweight vehicle for law enforcement to investigate. Count stations collect data to support the estimation of average annual daily traffic and other data, typically through loop detectors or microwave radar units. . There are 15 VC stations and two WIM stations in the study area. This is a challenge given the magnitude of freight activity on the region's highway system and the prevalence of oversize/overweight trucks transporting sand, water, and other oilfield commodities and equipment. **Exhibit** 48 shows the deployment of WIM and VC stations in the Permian Basin.

Exhibit 48. Weigh-In-Motion and Vehicle Count Stations in the Permian Basin, 2019



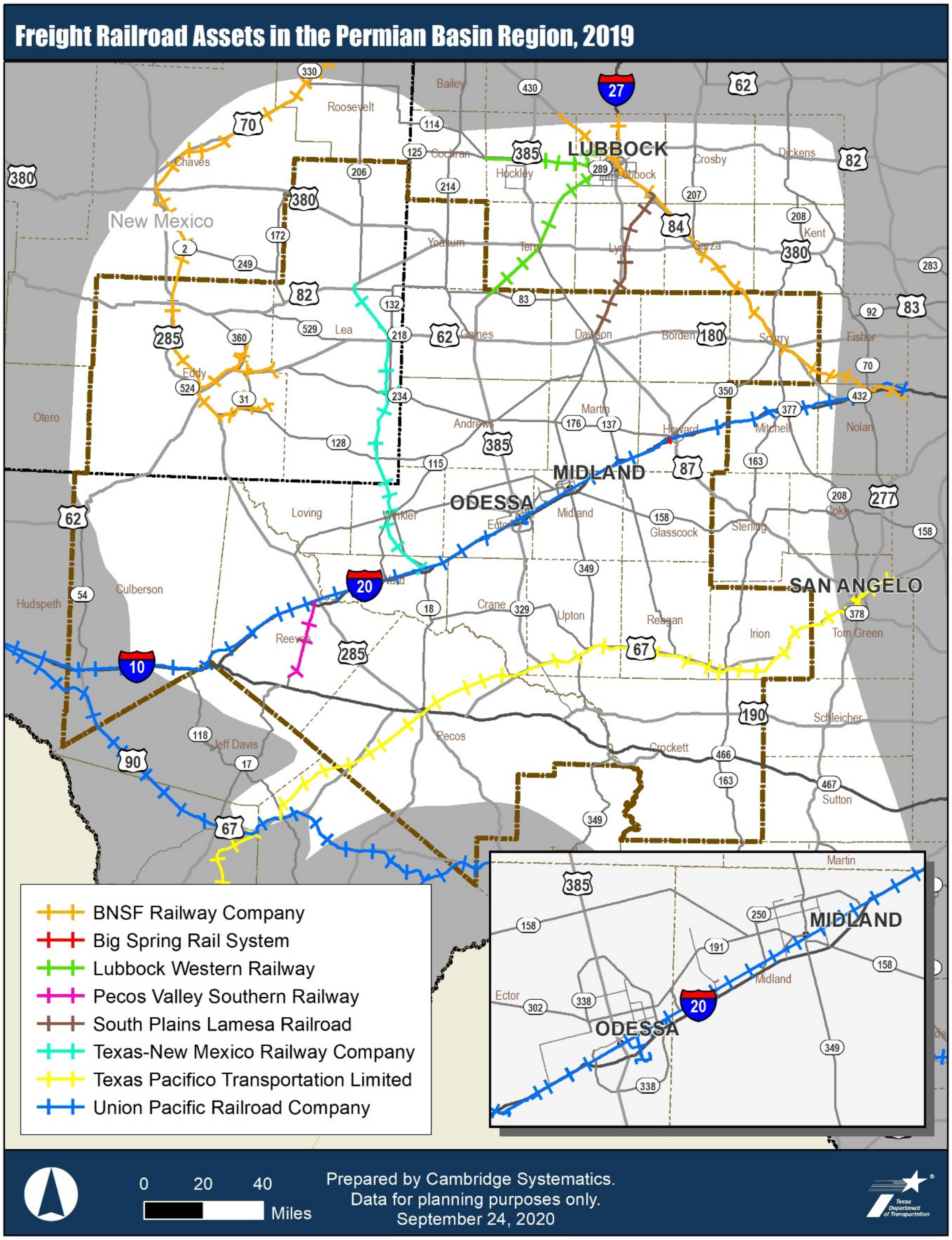
Source: Texas Department of Transportation Open Data Portal, , 2019.

3.2.4 PERMIAN BASIN FREIGHT RAILROAD ASSETS

There are over 920 miles of active railroad in the Permian Basin region. This network varies in ownership by two Class I and six regional railroad operators, as depicted in **Exhibit** 49. Railroad classification is determined by the U.S. Surface Transportation Board (STB) based on annual revenue dollars. In 2017 dollars, railroads with annual operating revenues of $447.6 million or more are classified as Class I railroads. Railroads with operating revenue less than $447.6 million are classified as Class II or Class III. While Class I railroads primarily haul freight over long distances between large yards, Class II and III operators (i.e., "regional railroads") are responsible for the first and last mile deliveries to smaller terminals and rail-served properties. Union Pacific Railroad (UP) and BNSF Railway Company (BNSF) are the Class I operators serving the Permian Basin region.

The majority of the region's freight rail infrastructure is owned by UP or TxDOT, though TxDOT's rail infrastructure is operated by Texas Pacifico. These two operators account for over 57% of railroad miles in the Permian Basin. For the Texas portion of the region, TxDOT and UP account for approximately 80% of the freight rail network while the region's other Class I operator, BNSF, accounts for only about seven percent. For the New Mexico portion of the region, BNSF and the Texas-New Mexico Railway Company are the only operators.

Exhibit 49. Freight Railroad Assets in the Permian Basin Region, 2019



Source: National Transportation Atlas Database, 2019; Texas Department of Transportation Open Data Portal, 2019.

Note: Texas Pacifico is owned by TxDOT

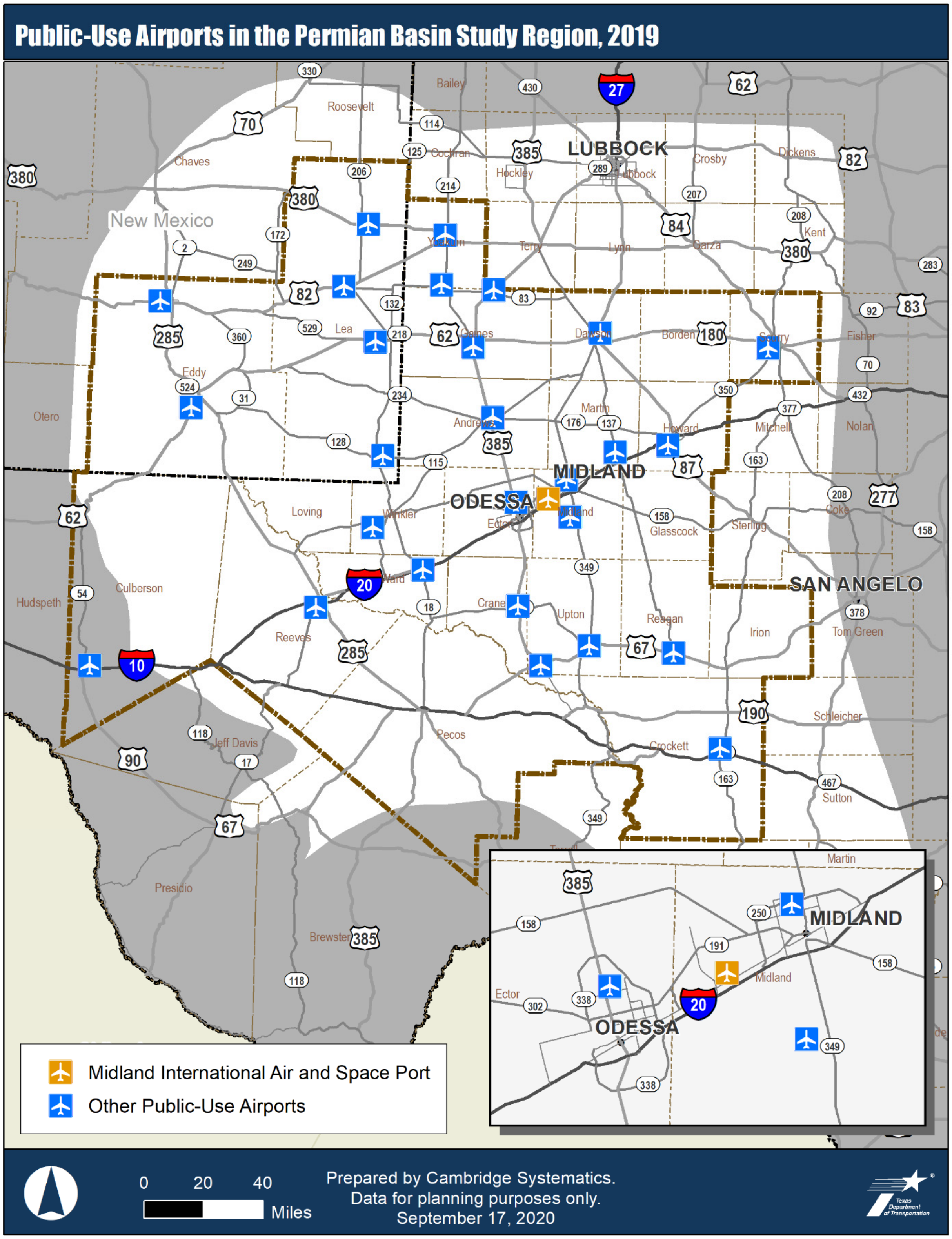
3.2.6 PERMIAN BASIN AIR CARGO TRANSPORTATION ASSETS

In general, air cargo is typically lightweight, time-sensitive, and high-value. Common examples of air freight include perishables (flowers, fish, produce), computers and peripherals, telecommunications equipment, pharmaceuticals, medical supplies and equipment, and beauty supplies. Air cargo movements take place via one of three types of carriers: all-cargo, integrated express, or on passenger airlines as belly cargo.

There are 28 public-use airports in the study area as shown in **Exhibit 50.** The Midland International Air and Space Port (MAF) is the only public-use airport in the region that handles cargo. Passenger travel has grown rapidly at MAF as the region's population and transient workforce has increased, spurred by the growing oil and gas industry.[31] There is relatively little air cargo at MAF as Federal Express (FedEx) and United Parcel Service (UPS) each operate only one plane per day. Southwest Airlines carries some belly cargo on passenger flights, predominately fresh fish, flowers, and deceased persons for burial.

[31] Interview with Justin Ruff (Director of Airports, City of Midland), June 28, 2019.

Exhibit 50. Public-Use Airports in the Permian Basin Region, 2019



Source: National Transportation Atlas Database, April 12, 2019; Texas Department of Transportation Open Data Portal, 2019.

3.2.6 PERMIAN BASIN PIPELINE ASSETS

Pipelines are an important component of the multimodal freight system given the reliance of the energy sector on this mode. The region relies on this multimodal system to transport crude oil, natural gas, natural gas liquids (NGLs), and other associated products to and from the region. The petroleum supply chain relies on multiple types of pipelines to collect, transmit, and distribute petroleum products. Collection pipelines move products to regional hubs which then connect to storage facilities or terminals along the Texas Gulf Coast, providing access to many international markets. Transmission pipelines carry products from terminals to market hubs, other terminals, and processing plants that sell fuel and other products refined from these resources to customers, often via distribution pipelines. Many of the transmission pipelines are interstate systems that supply products to other states and to Mexico. Maritime ports transport beyond Texas to global markets. There are also dedicated chemical pipelines that carry synthesis gas, anhydrous ammonia, carbon dioxide, and hydrogen from the Permian Basin to fractionalization and cracking plants located along the Gulf Coast.

Four Main Commodities Transported by Pipelines

- Crude oil
- Natural gas
- Natural gas liquids (NGLs)
- Refined petroleum products

Common Capacity Metrics used for Pipelines

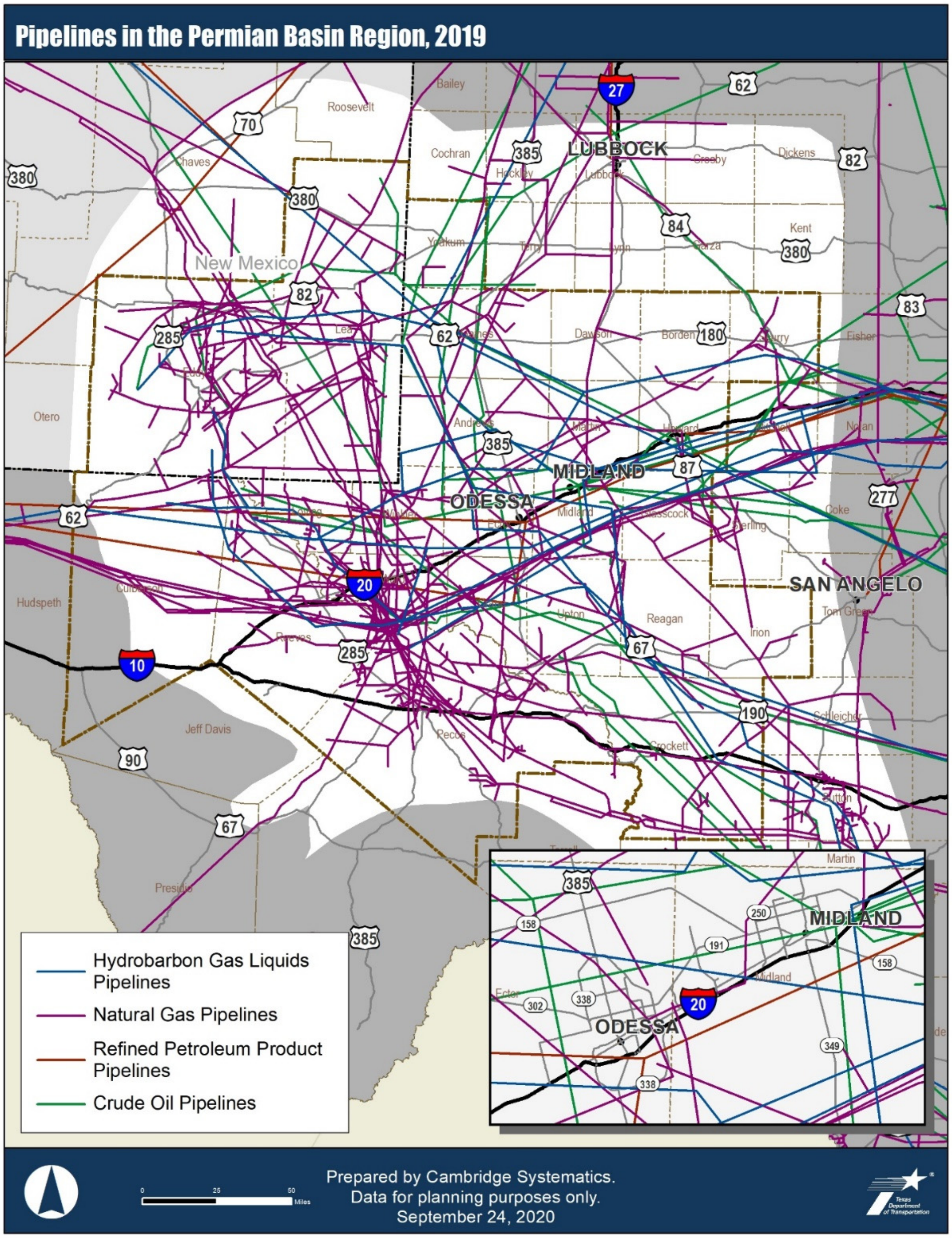
MMbbl/d	Million Barrels per Day
MMbbl	Million barrels
Mbbl/d	Thousand barrels per day
Mbbl	Thousand barrels
Mcf	Thousand cubic feet
MMcf	Million cubic feet
MMcf/d	Million cubic feet per day

Texas exported more than $83.3 billion in petroleum in 2019, making it the state's number 1 export product in terms of value. Natural gas was number 10 in top exported commodites with more than $3.8 billon worth of exports.[32] Takeway pipelines play a critical role in ensuring the competitiveness of oil and gas exports in Texas and in the Permian Basin as they provide the safest and most cost-effective way to transport oil and gas. According to the U.S. EIA, since 2018, operators in the Permian Basin region have increased pipeline capacity by approximately 635 thousand barrels per day (Mbbl/d) to a total of about 6 MMbbl/d. The build-out started with Cactus I, Plains All American's Sunrise Expansion (350 Mbbl/d) in November 2018. Magellan Midstream's BridgeTex (40 Mbbl/d) followed in December 2018 from Midland to Houston. Enterprise Products Partners' Midland-to-Echo pipeline (45 Mbl/d) was completed in March 2019. In addition, Enterprise's most recent conversion of an existing NGL pipeline to crude oil service added 200 Mbbl/d of capacity. According to RBN Energy, in the Permian Basin alone, there was an estimated 4.3 MMbbl/d of new pipeline takeaway capacity planned or under construction in 2019. As of 2019, there were 13 pipelines owned by seven different companies that provide critical connections for transporting Permian Basin crude oil to the Gulf Coast and

32 U.S, Census Bureau, Foreign Trade Statistics.

to Cushing, Oklahoma.[33] **Exhibit 51** displays the pipeline connections at the regional level and **Exhibit 52** displays the pipeline connections at the state level.

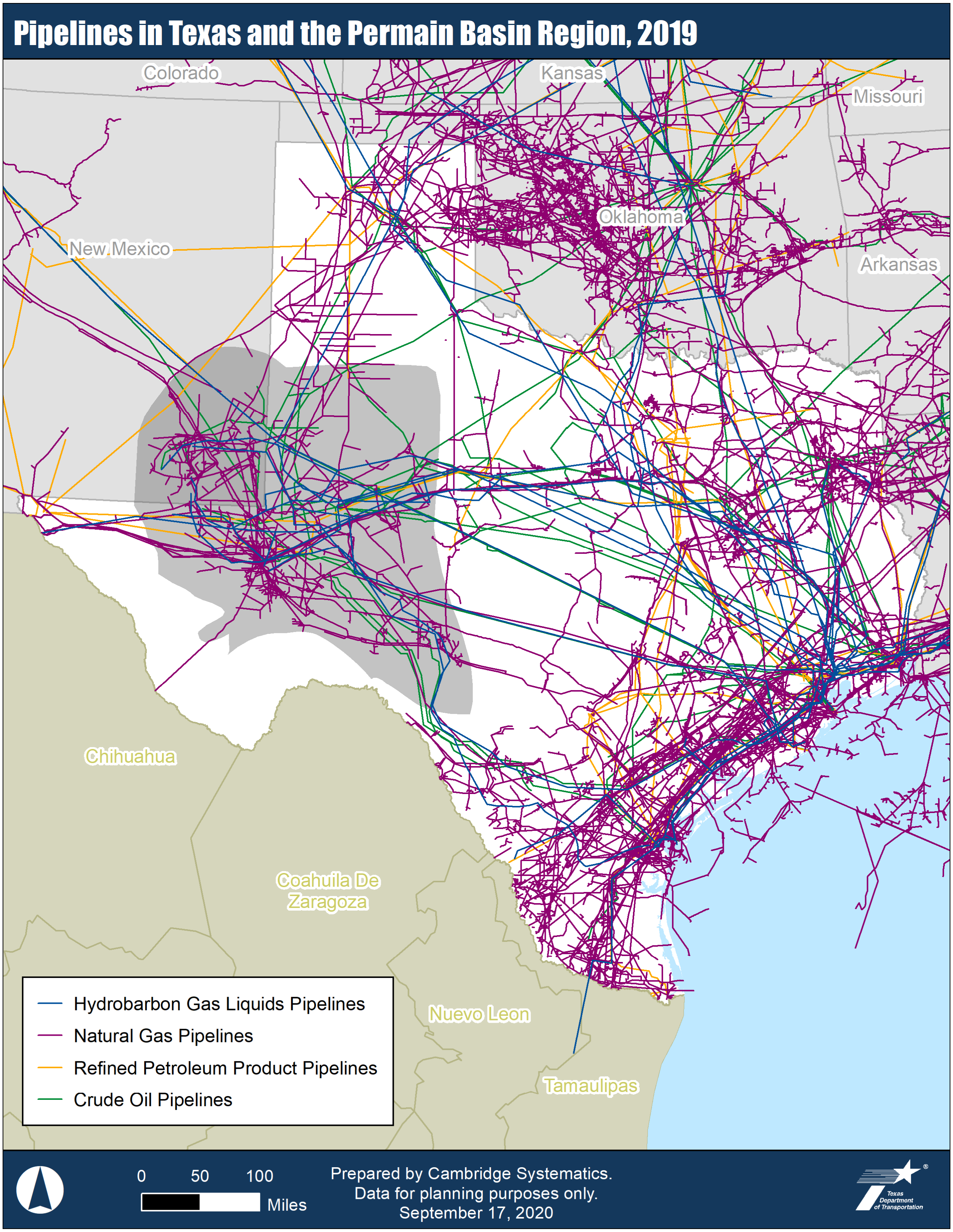
Exhibit 51. Pipelines in the Permian Basin Region, 2019



Source: U.S. Energy Information Administration, 2019.

33 Source: U.S. Energy Information Administration, https://www.eia.gov/petroleum/data.php, RBN Energy.

Exhibit 52. Pipelines in Texas and the Permian Basin Region, 2019



Source: U.S. Energy Information Administration, 2019.

3.2.7 PERMIAN BASIN MULTIMODAL FREIGHT NETWORK

The designation of the Permian Basin Multimodal Freight Network (PBMFN) is a key outcome of the Permian Basin Freight Plan. The PBMFN:

- Focuses investments on the portion of the system that carries most of the region's freight;
- Identifies candidates for Critical Urban and Rural Freight Corridors for the National Highway Freight Network;
- Establishes the basis for data collection and analysis for the Permian Basin Freight Plan; and
- Positions projects for federal funding through the National Freight Program and federal grant opportunities.

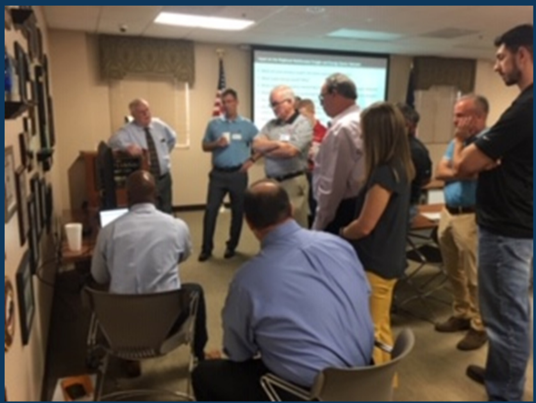
The designation of the regional network, summarized below and detailed in the Permian Basin Multimodal Freight Network Report, follows the process used at the state level with enhancements to account for the unique impact of the energy sector in the region.

Stakeholder Input in Designating the PBMFN

Regional stakeholders played a critical role in defining the region's multimodal freight network. Input was collected through:

- More than 40 Stakeholder interviews
- 12 Industry forums
- Two web-based surveys with over 100 responses
- 5 Steering committee meetings

The quantitative scoring of the network was supplemented with stakeholder comments to derive the total score and ultimate designation.



Permian Basin Highway Freight Network

The designation of the Permian Basin Highway Freight Network (PBHFN) utilized criteria in four key categories: including:

- Economic Readiness: socioeconomic factors, freight intensity, and economic activity generators along a roadway segment;
- Goods Movement: truck volumes and tonnage and value of freight moving on a roadway segment;
- Supply Chain: number and size of businesses in the energy sector and other key supply chains being served by a roadway segment; and
- Market Access and Connectivity: intermodal connectivity (connections to rail, pipeline, sand mine, airport, etc.), connectivity to key domestic and international trading partners, and connectivity to international gateways provided by a roadway segment.

The PBHFN was designated using the process shown in **Exhibit 53**. The network, presented in **Exhibit 54** and **Exhibit 55**, consists of three tiers. Roadways on Tier 1 and 2 are the most critical for goods movement and energy sector operations in the region; roadways on Tier 3 are important connector routes on which freight volumes are likely to increase as the region continues to grow.

Exhibit 53. Process for Designating the Permian Basin Highway Freight Network

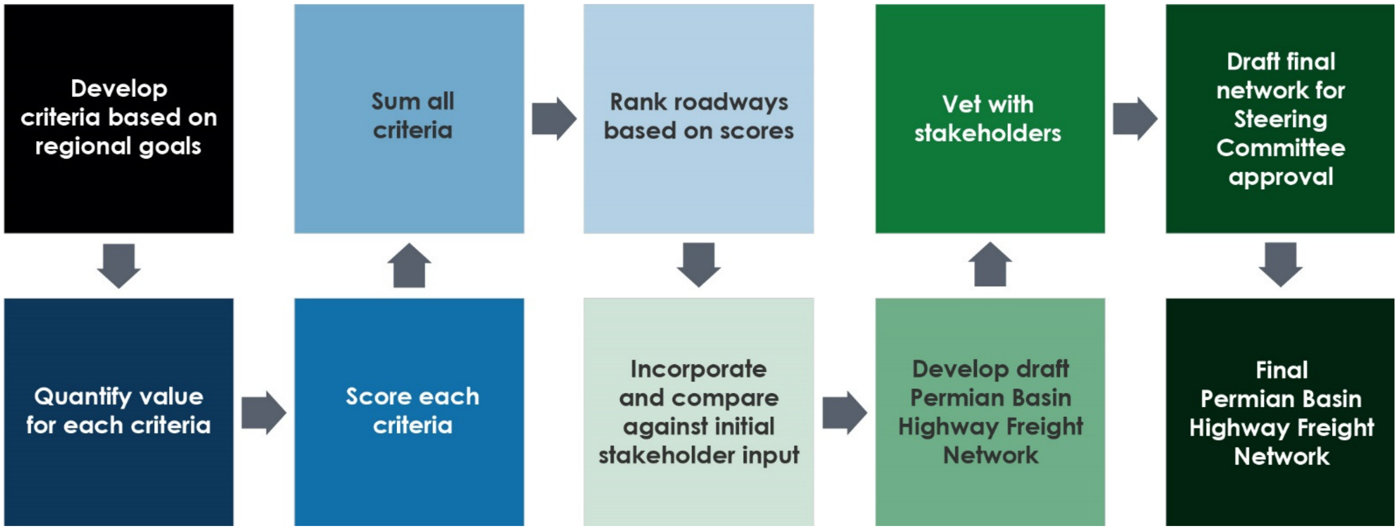
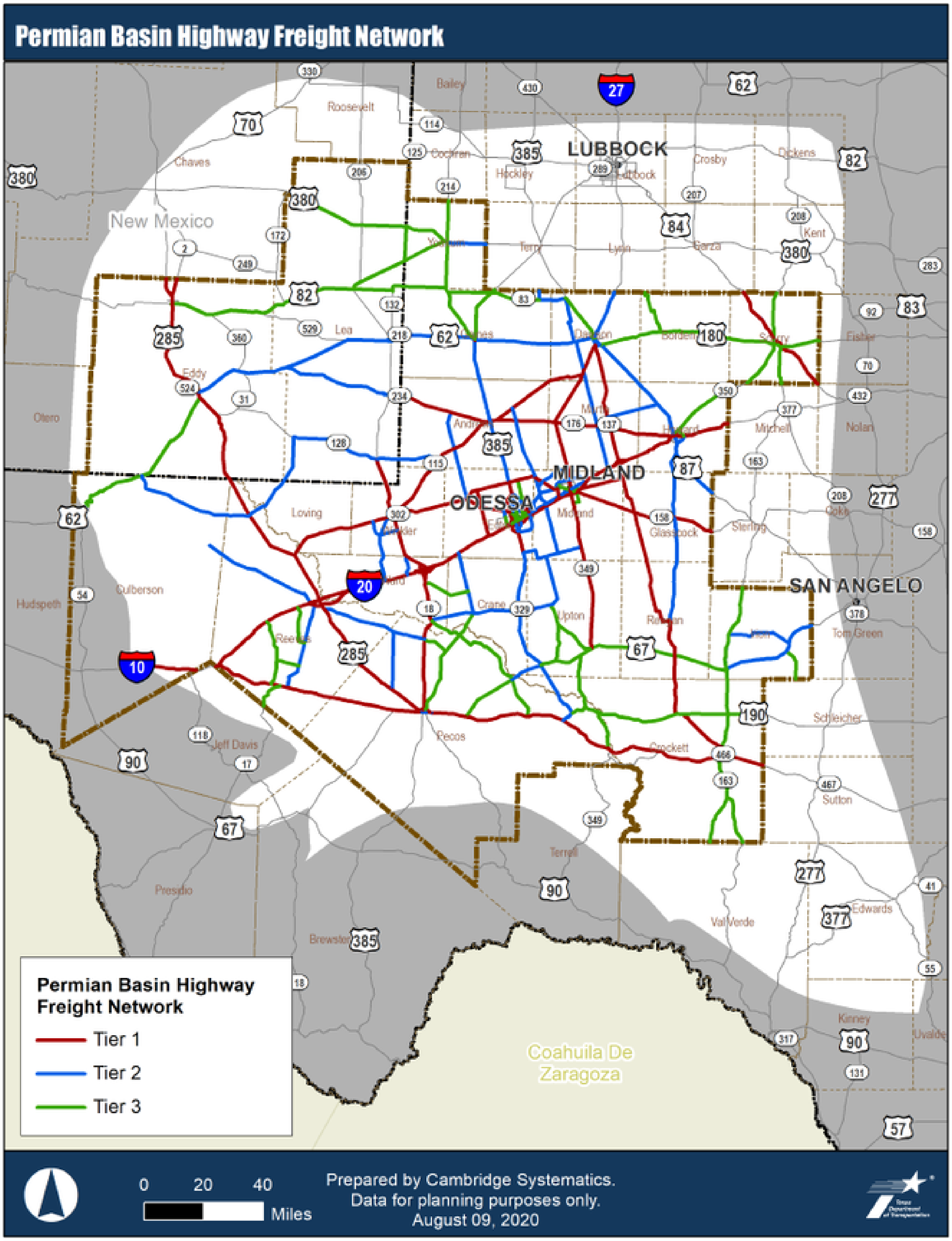
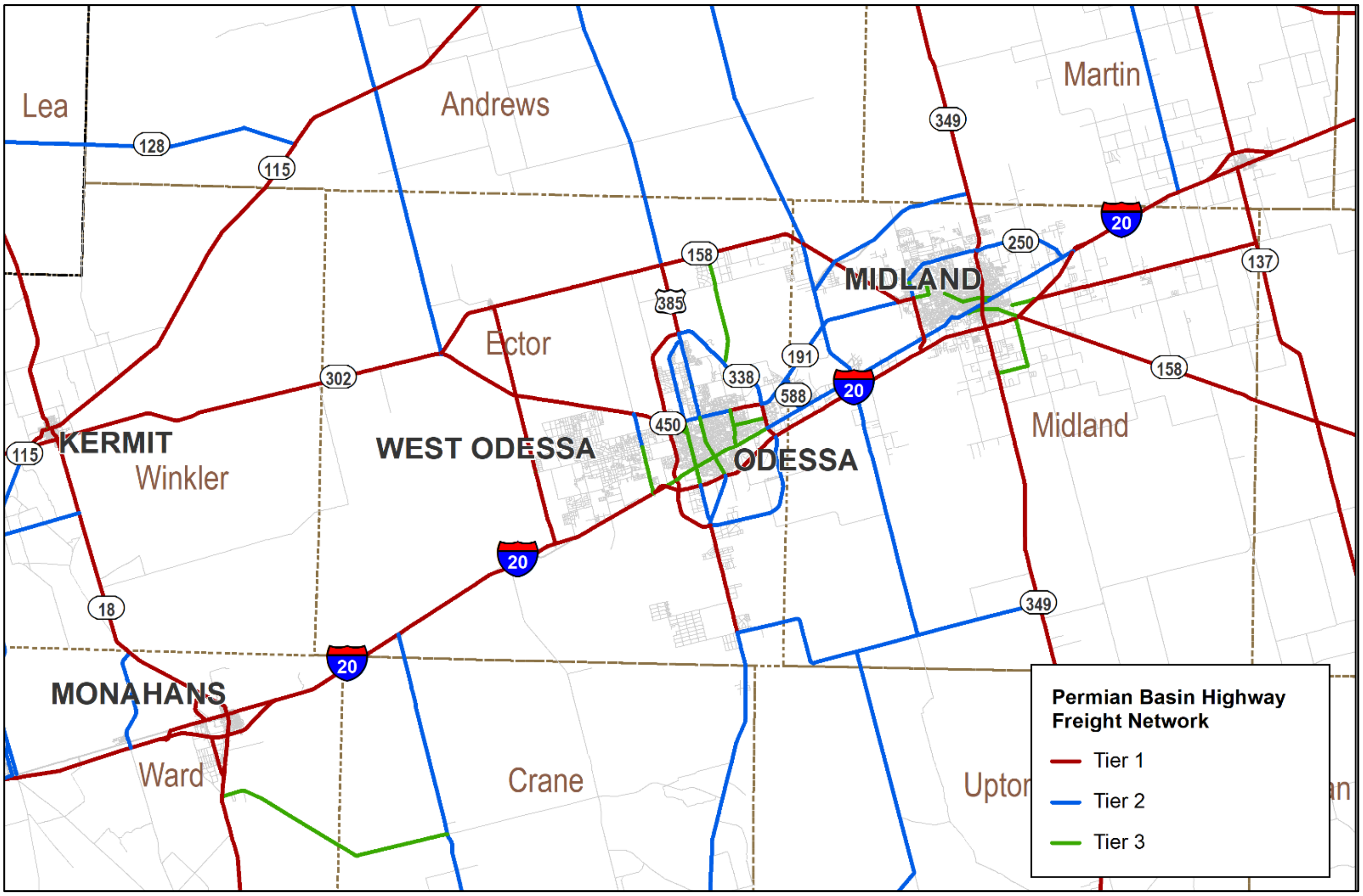


Exhibit 54. Permian Basin Highway Freight Network



Source: Cambridge Systematics analysis and stakeholder input.

Exhibit 55. Permian Basin Highway Freight Network (Center of Region)

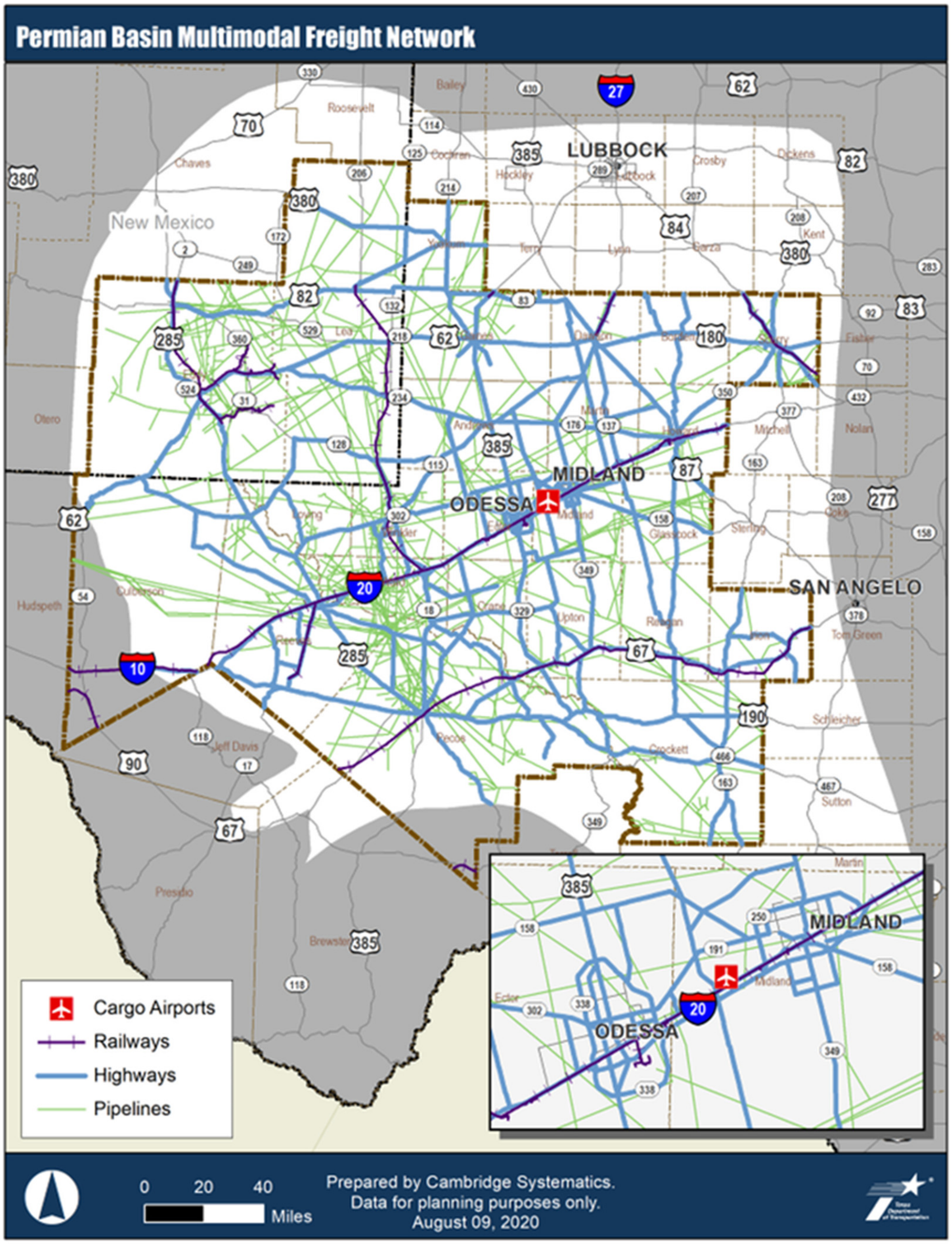


Source: Cambridge Systematics analysis and stakeholder input.

Permian Basin Multimodal Freight Network

The PBMFN includes the PBHFN as well as railroads, pipelines, and airports in the region. Because of the critical role they play in transporting freight, all freight railroads, pipelines, and MAF were included on the PBMFN. Together, these modes provide for critical transportation of freight within, into, and out of the Permian Basin region. The PBMFN is presented in **Exhibit 56**.

Exhibit 56. Permian Basin Multimodal Freight Network



Source: Cambridge Systematics analysis and stakeholder input.

Chapter 3 presented a profile of the freight and energy sector transportation assets, commodity flows, and the Permian Basin Multimodal Freight Network. **Chapter 4** discusses the performance and condition of the network.

CHAPTER 4 Permian Basin Freight Multimodal Network Conditions and Performance

4.1 PERMIAN BASIN HIGHWAY FREIGHT NETWORK CONDITIONS AND PERFORMANCE

Understanding freight transportation's current and future demand, needs, and issues is critical to ensuring safe and efficient freight movement in the Permian Basin. By assessing freight system conditions and performance, TxDOT, along with regional and local governments and planning agencies, can establish freight transportation policies and priorities, plan and execute appropriate infrastructure investments, and enhance transportation operations for the region. Since land use has a significant impact on the performance of the system, freight intensive land uses, and the implications for vulnerable communities must be examined and factored into the planning process.

This chapter summarizes the conditions and performance of the PBHFN and other components of the PBMFN, including railroads, MAF, and pipelines. Additionally, the chapter provides an overview of the freight and land use analysis and findings for the Permian Basin. The findings presented in this chapter lay the foundation for the needs assessment. An analysis of network usage, performance, conditions, and multimodal connectivity provides insights into the demands being placed on the Permian Basin transportation network and helps identify where the system is meeting (or failing to meet) those demands. The information provides regional decision-makers with a stronger foundation for identifying and assessing potential freight system investments.

Identification of the region's highway freight conditions and performance focused only on routes on the PBHFN, as these facilities have been identified as the most critical for the movement of freight throughout the region. Evaluation of the conditions and performance of the PBHFN allows for the identification of needs and gaps across the network. This evaluation is organized around the goals of the Permian Basin Freight Plan. Specific performance and condition factors were grouped into four major categories: mobility and reliability; safety; freight asset utilization and preservation; and rural roads and connectivity (see **Exhibit 57**).

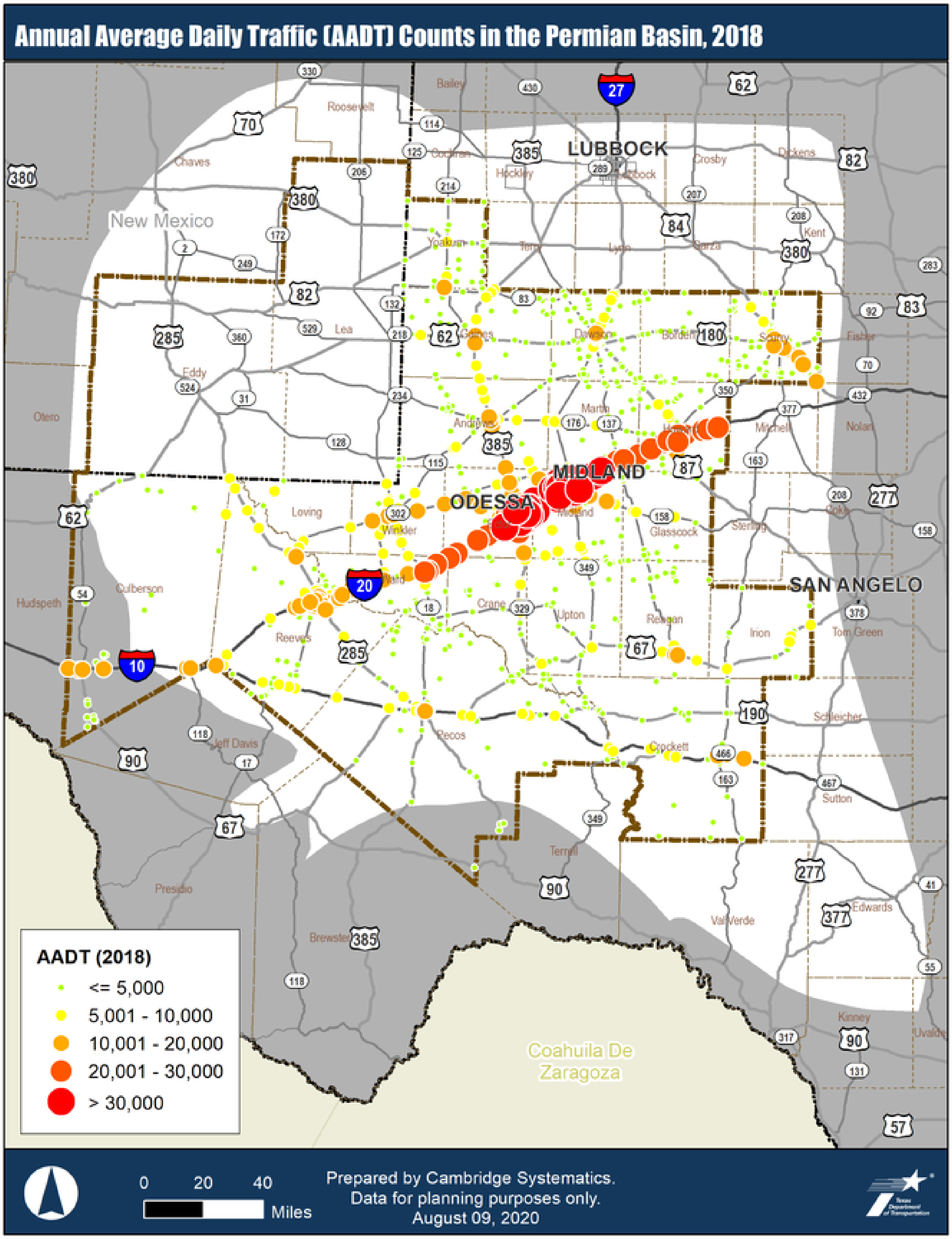
Exhibit 57. Factors Included in the Evaluation of Conditions and Performance of the Permian Basin Highway Freight Network

Mobility & Reliability	Safety	Asset Utilization and Preservation	Rural Roads Connectivity
• Truck counts • Truck travel time reliability • Buffer time index	• Truck involved crashes • Rest areas and truck parking • Access management	• Pavement conditions • Bridge load restrictions and conditions • Bridge vertical clearance • OS/OW activity	• Frontage roads • Number of lanes

4.1.1 MOBILITY AND RELIABILITY

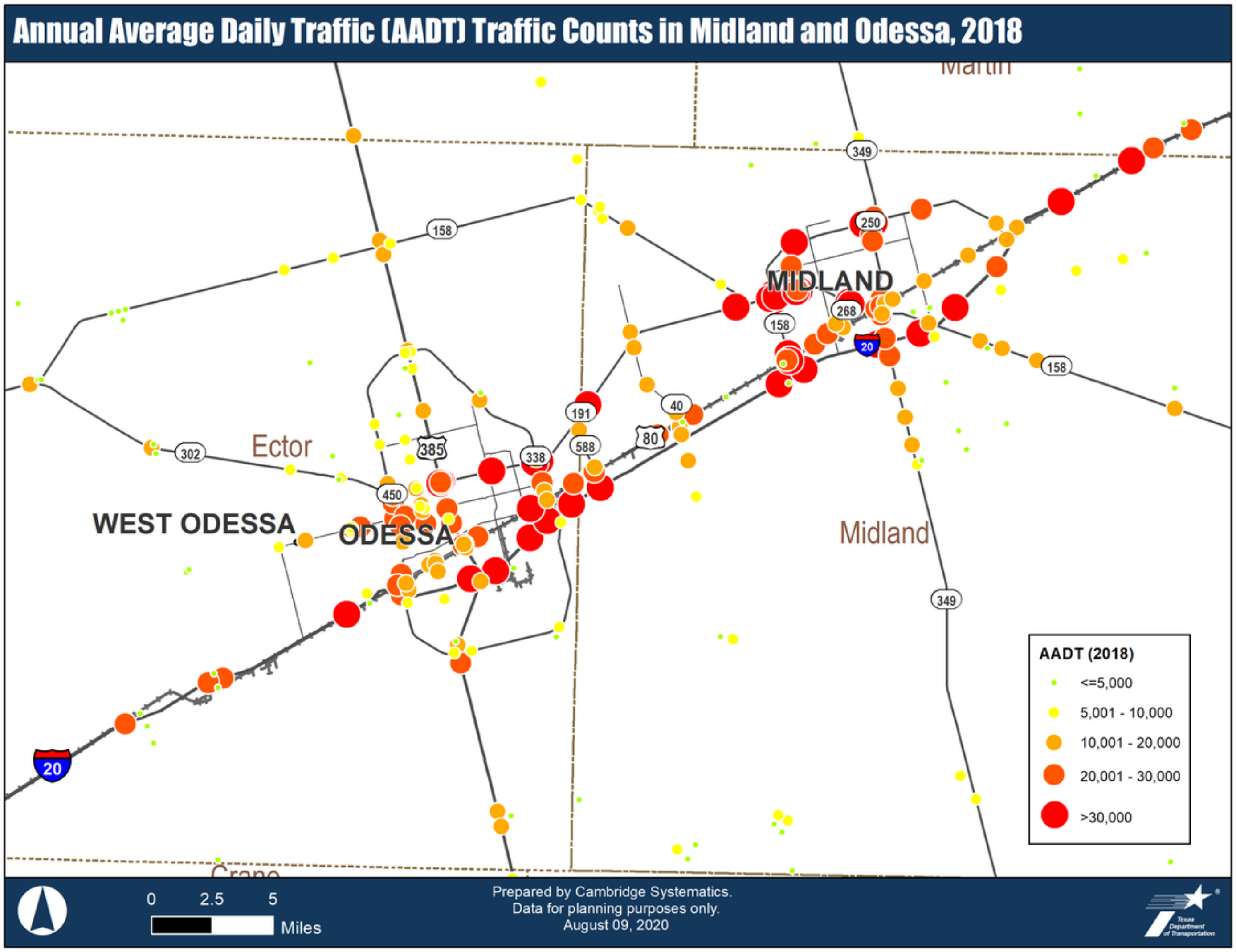
Traffic count data provide insights on where traffic activity is generally centered in the region. As shown in **Exhibit 58** and **Exhibit 59**, much of the region's annual average daily traffic (AADT) activity is centered in the urban core. Particularly, the I-20 corridor between U.S. 285 in Reeves County and U.S. 87 in Howard County exhibit the highest AADT volumes. In addition, there is significant traffic activity along the U.S. 385 corridor between Odessa and Andrews.

Exhibit 58. Permian Basin Annual Average Daily Traffic Counts, 2018



Source: Texas Department of Transportation Open Data Portal 2019.

Exhibit 59. Annual Average Daily Traffic Counts, Midland and Odessa, 2018



Source: Texas Department of Transportation Open Data Portal, 2019.

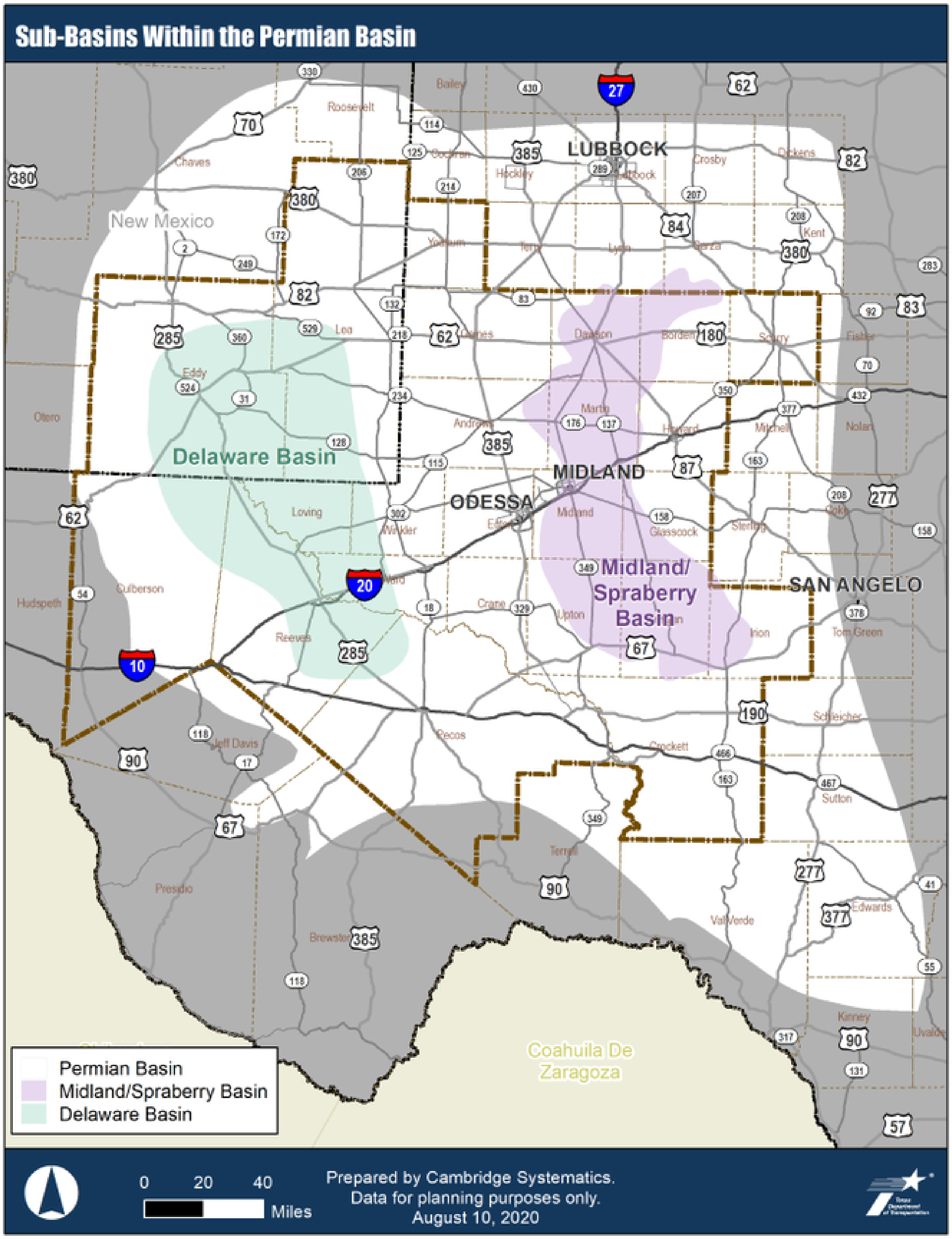
While the Interstate highways are the backbone of the region's multimodal freight system, non-Interstate highways play a vital role in providing freight mobility, especially for truck traffic generated by the energy sector. Truck trip generation on the region's roadways is discussed below.

Transient Oilfield Truck Trip Generation

A factor that makes capturing the full scale of truck traffic difficult, and infrastructure investment decisions challenging, in the areas surrounding active oil fields is that the traffic associated with the drilling sites is transient. The volume of trucks serving a new development site is initially high as the site is being prepared for oil and/or gas production and the levels off as production begins.

Exhibit 60 displays the two basins within the Permian Basin region. While the Midland Basin to the east is served by a network of multiple east-west and north-south routes, the network in the Delaware Basin to the west is not as well developed. For example, SH 349, SH 137, and U.S. 87 provide north-south options for the transport of oilfield commodities through the Midland Basin; Interstate 20, SH 176, and U.S. 67 provide east-west options. In the Delaware Basin, only I-20 and SH 302 provide for east-west moves for the transport of oilfield commodities (SH 302 only provides east-west coverage for a portion of the area). U.S. 285 is the only north-south route.

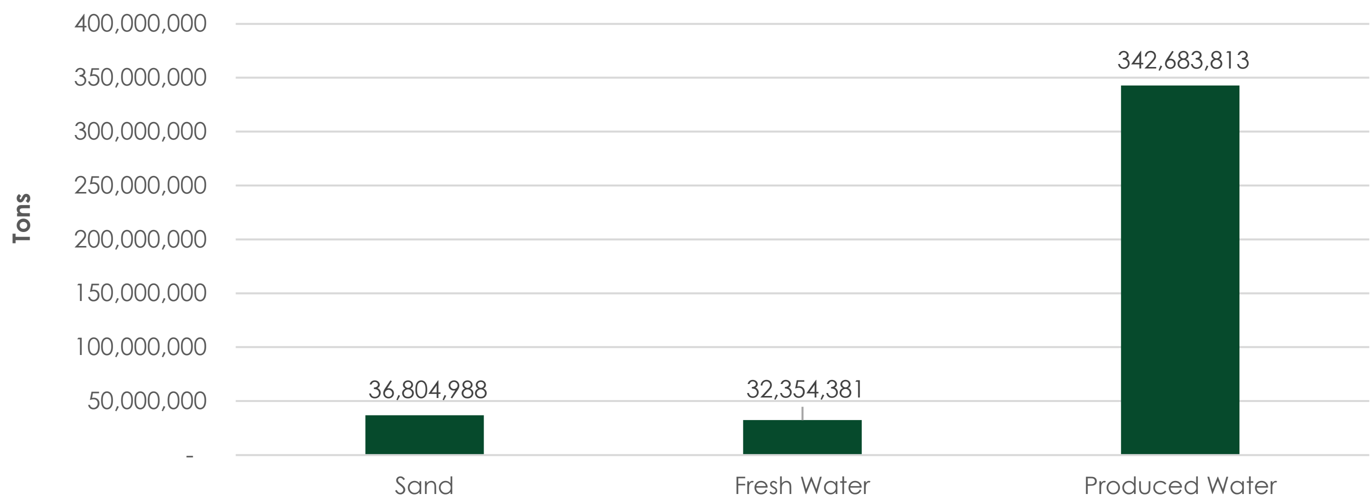
Exhibit 60. The Delaware and Midland/Spraberry Basins in the Permian Basin



Because traditional transportation data sources, such as TRANSEARCH and TxDOT vehicle count stations, do not capture the full scale of truck volumes in the region (specifically as it relates to oilfield commodities), the volume of truck traffic associated with the transport of sand, fresh water, and produced water has been estimated separately. Truck volumes were estimated using data on the total amounts of sand and water used in hydraulic fracturing in the Permian Basin for the year 2018 from the Enverus Drillinginfo database, the FracFocus database, and various reports from the Texas Railroad Commission; the New Mexico Energy, Minerals, and Natural Resources Department; and the Texas Water Development Board.

The estimated tonnages of sand, fresh water, and produced water transported by truck in 2018 are shown in **Exhibit 61.** Approximately 36.8 million tons of sand, 32.4 million tons of fresh water, and 342.7 million tons of produced water were estimated to have been transported by truck. Although, stakeholders indicated some sand is railed into the region from external sources, they confirmed that most sand used in hydraulic fracturing is generated locally and is delivered by truck. Importantly, for fresh water and produced water, it is estimated that 90% of the fresh water and 60% of the produced water are transported by pipeline based on stakeholder input. The high amount of produced water equates to as many as 7 barrels of produced water for every barrel of crude oil.[34]

Exhibit 61. Estimated 2018 Tonnage of Select Oilfield Commodities Moved by Truck in the Permian Basin



Source: Enverus Drillinginfo Database, 2020; FracFocus Database, 2020; New Mexico Energy, Minerals, and Natural Resources Department: Oil Conservation Division, County Production and Injection Summary by Month for Eddy and Lea Counties, 2020; Texas Water Development Board, Groundwater Database, 2020; Texas Water Development Board, Submitted Drillers Report Database, 2020; New Mexico Office of the State Engineer, Points of Diversion Geospatial File, 2020; Texas Railroad Commission, H-10 Reports, 2020; Cambridge Systematics analysis.

From the estimated tonnages for the three analyzed oilfield commodities, annual average daily truck trips are estimated as shown in **Exhibit 62**. For sand, nearly 8,800 truck trips per day are estimated to occur across the study region. Over 8,400 truck trips per day are estimated to be generated by movements of fresh water to wells. For produced water, the estimated truck trip volume is much higher (reflecting a higher mode split by truck), at over 89,000 truck trips per day. This activity is believed to be largely uncaptured by

34 https://www.evs.anl.gov/publications/doc/ProducedWatersWP0401.pdf

traditional traffic counts and truck volume estimation methodologies due to the transience of oilfield production activity as discussed earlier.

The broader implications of these results suggest that portions of the region's highway freight network can be subject to intense, heightened levels of congestion and vehicle loadings within a short period of time (45 to 75 days as discussed below). This negatively impacts mobility, safety, and the state of good repair of roadways that serve as primary access points to active energy exploration areas. For example, as discussed earlier in this section, U.S. 285 in the Delaware Basin is the only north-south arterial highway proximate to active oil fields in that area. Thus, it is directly impacted by the mobility, safety, and infrastructure condition challenges brought on by the movements of oilfield commodities.

Exhibit 62. Estimated Truck Volumes from Select Oilfield Commodities

Oilfield Commodity	Annual Loaded Truck Trips	Annual Total Truck Trips (Loaded + Empty)	Average Daily Truck Trips
Sand	1,600,217	3,200,434	8,768
Fresh Water	1,540,685	3,081,370	8,442
Produced Water	16,318,277	32,636,554	89,415
Total	19,459,179	38,918,358	106,625

Source: Enverus Drillinginfo Database, 2020; FracFocus Database, 2020; New Mexico Energy, Minerals, and Natural Resources Department: Oil Conservation Division, County Production and Injection Summary by Month for Eddy and Lea Counties, 2020; Texas Water Development Board, Groundwater Database, 2020; Texas Water Development Board, Submitted Drillers Report Database, 2020; New Mexico Office of the State Engineer, Points of Diversion Geospatial File, 2020; Texas Railroad Commission, H-10 Reports, 2020; Cambridge Systematics analysis.

Note: The analysis assumes 23 tons per truck for sand and 21 tons per truck for fresh and produced water, per stakeholder input. It also assumes that for every loaded trip there is a corresponding empty movement.

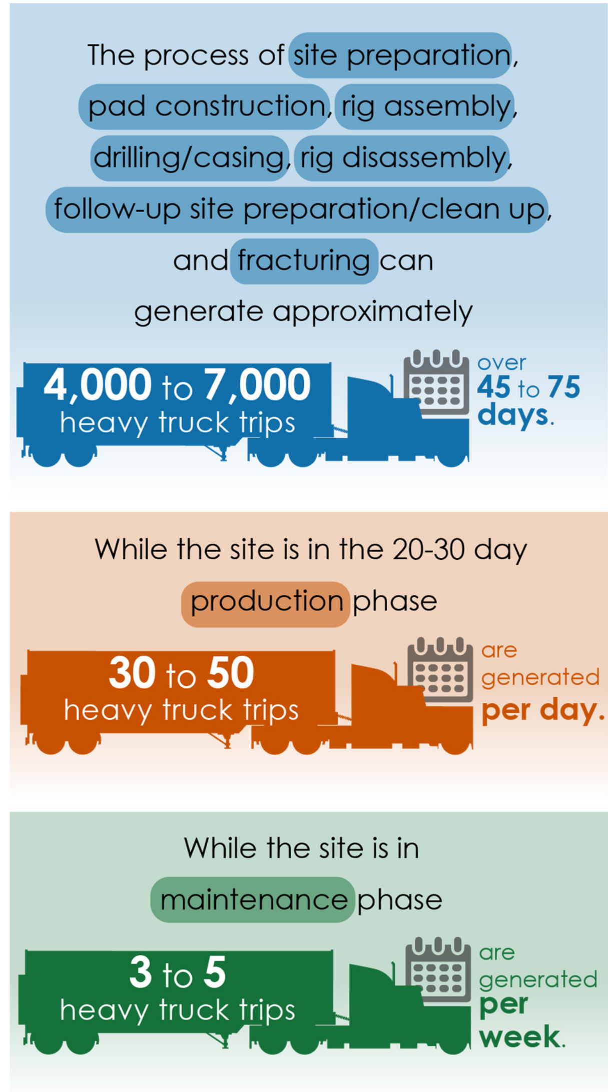
Based on the estimation of sand and water generated truck trips presented above, it is estimated that for a typical new development site,[35] the process of site preparation, pad construction, rig assembly, drilling/casing, rig disassembly, follow-up site preparation/clean up, and fracturing can generate approximately 4,000 to 7,000 heavy truck trips over 45 to 75 days. Once the site is in full operation and enters its production phase, truck traffic drops off considerably, with only 30 to 50 heavy truck trips over a 20 to 30-day period being generated to serve the site. Heavy truck traffic continues to drop once the site enters its maintenance phase, generating 3 to 5 heavy truck trips per week. This process repeats itself as the heavy truck traffic relocates to a new site. These estimated ranges vary depending on several factors, but they provide an idea of the intensity of freight activity associated with developing new production sites. Because of this, the levels of truck activity as indicated by Annual Average Daily Truck Traffic (AADTT) and the TxDOT travel demand model (SAM) are conservative, as they reflect average daily volumes that likely miss the peaking associated with site preparation and operation.

[35] Stakeholder input.

The analysis assumes that a typical new development site consists of 1 pad that is 6 to 8 acres in size, with 6 to 8 wells located on the pad, and an 18,000-foot vertical component to each well.

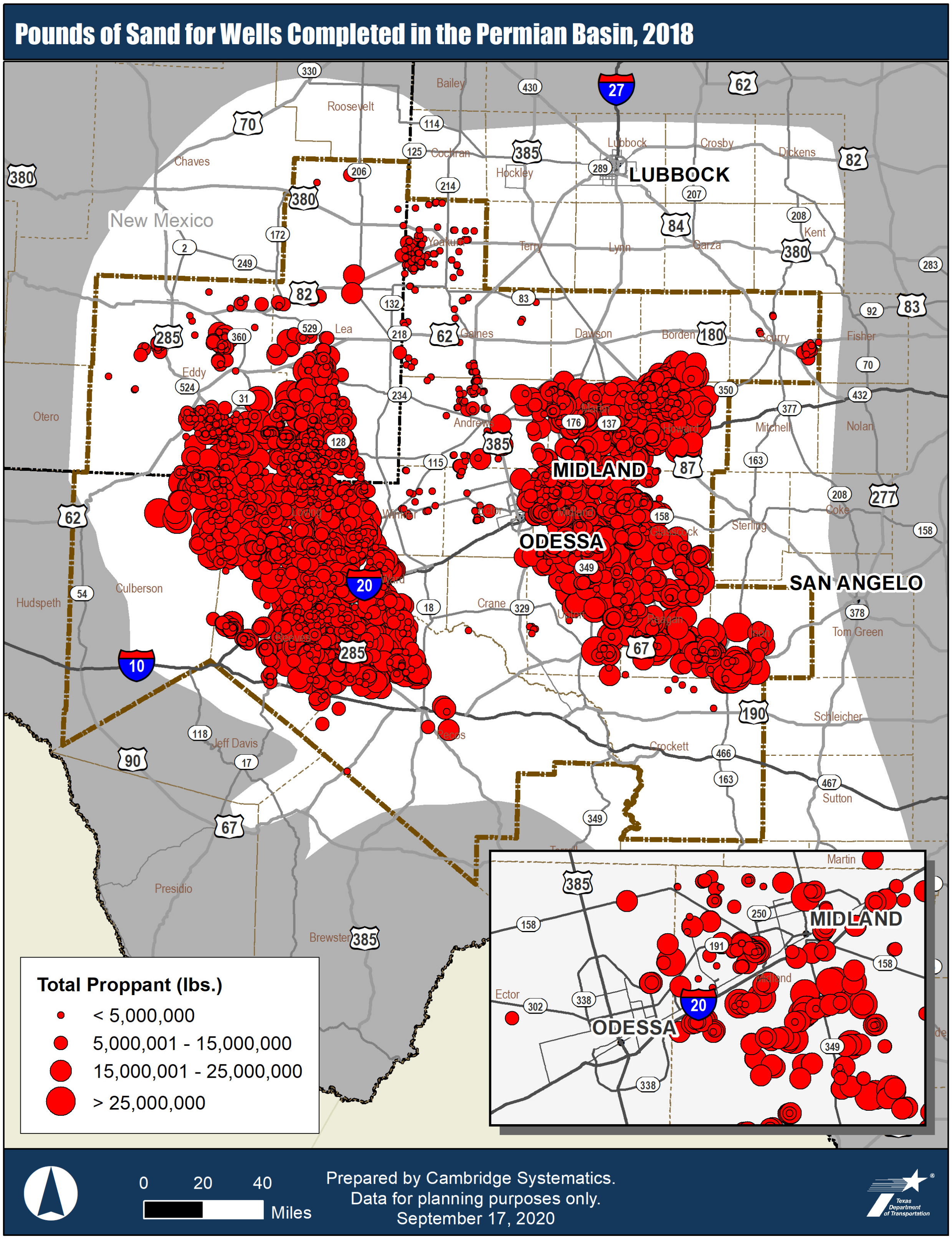
The location of the truck trip generation for these three key oilfield commodities: sand (or proppant), fresh water that is injected into wells, and produced water which is generated as a byproduct of petroleum extraction depends on where the drilling activity is occurring and it changes as drilling activity moves around the region. **Exhibit 63** depicts the weight of proppant used per well, for those that were completed in 2018. **Exhibit 64** shows the total fluid (e.g., fresh water plus chemicals and additives) measured in barrels used in the hydraulic fracturing process) per well. **Exhibit 65** depicts water produced, measured in barrels per well, as a byproduct of the drilling process. While a significant percentage of fresh water and produced water may be delivered and taken away from wells by pipeline, trucks are still an important component of the supply chain. Sand, or proppant, is delivered entirely by truck. As long as energy sector demands on the network remain at high levels, it will continue to be critical to understand the negative impacts that the sand and water trucks have on the infrastructure, and the improvements and design considerations generated by the movement of these and other energy sector commodities.

Estimating truck trip generation levels by phase allows TxDOT and the MPO to estimate future network demand based on forecasted drilling activity. However, the rapidly changing drilling technology and business models of the energy companies will continue to impact truck trip generation levels in the future so there is a need for increased and continuous data collection.



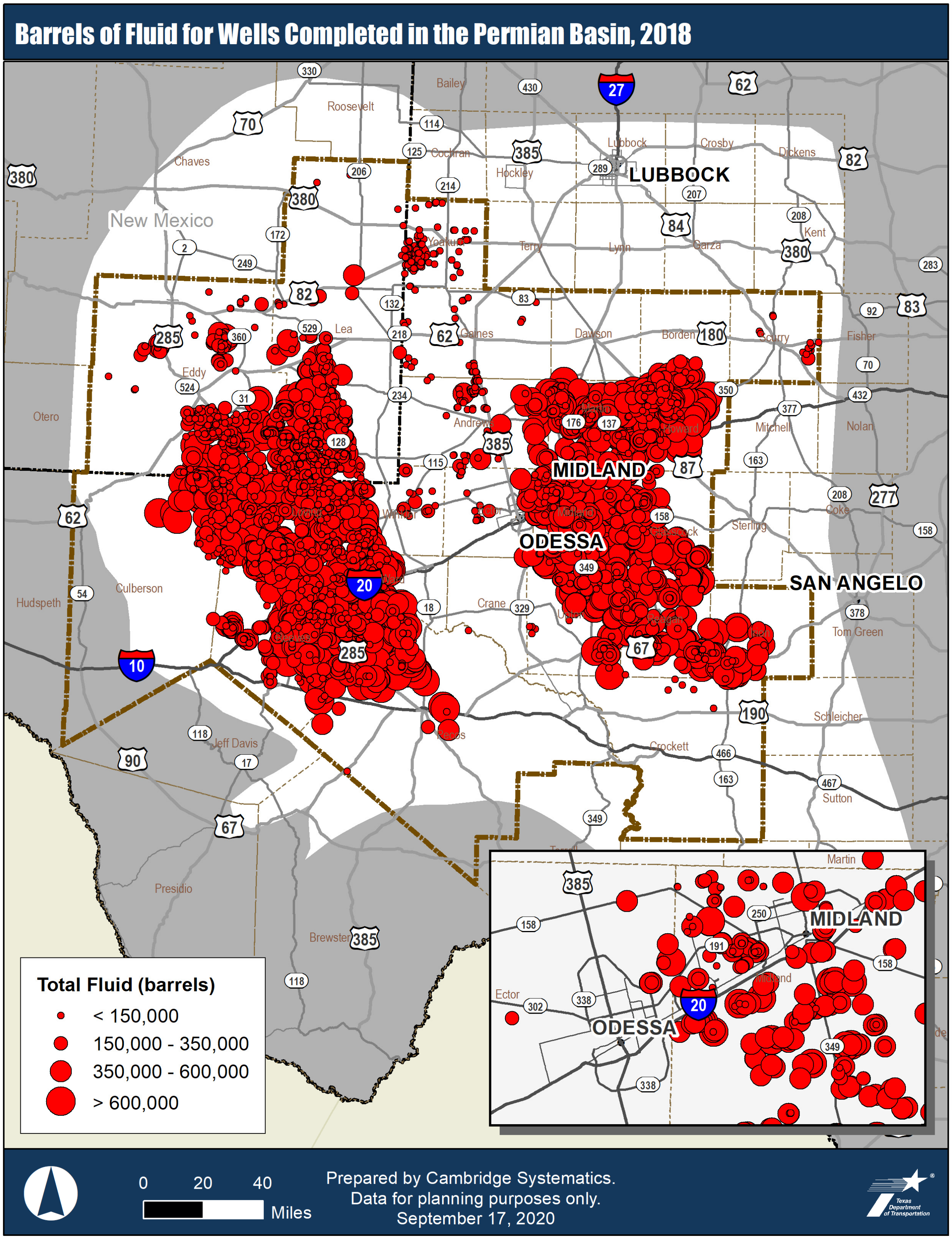
Source: Cambridge Systematics analysis based on Enverus, FracFocus and Permian Basin stakeholder input.

Exhibit 63. Pounds of Sand for Wells Completed in the Permian Basin, 2018



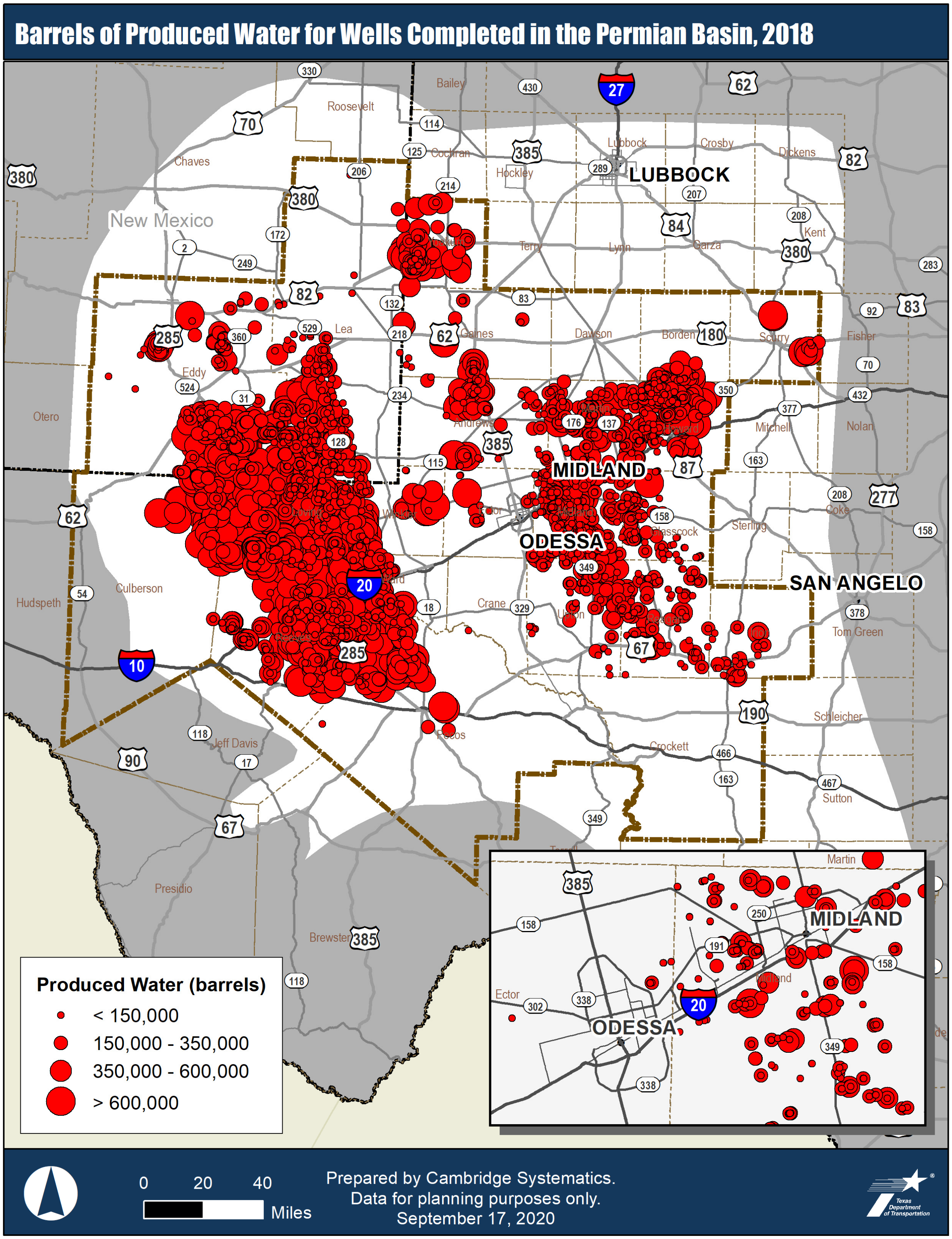
Source: Enverus Drillinginfo Database; Cambridge Systematics analysis.

Exhibit 64. Barrels of Fluid for Wells Completed in the Permian Basin, 2018



Source: Enverus Drillinginfo Database; Cambridge Systematics analysis. A barrel of fluid represents 42 gallons.

Exhibit 65. Barrels of Produced Water for Wells Completed in the Permian Basin, 2018



Source: Enverus Drillinginfo Database; Cambridge Systematics analysis. A barrel of fluid represents 42 gallons.

Truck Travel Time Reliability

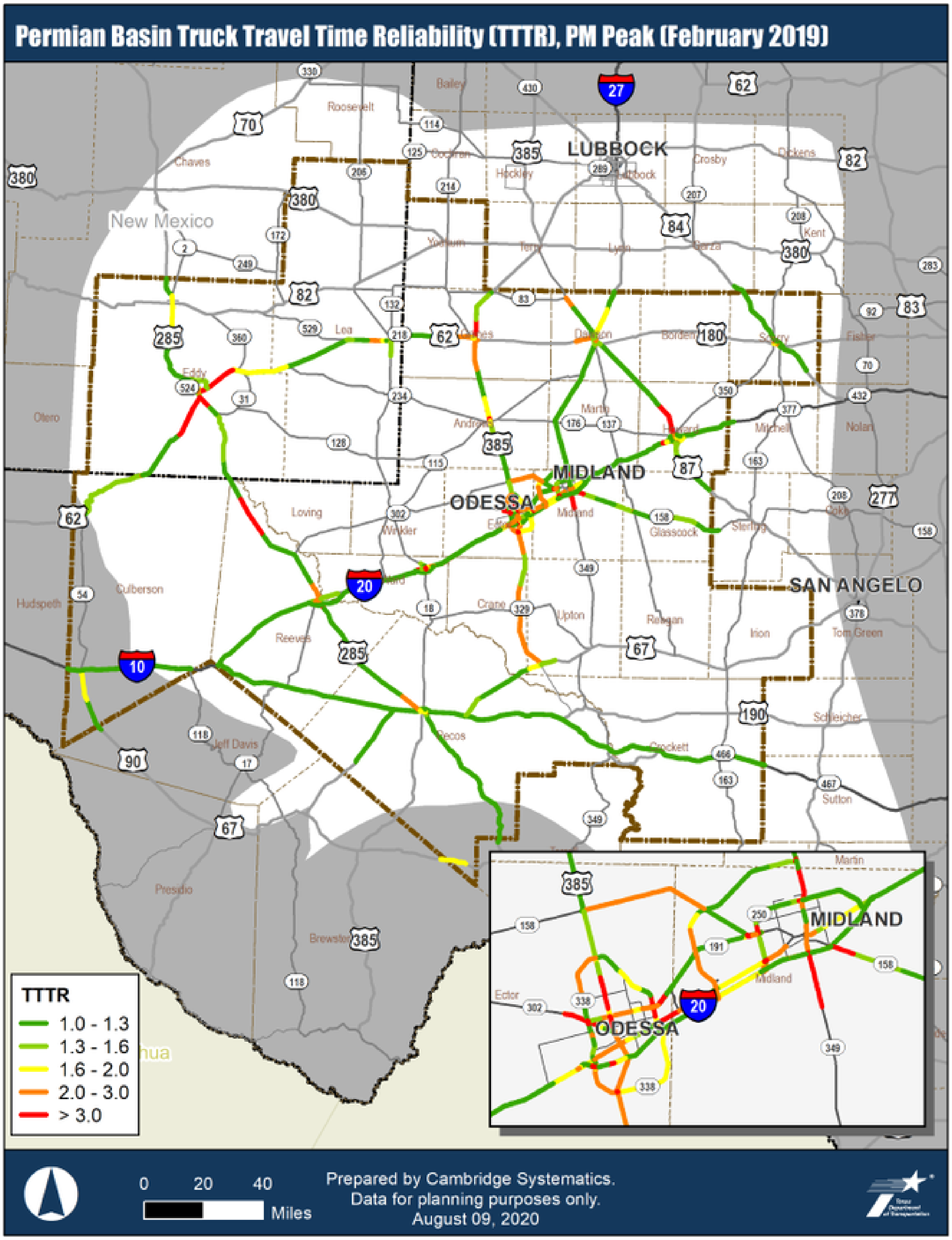
An important source of information on freight mobility is truck travel time data from the National Performance Management Research Data Set (NPMRDS). The NPMRDS contains average travel times in 15-minute bins over roadway segments that comprise the National Highway System (NHS). Truck travel times are derived from in-vehicle monitoring systems, navigation systems, and other on-board devices that generate Global Positioning System (GPS) data. Thus, the NPMRDS data set is a great source of information on congestion and mobility. Because there are several non-NHS roadways on the PBHFN, an alternate source of truck GPS data acquired from ATRI was used to capture data for those facilities. It should be noted that some of the routes may have been under construction during the data collection period, and thus the results may not accurately represent actual operating conditions.

Truck travel time reliability (TTTR) quantifies the variability in truck travel times as the difference in magnitude between the worst (i.e. 95th percentile) travel times and the average (i.e. 50th percentile) travel times. Higher TTTR values indicate less reliable roadway segments because the difference between the worst travel times and the average travel times is great. Lower TTTR values indicate more reliable roadway segments because that difference is small. Thus, consistency in travel times, as captured by the 95th and 50th percentiles, indicates greater reliability.

Exhibit 66 depicts TTTR on the region's Interstate and NHS highways for the 4:00 – 8:00 PM evening peak period for an average day. As shown, TTTR is highest, indicating poorer reliability, in Midland and Odessa. This is likely due to roadways in this portion of the region, which is the Permian Basin's main population and commercial center, containing more access points in the form of driveways and intersecting local roadways, as well as traffic signals and other intersection control devices.

The data suggest that other roadways outside of Midland and Odessa also experience challenges related to TTR. Notably, U.S. 285 in Reeves County has consistently high TTTR values with portions of the corridor exhibiting values that exceed 3.0. In 2018, TxDOT began multiple roadway improvement projects on U.S. 285, so for the source data, construction would impact observed travel times. U.S. 87 north of Big Spring in Howard County also exhibits reliability challenges. U.S. 385 south of Odessa and between SH 329 and U.S. 67 also exhibit TTTR values that exceed 2.0. On the northern end of this corridor, in Crane, TX, U.S. 385 has pedestrian facilities, on-street parking, and is accessed by multiple driveways.

Exhibit 66. Truck Travel Time Reliability (TTTR), P.M. Peak (February 2019)



Source: National Performance Management Research Data Set, February 2019; Cambridge Systematics analysis.

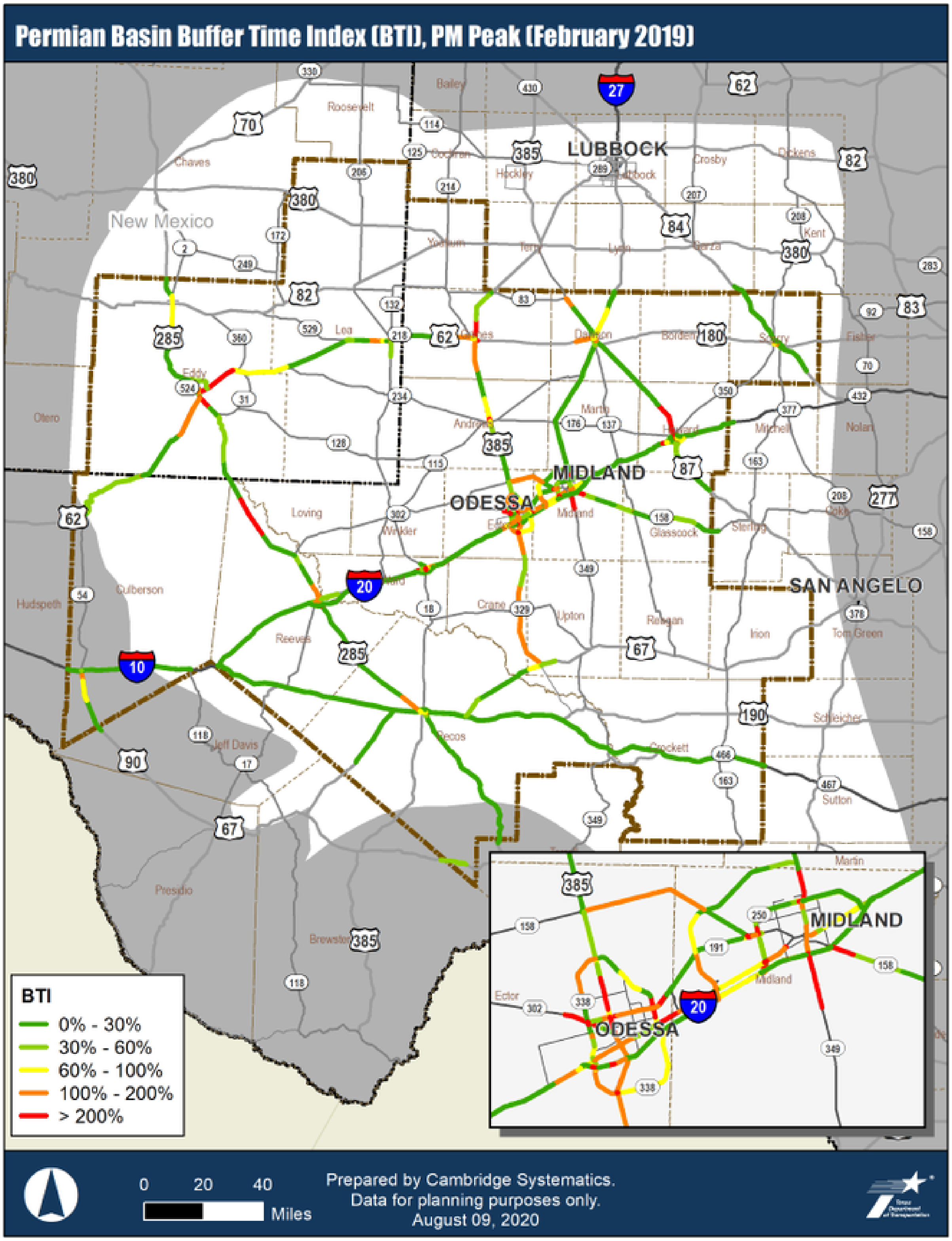
Note: Peak period refers to 4:00-8:00 P.M.

TRUCK TRAVEL BUFFER TIME INDEX

While TTTR is the designated performance metric for highway freight, an alternative metric that also yields insight into truck travel conditions is the buffer time index (BTI). Using NPMRDS as the primary data source, the BTI represents the extra time (i.e. buffer) that must be factored into scheduling to ensure an on-time arrival for 95% of truck trips. A lower buffer time index indicates expected travel delays are minimal and additional time may not be required to travel through a corridor. A higher BTI indicates the opposite, that extra travel time is needed to traverse a corridor. For example, a BTI equal to 50% indicates a trip that on average takes 30 minutes would need an extra 15 minutes (for a total scheduled travel time of 45 minutes). Buffer time is a useful measure of reliability, especially for the Permian Basin, because it provides an indication of the extra cost in terms of travel time imposed on motor carriers. This impacts schedules, workforce size, and the number of trucks motor carriers send over the road.

Like the TTTR results, the BTI results indicate that reliability is most challenged in Midland and Odessa, as shown in **Exhibit 67**. In particular, the portions of I-20 and I-20 Business that connect the two cities exhibit some of the highest BTI values. These are also among the highest volume roadways in the region for both commuters and freight. Outside of Midland and Odessa, U.S. 285 in Reeves County, U.S. 87 in Howard County, and U.S. 385 south of Odessa again feature prominently as corridors with challenges related to reliability. Portions of these corridors exhibit BTI values exceeding 200%, indicating that, during peak hours, motor carriers must buffer in twice as much travel time as the average trip during non-peak hours to ensure on-time arrival.

Exhibit 67. Permian Basin Buffer Time Index, PM Peak (February 2019)



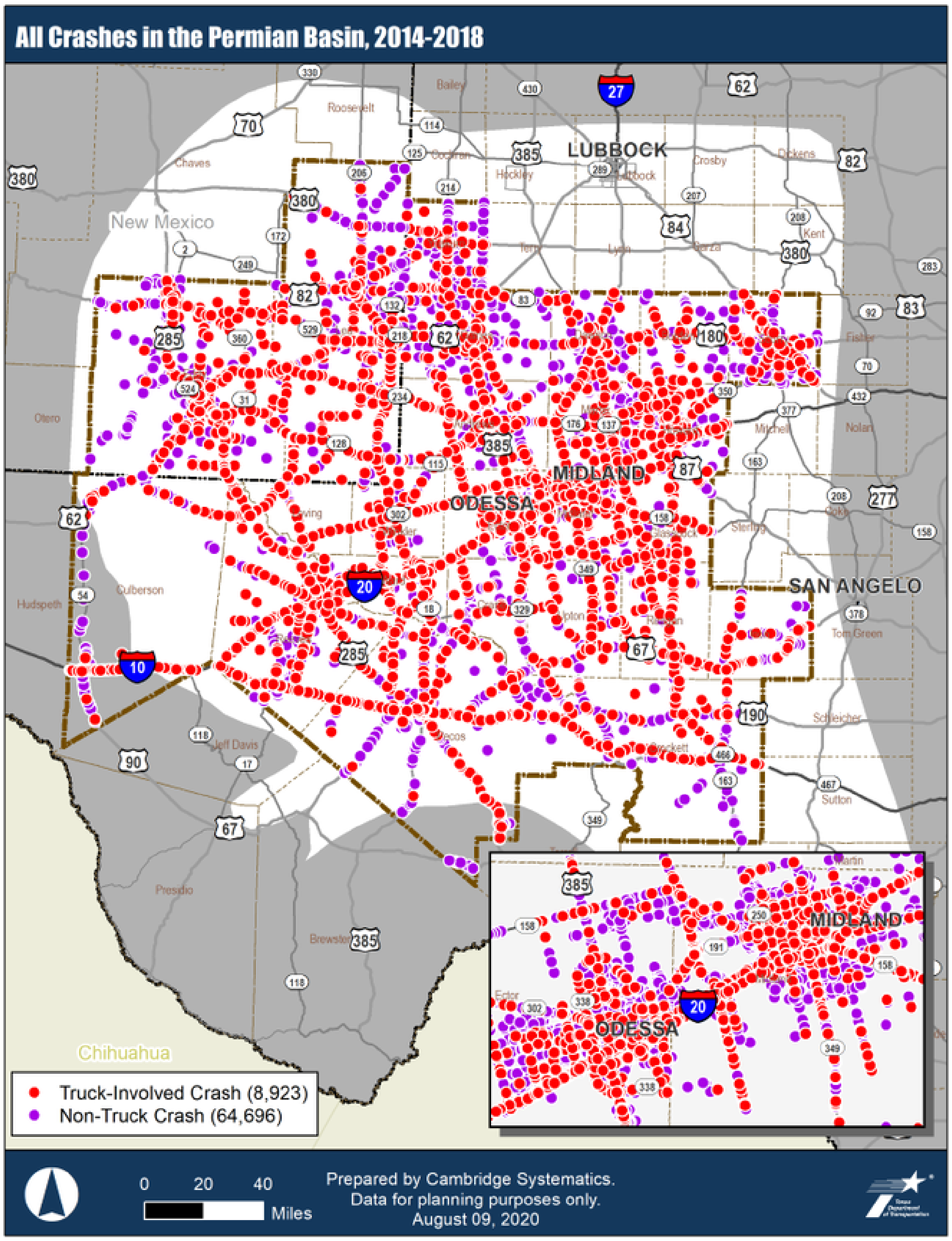
Source: National Performance Management Research Data Set, February 2019; Cambridge Systematics analysis.

Note: Peak period refers to 4:00-8:00 P.M.

4.1.2 HIGHWAY SAFETY

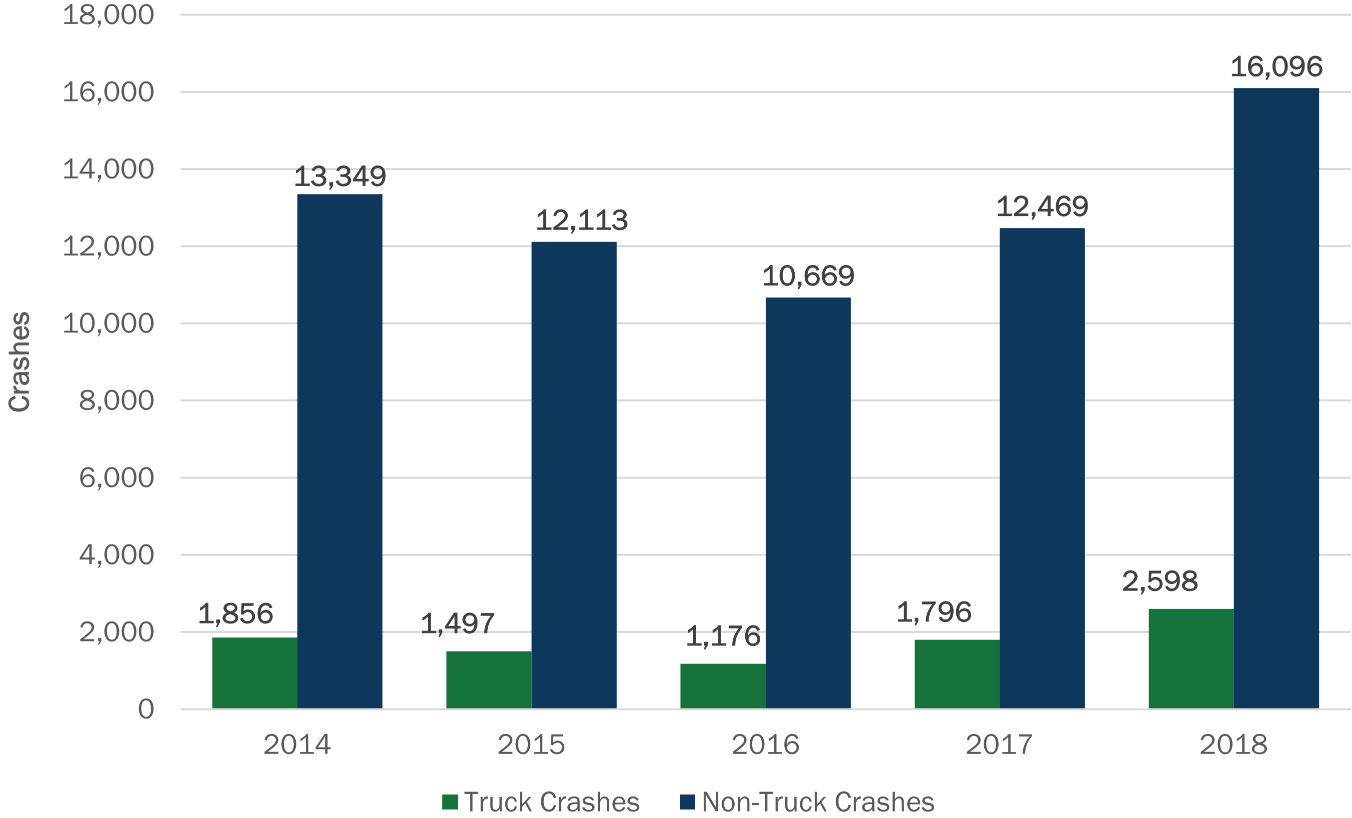
Highway safety performance can be measured by examining the frequency and severity of crashes that involve trucks as well as non-freight vehicles. **Exhibit 68** depicts the locations of all crashes in the region from 2014 to 2018. **Exhibit 69** shows the number of total crashes each year from 2014 to 2018. Over this period, the number of truck-involved crashes increased nearly 40%, from 1,856 to 2,598, while the number of total crashes increased nearly 21%, from 13,359 to 16,096. This increase is despite a decline in both total and truck-involved crashes between 2014 and 2016 and results from a sharp increase starting in 2017.

Exhibit 68. All Crashes in the Permian Basin, 2014-2018



Source: Texas Department of Transportation, Crash Record Information System, 2014-2018; New Mexico Department of Transportation, 2014-2018.

Exhibit 69. Permian Basin Crashes per Year, 2014-2018



Source: Texas Department of Transportation, Crash Record Information System, 2014-2018; New Mexico Department of Transportation, 2014-2018.

Crashes are costly to the Permian Basin region both in terms of human capital costs and societal costs as shown in **Exhibit 70**. Using the methodology outlined in the Highway Safety Manual,[36] the average annual comprehensive cost of crashes in the Permian Basin over the 2014-2018 period is estimated to be $1.88 billion. For truck-involved crashes, the estimated annual comprehensive cost is nearly $493 million. Truck-involved crashes accounted for about 14% of the total number of crashes but about 26% of comprehensive crash costs for the Permian Basin.

[36] The Highway Safety Manual (HSM) gives the following human capital costs in 2001 dollars: fatal = $1,245,600, disabling injury = $111,400, evident injury = $41,900, possible injury = $28,400, and property damage only = $6,400. Societal costs in 2001 dollars are: fatal = $4,008,900, disabling injury = $216,000, evident injury = $79,000, possible injury = $44,900, and property damage only = $7,400. The costs in 2001 dollars were adjusted using the consumer price index and employment cost index per the HSM procedure.

Exhibit 70. Comprehensive Cost of Crashes in the Permian Basin, 2014-2018

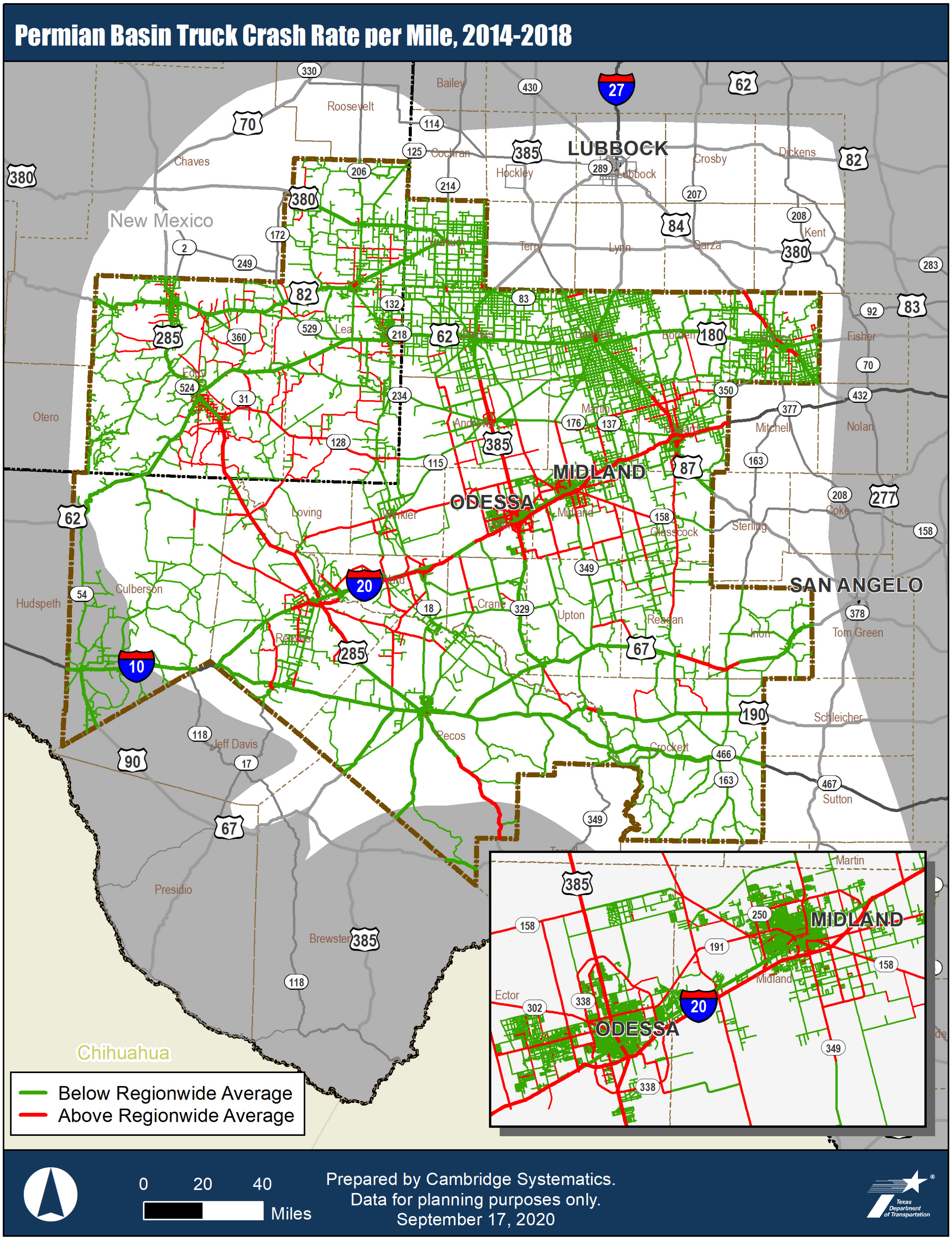
Severity	Comprehensive Cost of All Crashes	Comprehensive Cost of All Truck Crashes	Avg. Annual Comprehensive Cost of All Crashes	Avg. Annual Comprehensive Cost of Truck Crashes
Fatal	$6,469,000,000	$2,045,000,000	$1,294,000,000	$409,000,000
Incapacitating Injury	$735,000,000	$152,000,000	$147,000,000	$30,000,000
Non-Incapacitating Injury	$1,021,000,000	$152,000,000	$204,000,000	$30,000,000
Possible Injury	$613,000,000	$50,000,000	$123,000,000	$10,000,000
Not Injured	$522,000,000	$64,000,000	$104,000,000	$13,000,000
Unknown	$34,000,000	$600,000	$7,000,000	$100,000
Total	**$9,393,000,000**	**$2,464,000,000**	**$1,879,000,000**	**$493,000,000**

Source: Texas Department of Transportation, Crash Record Information System, 2014-2018; New Mexico Department of Transportation, 2014-2018; Cambridge Systematics analysis.

Exhibit 71 shows the comparative truck crash rate[37] per mile. The average crash rate by functional classification is shown in **Exhibit 72**. The highest crash rates are primarily on roadways in Midland and Odessa, such as I-20 Business, U.S. 385, Loop 250, and SH 158. Some corridors outside Midland and Odessa also exhibit relatively high crash rates. These include U.S. 285 in Reeves County and SH 302 in Loving and Winkler Counties.

[37] Truck crash rates are calculated as crashes per 100 million vehicle miles traveled.

Exhibit 71. Permian Basin Truck Crash Rate per Mile, 2014-2018



Source: TxDOT Crash Record Information System.

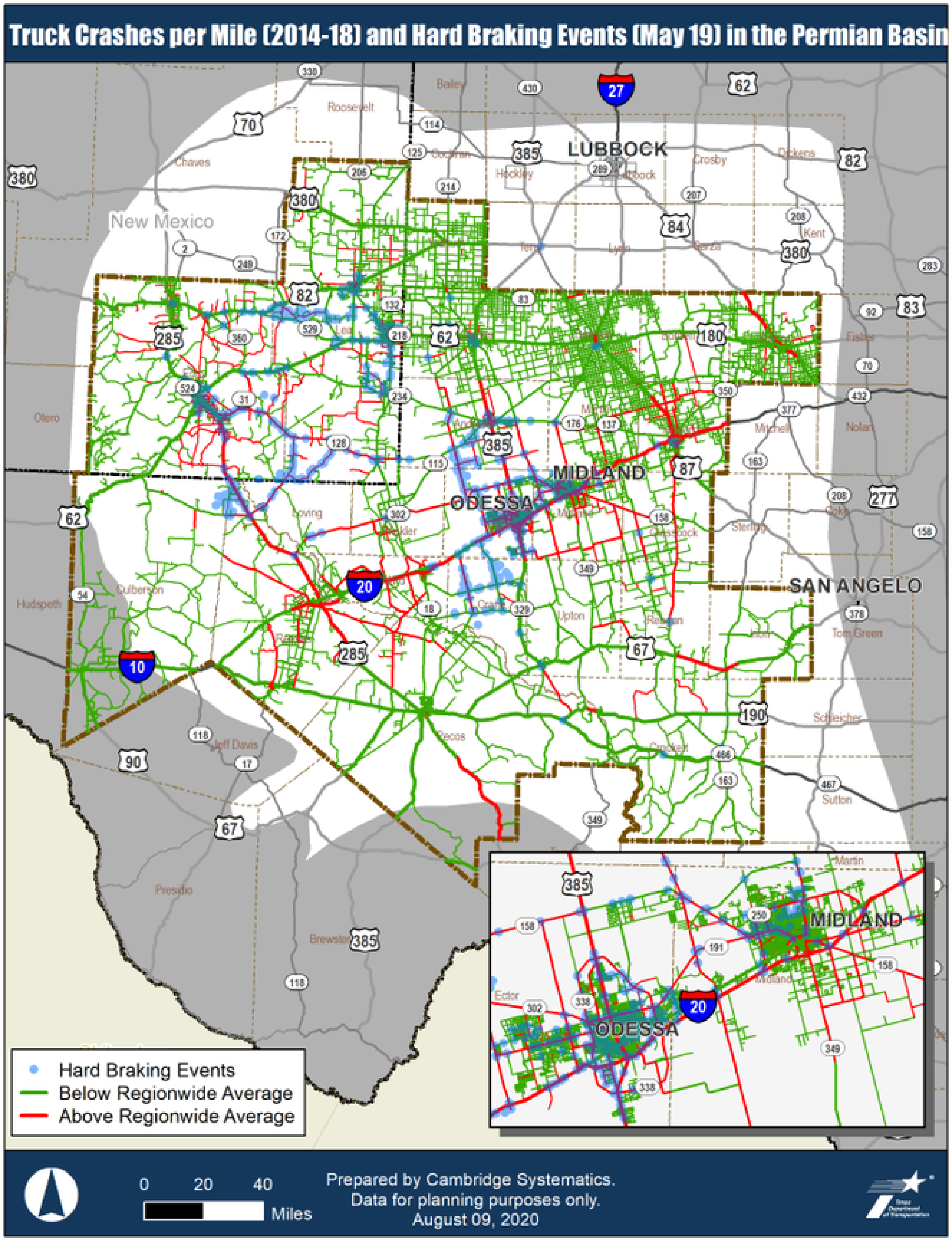
Exhibit 72. Average Crashes per Mile and Crash Rate by Funcional Classification in the Permian Basin

Road Type	Avg. Truck Involved Crashes per Mile	Avg. Truck Involved Crashes per 100MVMT
Interstate	0.89	124.34
US Highways	0.29	163.99
State Highways	0.48	166.96
Farm-to-Market	0.08	140.95
Local	0.01	NA
Road Type	**Avg. Crashes per Mile**	**Avg. Crashes per 100MVMT**
Interstate	4.34	206.63
US Highways	1.56	241.45
State Highways	4.22	274.05
Farm-to-Market	0.47	131.14
Local	0.42	NA

Source: Texas Department of Transportation, Crash Record Information System, 2014-2018; New Mexico Department of Transportation, 2014-2018; Cambridge Systematics analysis

A common factor as to why crashes occur is because of trucks having to stop suddenly. Some companies in freight-intensive industries in the region track when their trucks experience a "hard braking event." Overlaying the location of these hard braking events with the crash data provides for interesting observations, as seen in **Exhibit** 73. While the two do not perfectly align, and the hard braking data is from only one month and from only a small sample of companies operating in the region, a strong correlation between hard braking events and high crash rates can be seen throughout the region, especially U.S. 285, U.S. 385, and SH 128.

Exhibit 73. Permian Basin Truck Crashes per Mile, 2014-2018, and Hard Braking Events, May 2019



Source: Texas Department of Transportation, Crash Record Information System, 2014-2018; New Mexico Department of Transportation, 2014-2018; Permian Road Safety Coalition, Hard Braking Events, May 2019; Cambridge Systematics analysis.

Truck Parking

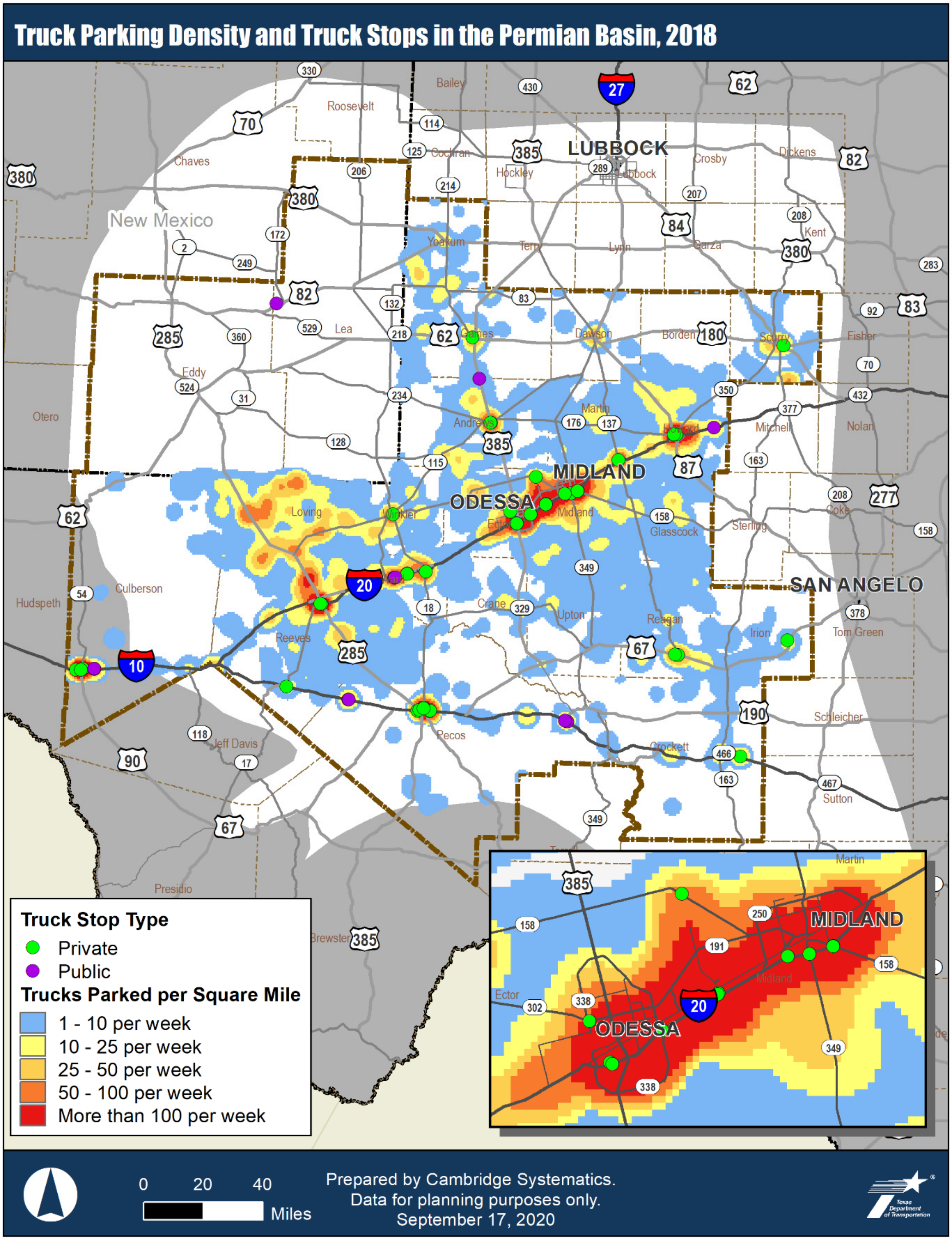
With the abundance of freight activity in the Permian Basin region, truck parking is an important consideration for the safe and efficient movement of freight. An inadequate supply of truck parking capacity can result in fatigued drivers continuing to drive because they have difficulty finding authorized parking. It may also result in drivers feeling compelled to park at unsafe locations, such as on the shoulder of the road, exit ramps, or vacant lots. In addition, federal truck driver hours-of-service (HOS) regulations require drivers to rest at defined intervals. In a location where truck parking is scarce, drivers must search for available truck parking well before their allowable drive time expires or while staging for their pick-up and delivery, leading to lost productivity and higher shipping costs.

The scarcity of safe truck parking locations for trucks is a local, state, and nationwide issue. Texas, like most states, has a shortage of truck parking capacity, as documented in the 2020 Texas Statewide Truck Parking Study.[38] **Exhibit 74** shows the density of parked trucks in the Texas portion of the Permian Basin region. The highest concentrations of parking occur in urban areas such as Midland, Odessa, Lubbock, and Pecos. Those areas observed truck parking densities of more than 100 parked trucks per week. Truck parking densities are also high along key corridors for freight movements, such as U.S. 285 and SH 302.

Mapping the locations of truck stops in the Permian Basin with the truck parking density estimates provides an idea of where current capacity is located versus where truck parking demand is located, as illustrated in **Exhibit 74**. The results show that while truck parking densities are high along routes such as U.S. 285 and SH 302, there are relatively few truck stops along these corridors. This suggests high levels of unauthorized parking and the need for additional parking capacity to meet demand along these corridors. On I-20, the locations of truck stops are aligned with truck parking densities but as will be shown later, this does not mean that truck parking is adequate to meet the demand.

38 Texas Department of Transportation, Texas Statewide Truck Parking Study, 2020.

Exhibit 74. Permian Basin Truck Parking Density and Truck Stops, 2018



Source: American Transportation Research Institute; Texas Statewide Truck Parking Study, 2020; Cambridge Systematics analysis.

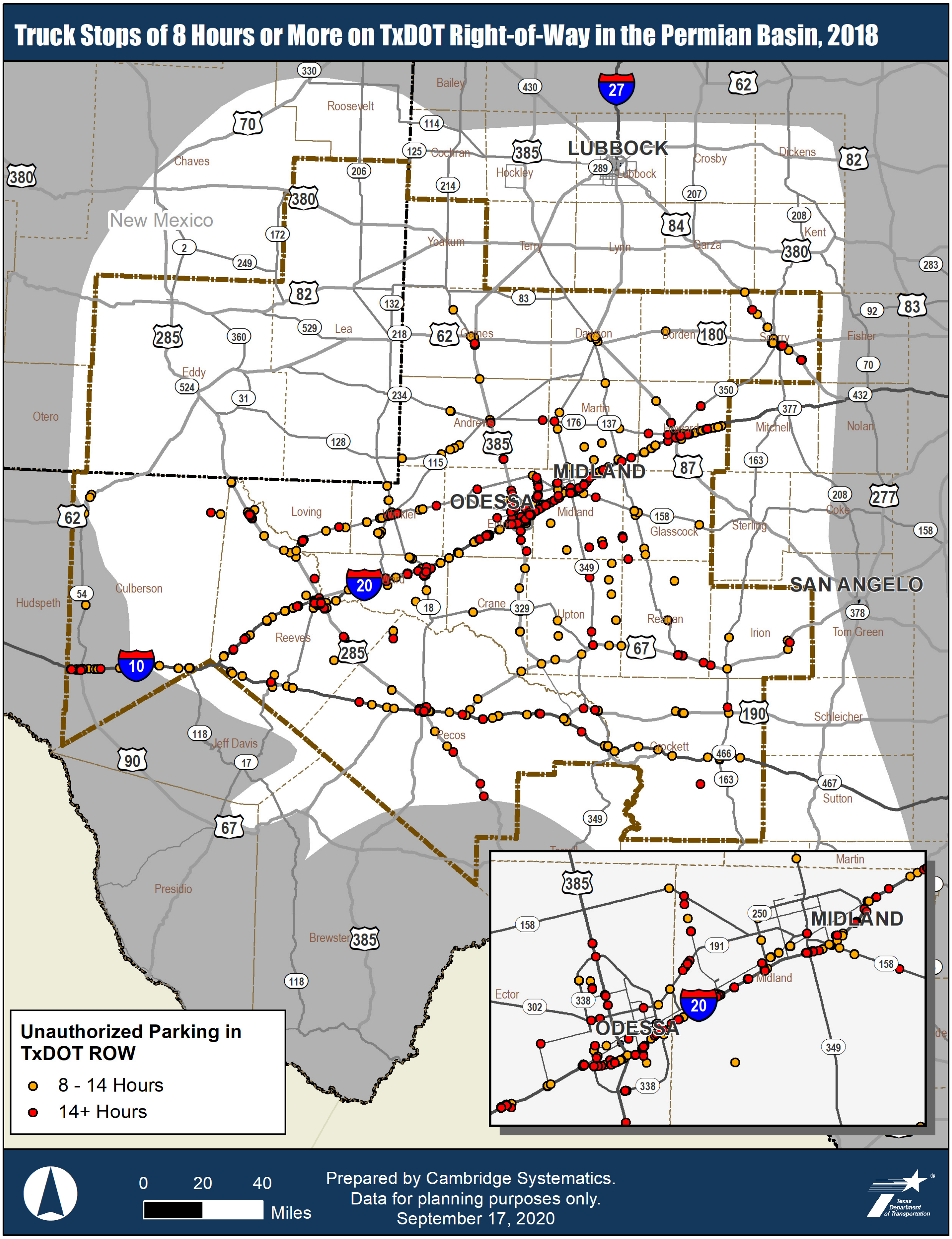
Another important component of the analysis determines where truck parking is occurring in unauthorized locations, such as on the shoulders of roads. Trucks parked in these locations pose safety hazards for other drivers and cause infrastructure damage to portions of the highway that are not designed to support heavy loads. In addition, truck parking in unauthorized locations can be dangerous for the truck driver and the motoring public. Truck parking can also be a nuisance and public safety concern for communities if trucks are parked in vacant areas without a law enforcement presence. Reasons for unauthorized parking vary, but most often reflect the lack of authorized truck parking locations in the area of need or overcrowding of authorized locations.

Exhibit 75 shows results from an analysis of unauthorized parking from the 2020 Texas Statewide Truck Parking Study. It depicts trucks parked within TxDOT right-of-way during weekdays. Despite containing multiple truck stops, I-20 has the highest number of parked trucks in unauthorized locations. This suggests that existing truck parking facilities along that corridor do not have enough capacity to meet demand. U.S. 285 and U.S. 385 also have relatively high rates of unauthorized parking. While there are no truck stops north of I-20 along U.S. 285, U.S. 385 has multiple facilities.

Approximately 77% of the estimated number of trucks parked in unauthorized locations stopped for less than 1 hour. About 15% of stops are for less than 4 hours. These durations likely represent trucks meeting their 30-minute rest requirements or trucks staging near a business while waiting for their pickup or delivery window. Stops over 8 hours (i.e., long stops) in unauthorized locations pose even greater concerns in terms of safety as these stops often occur overnight when a driver is sleeping in the truck or not with the truck. Each point in **Exhibit 75** represents a single truck in the data set that was observed making a long stop on TxDOT right-of-way in the region. The highest concentrations are seen in Midland and Odessa.

Outside of Midland and Odessa, certain corridors appear to be frequent locations of longer stops. These include U.S. 285, SH 302, U.S. 385, U.S. 84, and U.S. 67. There is only one truck stop on U.S. 84 between I-20 and Lubbock (about 82 miles) and on U.S. 67 between San Angelo and I-10 (about 120 miles). There are no facilities on U.S. 285 north of I-20 and none on SH 302. These corridors should be the focus of efforts to improve truck parking capacity in the Permian Basin.

Exhibit 75. Truck Stops of 8 Hours or More on TxDOT Right-of-Way in the Permian Basin, 2018



Source: American Transportation Research Institute; Cambridge Systematics analysis.

4.1.3 ASSET UTILIZATION AND PRESERVATION

The condition of roadways that make up the PBHFN play an important role in facilitating the movement of freight. Pavement and bridge conditions were the primary factors used to evaluate freight asset utilization and preservation needs. Several factors related to bridge condition were evaluated, including vertical clearance, load restrictions, and level of oversize/overweight (OS/OW) activity.

Pavement Conditions

Roadway pavement condition can impact the cost and safety of travel for passengers and freight.[39] Cracked and rutting roadway surfaces can cause additional wear and tear on freight vehicles as well as damage the goods they are transporting. Poor pavement conditions can also impact travel time-based performance measures, such as TTTR, if vehicles must decrease their speeds to avoid potholes or other condition-related hazards. Pavement conditions may also impact safety performance. For example, worn roadway surfaces with reduced friction limit a vehicle's stopping ability and maneuverability, which can lead to a crash.

Pavement condition ratings for this Plan are derived from the International Roughness Index (IRI). IRI is a measure of a roadway's smoothness and is used as an indicator of its condition. Very low IRI values (e.g., a value of 50) indicate that a roadway is in very good condition, while very high values (e.g., a value of 200) indicate the opposite. The most recent TxDOT pavement condition data reports IRI values for approximately 1,640 miles of roadway (both on- and off-system) for the Texas portion of the Permian Basin region. As depicted in **Exhibit** 76, the majority of roadways are reported to have good pavement. In total, 1,058 miles (65%)are reported as good and only 127 miles (8%) have been reported as having poor pavement. The remaining 455 miles (28%) are rated as fair. I-10, I-20, and U.S. 285 account for the majority of the poor pavement condition rating in the Texas portion of the Permian Basin study area.

Exhibit 77 shows pavement conditions in Eddy and Lea Counties in New Mexico.[40] Of the 305 miles of highway for which there are data in these two counties, over 88% are in good or fair condition, as indicated by IRI. Only 11% are in poor condition. Pavements in poor condition are primarily concentrated on minor arterials and major collectors as opposed to higher functional classification highways.

Pavement conditions on the portion of U.S. 285 in New Mexico, which is an important north-south route for energy sector-related truck traffic and is part of the New Mexico Priority Freight Corridors network, has mostly good to fair pavement conditions. However, portions of SH 18, another important north-south route in Lea County, has poor pavement conditions between SH 128 and the Texas border.

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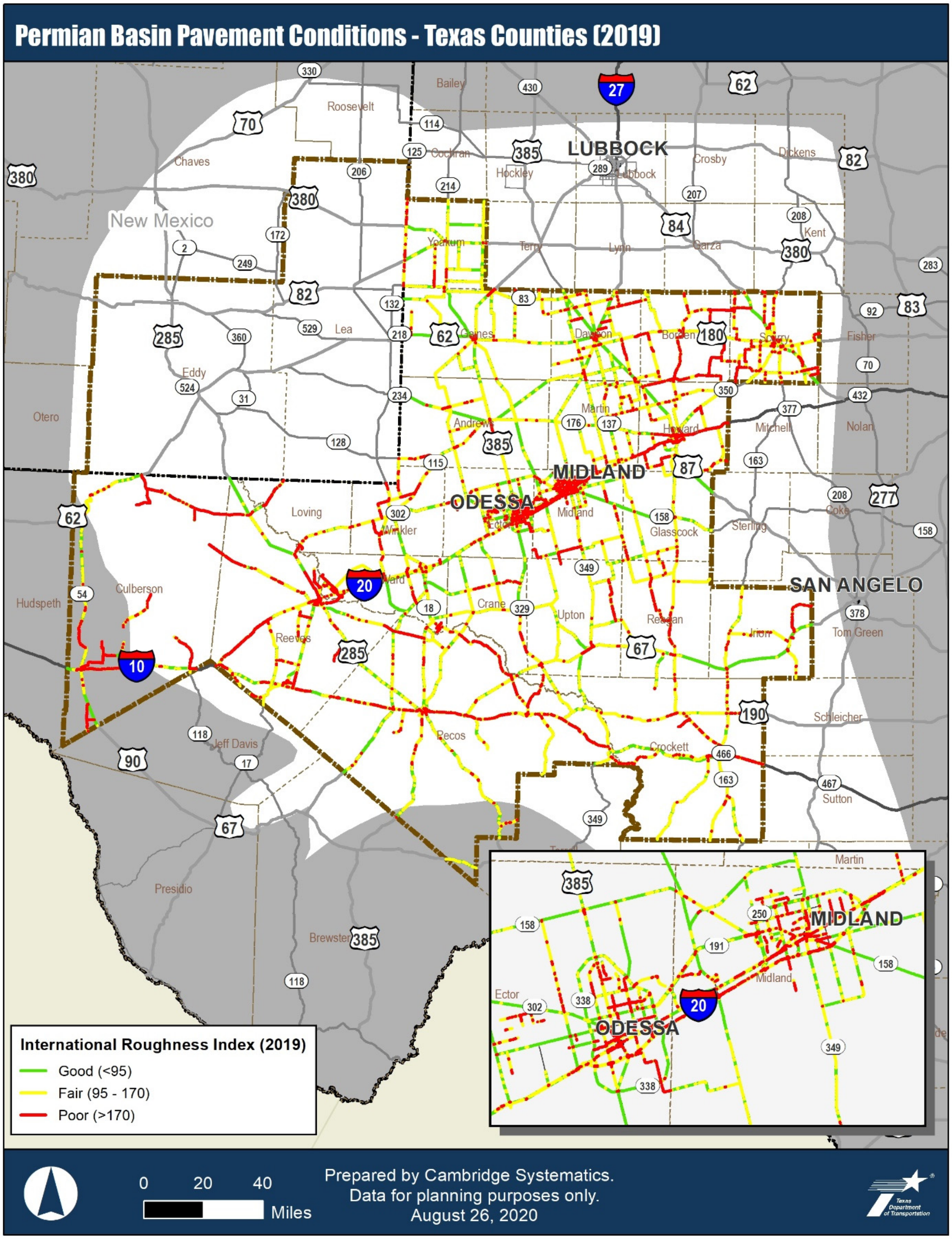
39 Federal Highway Administration, 2013 Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance, https://www.fhwa.dot.gov/policy/2013cpr/chap3.cfm#1.

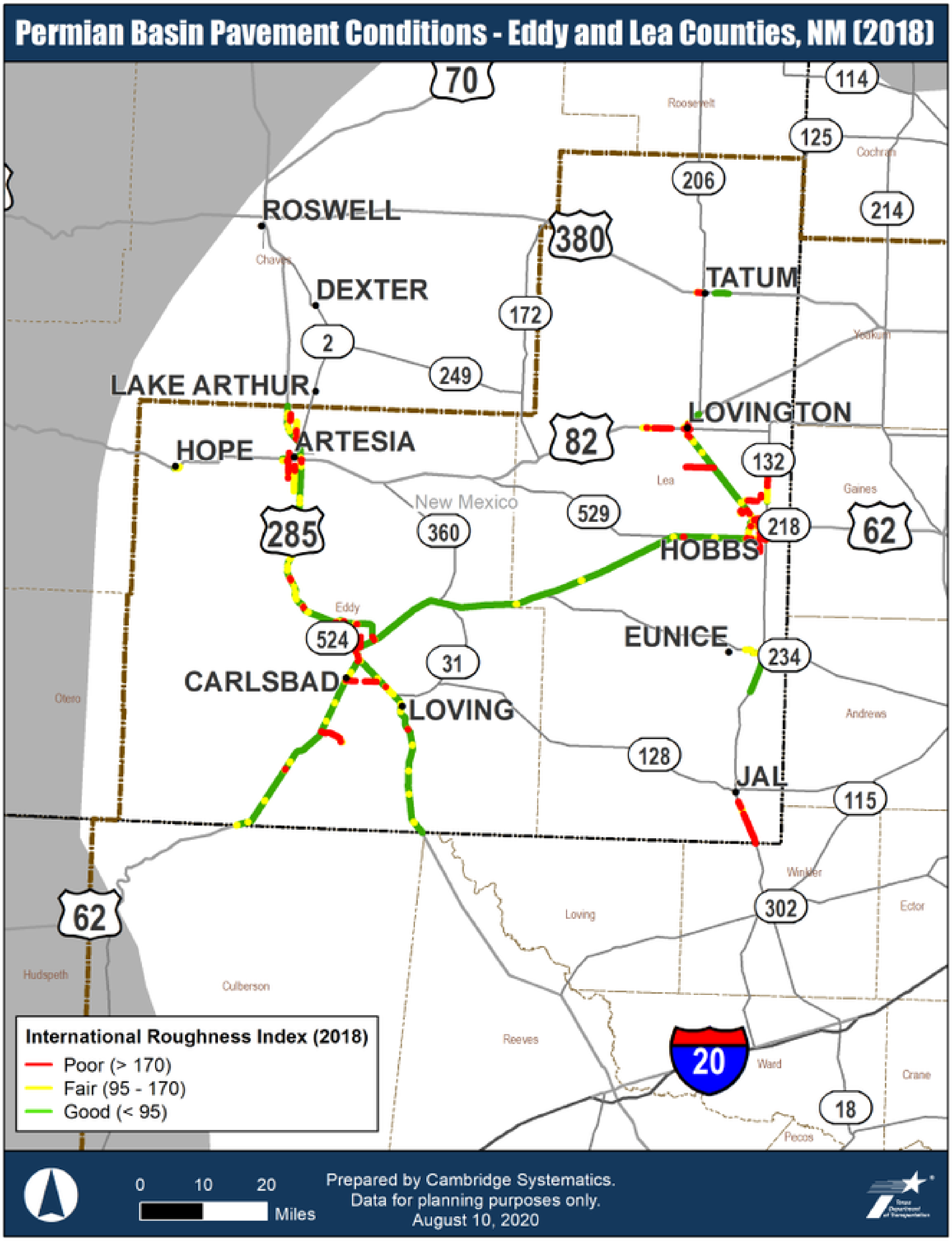
40 Roadway segments that do not contain IRI data are omitted from the analysis.

Exhibit 76. Pavement Conditions in the Permian Basin – Texas Counties, 2019



Source: Texas Department of Transportation, 2019.

Exhibit 77. Permian Basin Pavement Conditions – Eddy and Lea Counties, NM 2018



Source: New Mexico Department of Transportation, Highway Performance Monitoring System Submittal, 2019.

Bridge Conditions and Vertical Clearance

Bridges not rated for truck weight of 80,000 pounds may contribute to roadway congestion by requiring trucks exceeding the weight limit to re-route to higher classified routes, which are often higher traffic routes. The alternate route can prove costly if it adds significant length or time to a trip.

A breakdown of the 1,853 bridges (1,799 in Texas and 54 in New Mexico) in the region is shown in **Exhibit 78**. Of these, 950 (51%) are in at least "good" condition and 880 (47%) are in "fair" or "satisfactory" condition. There are 23 bridges, (just over 1%) in "poor" or worse condition or are "structurally deficient" (i.e. weight restricted). All 23 structurally deficient bridges are in the Texas portion of the Permian Basin.

Summary of Bridge Condition Ratings

9 = Excellent

8 = Very good

7 = Good

6 = Satisfactory

5 = Fair

4 = Poor

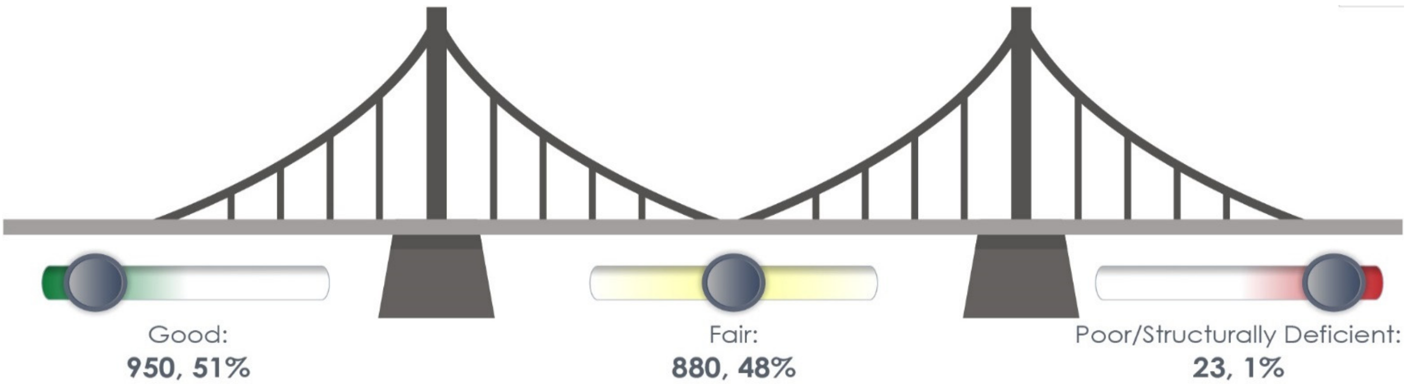
3 = Serious

2 = Critical

1 = Imminent failure

0 = Failed, bridge is out of service and beyond corrective action.

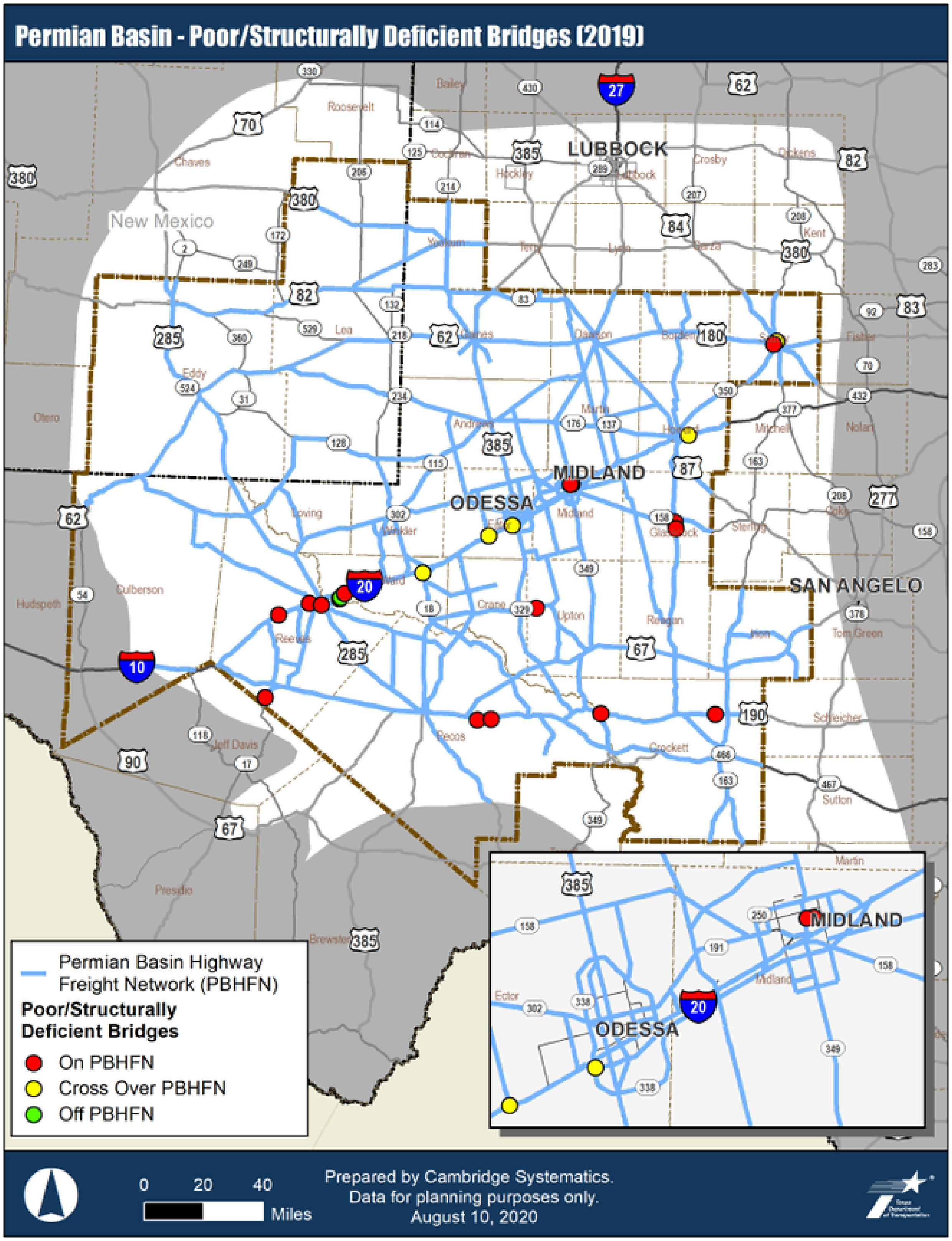
Exhibit 78. Permian Basin Bridge Condition Ratings Breakdown, 2019



Source: National Bridge Inventory, 2019.

Exhibit 79 displays the locations of the 23 bridges that are in poor condition or are structurally deficient. Seventeen of those bridges are located on the PBHFN (symbolized as red dots) and another five of them are bridges that cross over the PBHFN (symbolized as yellow dots). The remaining poor condition or structurally deficient bridge is located off the PBHFN. Eight of the bridges that are in poor condition *and* on the PBHFN are located on I-20 in Reeves and Ward Counties and along I-10 in Pecos and Crockett Counties. These eight bridges likely have the greatest potential to cause disruptions in freight traffic and should be monitored.

Exhibit 79. Permian Basin Poor/Structurally Deficient Bridges, 2019



Source: National Bridge Inventory, 2019.

Vertical clearance is another issue that can impact freight mobility, as over-height trucks are forced to divert to less efficient routes if a facility does not have sufficient vertical clearance. This is particularly important for the Permian Basin as the region has suffered multiple vertical clearance related bridge strikes impacting freight routes and resulting in costly damage. Since 2018, FM 1788 over I-20,[41] Loop 250 over I-20,[42] and Cotton Flat Road over I-20,[43] have all been struck by trucks. The region's struggle with bridge strikes prompted Texas House Bill 799, which was signed into law by the Governor and holds motor carriers liable for damages due to bridge strikes.

Exhibit 80 shows a map of PBHFN bridges and information about their vertical clearance. In Texas, bridges with less than the TxDOT minimum standard of 16.5 feet can impose significant challenges to the movement of goods. For all bridges and other overhead structures on the THFN, TxDOT is implementing a new vertical clearance standard of 18.5 feet. This standard applies to any bridge the THFN passes underneath, not when the THFN is traversing the bridge. The new standard, which applies to projects that let September 1, 2020 or later, applies to all construction and reconstruction projects. As such, bridges on the THFN that are currently less than 18.5 feet, of which there are 121 in the Texas portion of the Permian Basin, should be addressed during future projects.

In New Mexico, the policy for vertical clearances requires a minimum of 16.5 feet on roads that are expected to experience significant levels of truck traffic. This may be reduced to 15.25 feet if a roadway is projected to carry very little truck traffic.[44] All bridges in the New Mexico portion of the study area meet these standards for vertical clearance.

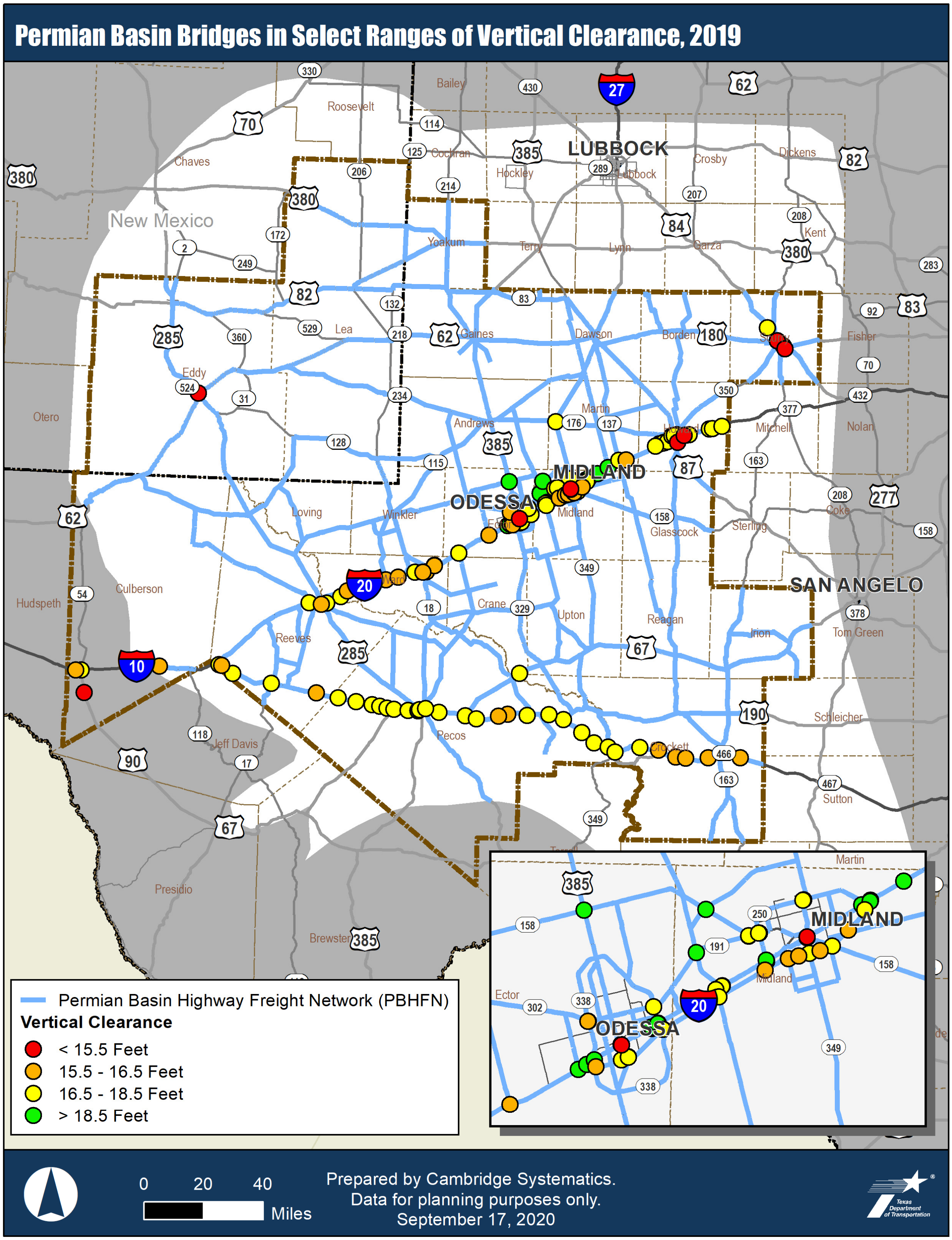
41 "TxDOT reports bridge strike in Midland County," Midland Reporter-Telegram, June 5, 2019, https://www.mrt.com/news/article/TxDOT-reports-bridge-strike-in-MIdland-County-13940644.php, Accessed May 26, 2020.

42 https://www.cbs7.com/content/news/West-Loop-250-overpass-closed-after-being-hit-by-oversized-load-499949121.html. Accessed May 26, 2020.

43 https://www.cbs7.com/content/news/Cotton-Flat-overpass-in-Midland-closed-following-bridge-strike-473422953.html. Accessed May 26, 2020.

44 New Mexico Department of Transportation, Bridge Procedures and Design Guide, February 2018, Section 1.3.3, https://www.dot.state.nm.us/content/dam/nmdot/Bridge/2018_Bridge_Procedures_and_Design_Guide.pdf.

Exhibit 80. Permian Basin Bridges in Select Ranges of Vertical Clearance, 2019



Source: National Bridge Inventory, 2019.

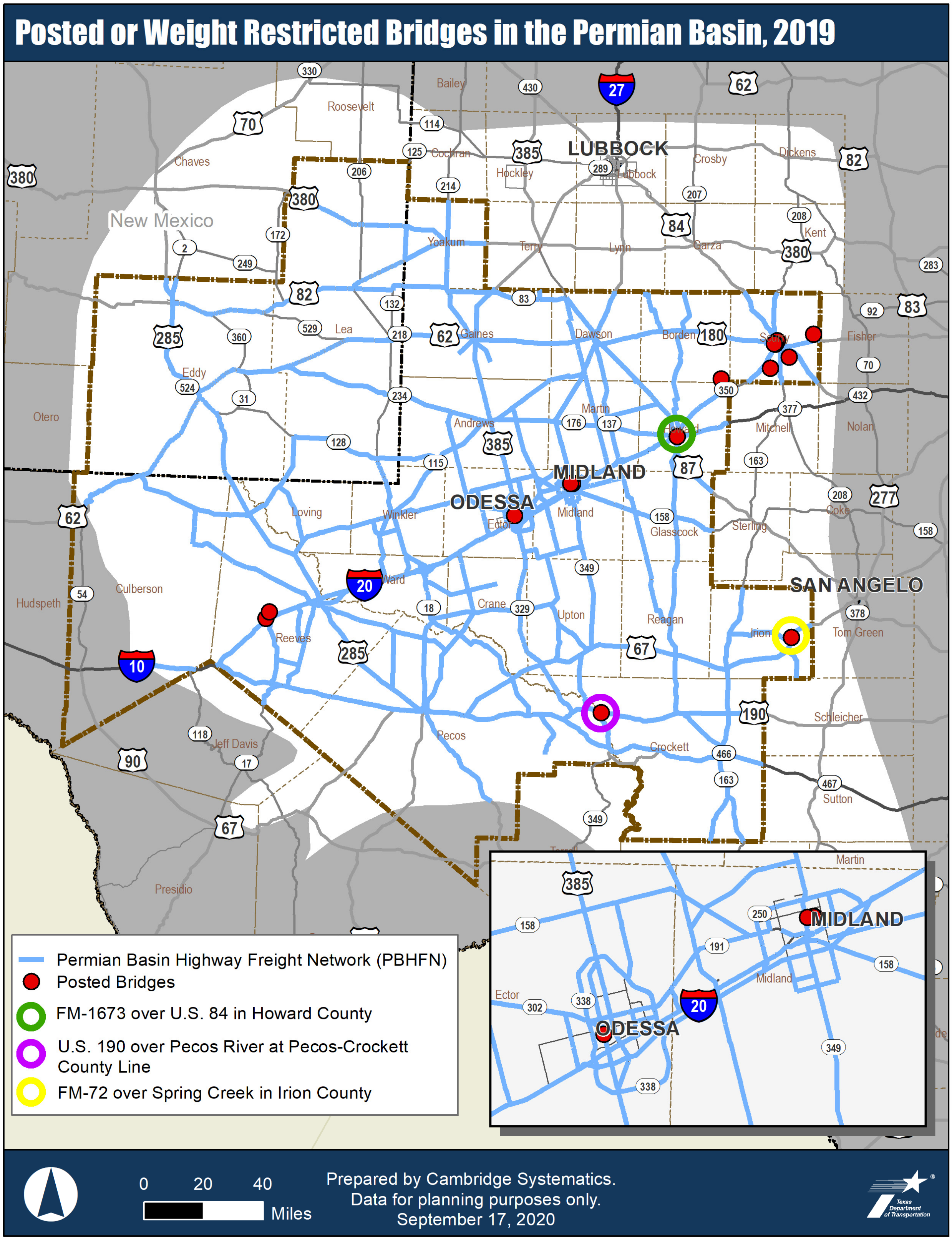
Posted bridges are another challenge to efficient freight movement. A posted bridge is one that has a weight limit below the standard gross vehicle weight and truck axle distribution weight due to its condition or age in the case of an older bridge that was not originally designed to modern standards. This means that heavier trucks that are still within state or federal operating standards for gross vehicle weight and truck axle distribution weight (for instance, a truck that is just under the federal 80,000 lb. gross vehicle weight limit for the Interstate System) would not be able to use a bridge with a posted weight limit below state and federal standards. The heavier truck must either detour around the bridge or reduce its payload, which would ultimately lead to more trucks on the road for the same haul.

Exhibit 81. shows a map of posted bridges in the Permian Basin. Most of the bridges are along local roads and not on the freight network. However, there are a few worth noting:

- Farm to Market (FM) 1673 over U.S. 84 in Howard County (circled in green in Exhibit 81. 1): The overpass that serves as an entrance to U.S. 84 is posted, but there are close alternative entrances/exits to the highway.
- FM 72 over Spring Creek in Irion County (circled in yellow in **Exhibit 81.** 1): The bridge serves as an entrance to U.S. 67 from the Sherwood community, but there is an alternative bridge north of the Sherwood community that can be used to access the highway.
- U.S. 190 over Pecos River at the Pecos-Crockett County line (circled in purple in Exhibit 81. 1): This bridge is on the THFN and there is no other close crossing of the Pecos River.

There are no posted bridges on the New Mexico portion of the Permian Basin.

Exhibit 81. Posted or Weight Restricted Bridges in the Permian Basin, 2019

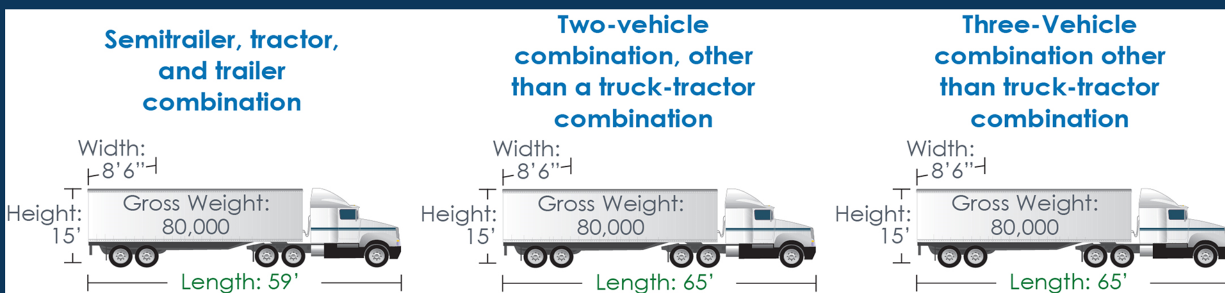


Source: National Bridge Inventory, 2019.

Oversize/Overweight Vehicles

While all vehicle traffic causes wear and tear to roadways, trucks cause considerably more damage due to their size and weight . Trucks that exceed state and federal legal limits for size and weight and require permits to operate legally on public roads (commonly referred to as oversize/overweight (OS/OW) vehicles) cause even more damage. The accelerated deterioration of roadways from OS/OW vehicle activity increases maintenance costs and directly impacts the condition and performance of the highway system. Because the energy sector, including oil and gas activities as well as wind and solar activities, relies heavily on moving large, oversize, and overweight pieces of equipment and commodities on a daily basis, understanding OS/OW permitted moves is critical to addressing asset preservation and maintenance needs in the Permian Basin.

Legal Truck Size and Weight Limits



Data for OS/OW vehicle activity were collected from the Texas Department of Motor Vehicles (DMV), which is responsible for issuing OS/OW permits. For the purposes of this study, there are some limitations to these data. The DMV offers several permits that allow motor carriers to haul multiple OS/OW loads continuously over a defined period so long as they are within specified thresholds for weight and size and are using an approved vehicle. For OS/OW loads transported using such a permit, no data are collected on the number of OS/OW loads that are hauled, the origin or destination of those loads, the specific commodities carried, or the specific routes used. This level of detailed information is only collected for loads so large and/or over-dimensioned that they must be routed using the DMV's OS/OW routing system – the Texas Permitting and Routing Optimization System (TxPROS). This analysis focuses on those TxPROS OS/OW loads. Though these represent only a fraction of OS/OW vehicle activity in the Permian Basin, they offer insight into which routes are most critical for facilitating OS/OW movements in the region.

TxPROS route data provided by DMV were analyzed for the 12-month period October 2018 to September 2019. There were 706,273 routed OS/OW trips in Texas in that period. Of those, 34% (or 240,817 trips) were routed through the Permian Basin, an average of about 660 per day. For comparison, the Permian Basin contains only about seven percent of TxDOT on-system highway miles.

Once trips routed through the Permian Basin were identified, corridors throughout the Permian Basin were selected for an analysis that determined the number of OS/OW vehicles that used those corridors over the 12-month period. These locations, listed in **Exhibit 82** and depicted in **Exhibit 83**, include major corridors for truck movements in the Permian Basin, as informed by traffic count data and stakeholder feedback. The results of the analysis indicate that I-20 is the most frequently used highway for routed OS/OW vehicles. The 5-mile section of I-20 between FM 1788 and Loop 250 in Midland was traversed over 35,000 times by routed OS/OW loads in the 12-month period, a daily average of 96 OS/OW vehicles.

Oversize/Overweight Permits are Commonplace for the Energy Sector Operating in the Permian Basin

What are Oversize/Overweight (OS/OW) Permits?

- Federal, State, and Local laws limit the size and weight of vehicles.
- Vehicles exceeding these limits require a permit to operate to ensure highway safety.
- The Texas Department of Motor Vehicles (DMV) issues permits for Interstate, U.S. Highways, and State-owned highways.
- DMV issues both single-trip and multiple trip permits, as well as permits for special types of vehicles, several of which are specific to the energy sector.

What are OS/OW Permit Restrictions?

- Some permits are restricted to a particular route, a particular radius from a fixed location, or a subset of highways.
- Texas DMV permits are primarily for Interstate and state-owned highways.
- OS/OW permits for exceptionally large loads require one or more "escorts" or "pilot cars" to travel with the vehicle.
- Only non-divisible loads (i.e., loads that cannot be broken into multiple loads) are allowed to be overweight on the Interstate, per Federal law.
- Operating Time: One-half hour before sunrise to one-half hour after sunset, including Saturday and Sunday. Loads not exceeding 10′ wide, legal height (14′) or 100′ long with legal front and rear overhang may travel at night on Interstate system only. Overweight only may have continuous movement.
- Texas oversize permits are valid for three to five days. Must have permit prior to entering the state.

Examples of OS/OW Permits Specific to Energy Sector Equipment

Fracing Trailer

- Semitrailer containing a tank and pump unit
- Valid for one year

Rig-Up Truck

- Truck equipped with a winch and gin poles
- Valid for one year

Water Well Drilling Machinery and Equipment

- Self-propelled or mounted machinery used exclusively for drilling water wells
- Valid for one year

Crane & Well Service Unit

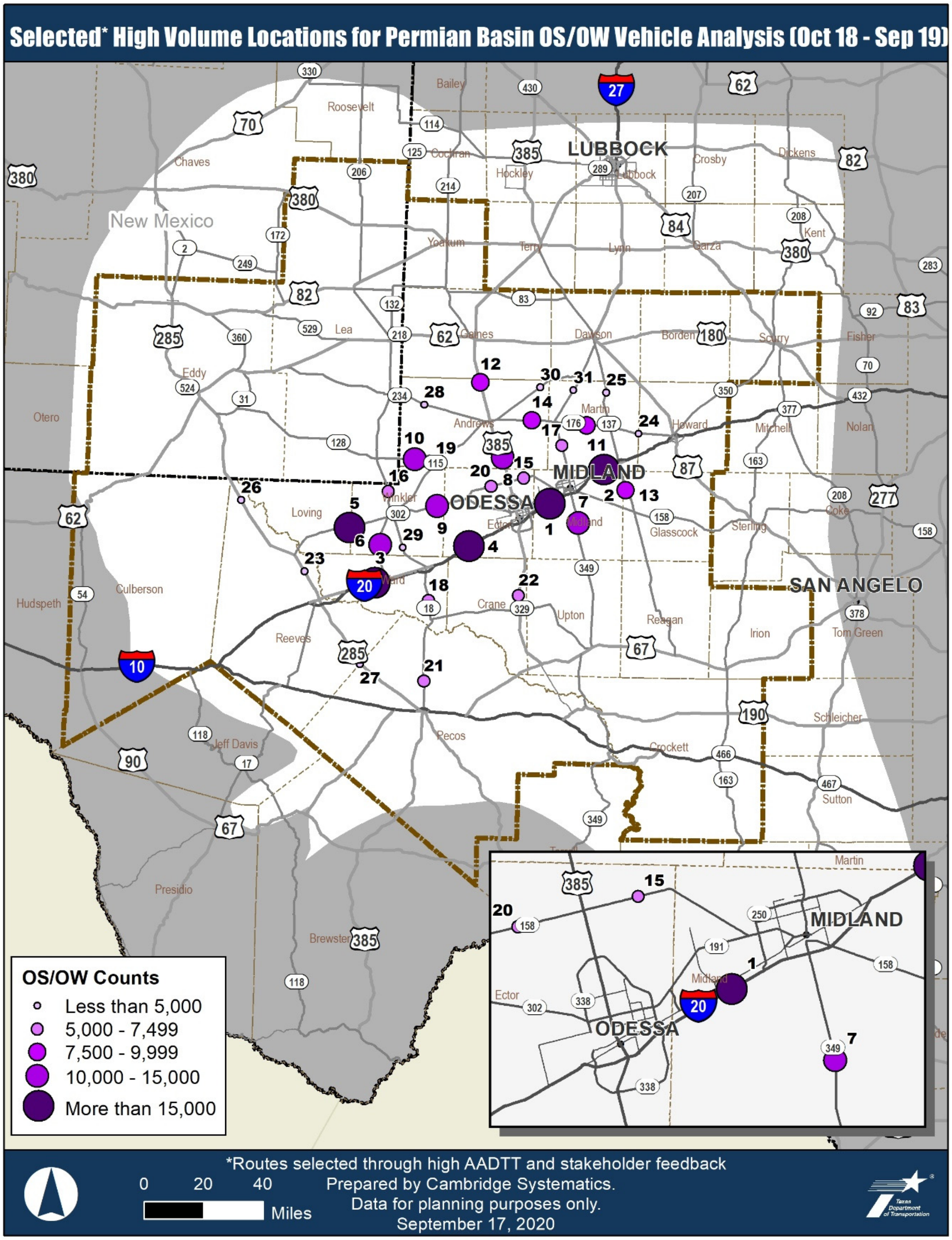
- Unladen equipment
- Fixed-load machinery used to drill, service, or clean oil wells
- Single, continuous movement

Exhibit 82. High Volume Locations for Permian Basin OS/OW Vehicle Analysis

Map ID	Route	Location	OS/OW Trips Oct 2018 – Sep 2019	Avg. Daily OS/OW Trips
1	I-20	Between FM 1788 and Loop 250	35,167	96
2	I-20	Between County Road 1050 and County Road 1090	31,638	87
3	I-20	Between RM 516 and SH 115	28,374	78
4	I-20	Between FM 1601 and FM 1053	26,908	74
5	SH 302	Between SH 115 and U.S. 285	17,010	47
6	SH 115	Between FM 1232 and I-20	12,779	35
7	SH 349	Between I-20 and FM 1787	12,455	34
8	U.S. 385	Between Loop 1910 and SH 158	12,224	33
9	SH 302	Between SH 18 and SH 158	11,950	33
10	SH 128	Between SH 115 and TX-NM Border	10,966	30
11	SH 176	Between FM 1212 and FM 829	9,931	27
12	U.S. 385	Between U.S. 180 and SH 176	9,833	27
13	SH 137	Between I-20 and SH 158	9,334	26
14	SH 176	Between FM 1788 and SH 349	7,942	22
15	SH 158	Between U.S. 385 and RM 1788	7,451	20
16	SH 18	Between SH 115 and the state border	6,915	19
17	SH 349	Between SH 176 and Loop 250	6,425	18
18	SH 18	Between RM 1219 and FM 1776	5,607	15
19	SH 115	Between SH 128 and FM 874	5,421	15
20	SH 158	Between SH 302 and U.S. 385	5,342	15
21	SH 18	Between FM 1450 and W. Gomez Road	5,323	15
22	U.S. 385	Between FM 1233 and Dump Ground Road	5,258	14
23	U.S. 285	Between SH 302 and I-20 Business	4,932	14
24	SH 176	Between FM 3033 and RM 2599	4,903	13
25	SH 137	Between SH 349 and SH 176	4,862	13
26	U.S. 285	North of RM 652	4,479	12
27	U.S. 285	Between RM 2007 and FM 1776	3,886	11
28	SH 176	Between FM 1967 and TX-NM Border	3,126	9
29	SH 18	Between County Road 404 and RM 1219	2,240	6
30	SH 115	Between SH 349 and FM 1788	2,090	6
31	SH 349	Between SH 115 and SH 176	1,704	5

Source: Texas Department of Motor Vehicles, Oversize/Overweight Permits Database, October 2018-September 2019; Cambridge Systematics analysis.

Exhibit 83. Selected High Volume Locations for Permian Basin OS/OW Vehicle Analysis, Oct 2018-Sep 2019



Source: Texas Department of Motor Vehicles, Oversize/Overweight Permits Database, October 2018-Septermber 2019; Cambridge Systematics analysis.

Note: Numbers correspond to data listed in Exhibit 79.

After I-20, SH 302 was the next most frequently used highway for routed OS/OW vehicles in the 12-month period. The portion of SH 302 between SH 115 and U.S. 285 was traveled by over 17,000 routed OS/OW trucks. Heading east on SH 302 towards Odessa (between SH 18 and SH 158), the frequency drops to around 12,000 routed OS/OW vehicles. While the data for I-20 may be indicative of trucks passing through the region, the data on SH 302 suggests that routed OS/OW vehicles are beginning or ending their trips in the area.

Despite its regional importance as a north-south route into New Mexico, the frequency of OS/OW vehicles on U.S. 285 is relatively low compared to other roadways in the region. About 5,000 OS/OW vehicles were estimated to travel on U.S. 84 between SH 302 and I-20 Business or between RM 652 and the New Mexico border. The likely reason for this is that construction activity over the 2018-2019 period limited U.S. 84's use for OS/OW vehicles.[45]

Other routes frequently used by OS/OW vehicles include SH 115, SH 349, and U.S. 385. These facilities were all estimated to have carried about 12,000 – 13,000 routed OS/OW vehicles over the 12-month period. Specifically, nearly 13,000 routed OS/OW vehicles traveled on SH 115 between I-20 and FM 1232. Over 12,000 routed OS/OW vehicles used U.S. 385 between Loop 1910 and SH 158. About 12,500 routed OS/OW vehicles were carried by SH 349 between I-20 and FM 1787. It is one of few OS/OW frequented corridors south of I-20.

4.1.4 RURAL ROADS AND CONNECTIVITY

During multiple engagement activities, stakeholders stated that poor connectivity in the region, especially to, from, and within rural areas, was a contributing factor to poor performance of the PBHFN. Poor connectivity as a driving factor of poor performance was especially stressed for the northwest portion of the region, where only three highways (i.e., U.S. 285, SH 302, and SH 18) provide primary access to that part of the Permian Basin. Contributing to the lack of access is the fact that many of the roads throughout the region are limited by factors such as the number of lanes, asset conditions, and safety concerns.

As can be seen in **Exhibit 84**, two-lane rural roads are the norm throughout the region, including for critical portions of Tier 1 and Tier 2 PBHFN routes that carry heavy truck traffic. In most rural settings, the use of a standard two-lane cross-section works well. This is not the case on key highways used by the energy sector. These highways are challenged with moving high volumes of traffic, consisting largely of trucks, while functioning as a mixed use corridor, providing regional connectivity, local access, and the movement of significant volumes of bulk material. Potential mitigation measures include the provision of turn lanes, passing lanes, adding shoulders, or expanding the roadway by adding lane capacity if warrented and feasible.

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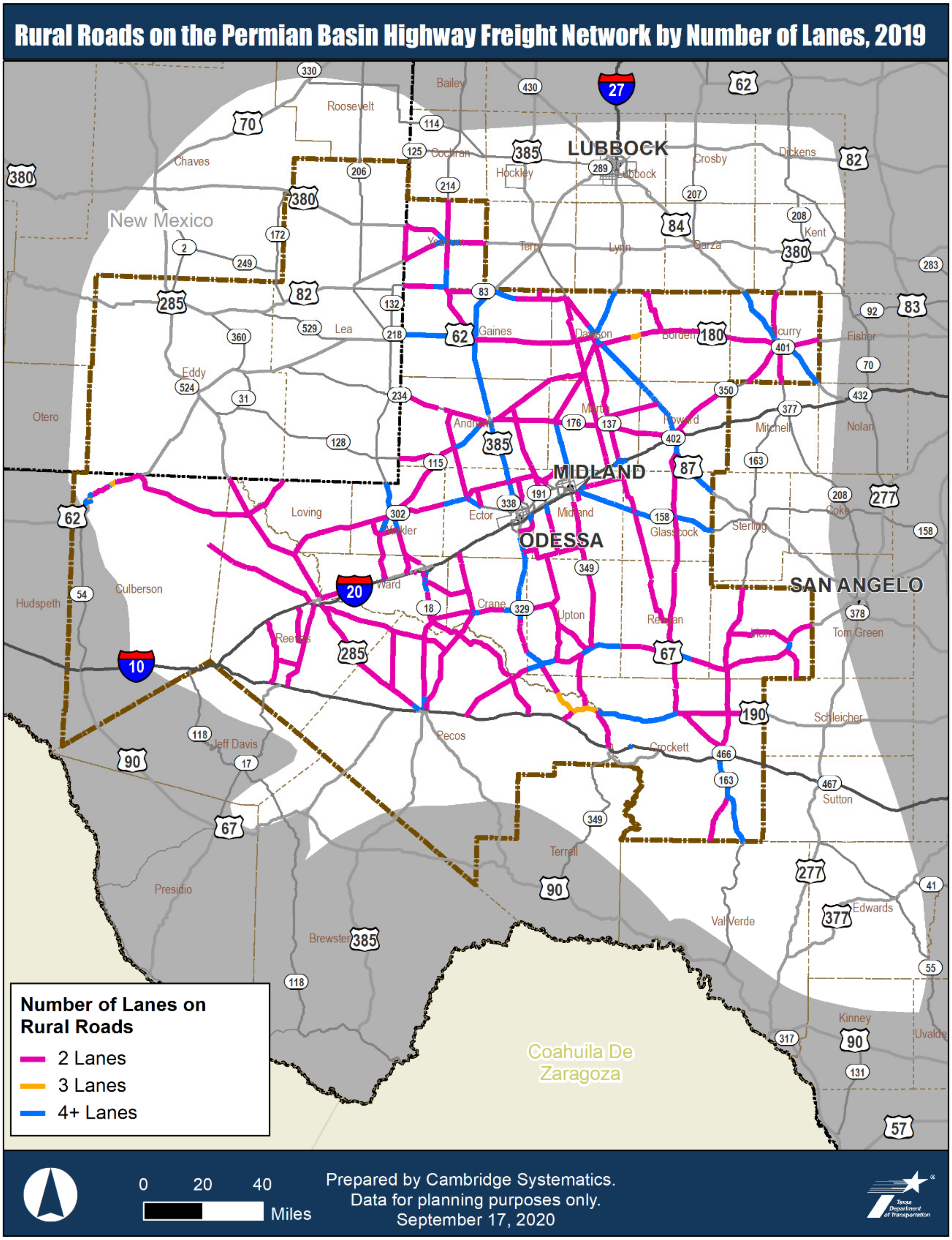
45 Midland Reporter-Telegram, "PBPA: Construction to impact oversized trucks on U.S. 285," October 3, 2018, https://www.mrt.com/business/oil/article/PBPA-Construction-to-impact-oversized-trucks-on-13279480.php.

Exhibit 84. Rural Roads on the Permian Basin Highway Freight Network by Number of Lanes, 2019



Source: Texas Department of Transportation Open Data Portal, 2019.

4.2 PERMIAN BASIN NON-HIGHWAY FREIGHT NETWORK CONDITIONS AND PERFORMANCE

While 92% of the freight tonnage in the Permian Basin moves by truck, the non-highway modes play critical roles as discussed in **Section 2.3**. The following sections summarize critical performance data available for the non-highway modes: safety for railroads, runway length and enplaned air cargo tonnage for airports, and pipeline age for pipelines. Additional detail is available in the Regional Freight Profile, Issues, Challenges, and Opportunities Report. While these data are not directly parallel to those used for highway conditions and performance, some observations can be made related to safety, asset preservation, and connectivity.

As shown in **Exhibit 85,** the highest volume freight rail segments are located along the UP corridor that runs from Howard County to Reeves County in the Permian Basin, roughly parallel to I-20. This line carries 15 to 20 trains per day. The next busiest corridor is the BNSF line through Scurry County that parallels U.S. 84. It carries 14 to 18 trains per day. Lastly, the Texas Pacifico corridor between Pecos County and Irion County carries 2 to 4 trains per day.

Exhibit 85. Trains per Day on Most Active Rail Lines, 2014-2018

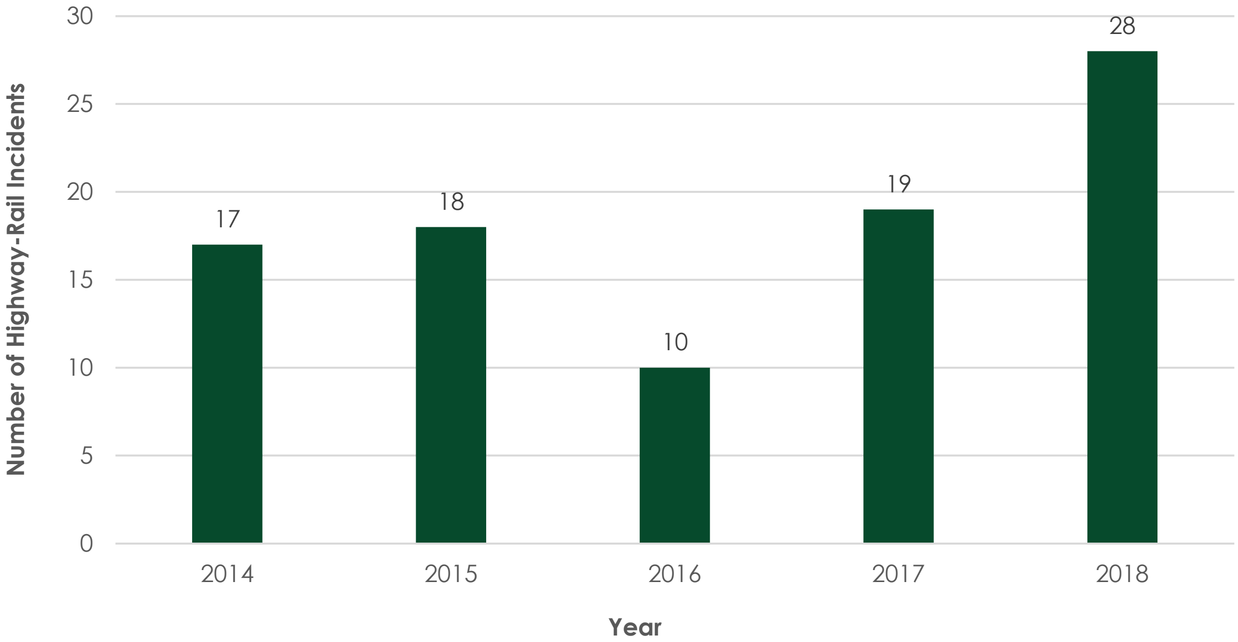
Railroad	No. of Trains per Day
Union Pacific	
Reeves County to Howard County in the Permian Basin	15 - 20
Burlington Northern Santa Fe	
Through Scurry County in the Permian Basin	14 – 18
Texas Pacifico	
From Pecos County to Irion County in the Permian Basin	2 - 4

Source: Federal Railroad Administration, Office of Safety Analysis, Highway-Rail Crossings, 2014-2018.

4.2.1 PERMIAN BASIN FREIGHT RAILROADS

Interviews with the largest railroad in the region, UP, indicated that safety related to at-grade highway-rail crossings is the biggest operating concern for railroads in the Permian Basin. There were 92 highway-rail incidents in the Permian Basin from 2014 to 2018. As shown in Exhibit 86**Exhibit 86**, the 2014-2018 period is characterized by an upward trend in incidents. In part, this increase appears to be driven by an uptick in incidents in Ward County, which experienced seven highway-rail incidents in 2018. By comparison, Ward County experienced only three highway-rail incidents in the previous four years combined. Similarly, Reeves County experienced six highway-rail incidents at three different crossings in 2018, while from 2014 to 2017 it experienced five total incidents at four different crossings.

Exhibit 86. Permian Basin Highway-Rail Incidents by Year, 2014-2018



Source: Federal Railroad Administration, Office of Safety Analysis, Highway Rail Accidents Database, 2014-2018.

As shown in **Exhibit 87**, most highway-rail incidents in the Permian Basin occur in four counties: Midland, Ector, Reeves, and Culberson. These counties account for 62 percent of incidents over the analysis period. Midland, Ector, and Reeves Counties are among the most traveled counties in the Permian Basin as captured by daily vehicle miles traveled,[46] which can be a contributing factor as there are more vehicular trips using the at-grade crossings. Culberson County experiences much lower daily vehicle miles traveled relative to the other counties, but it also lacks grade-separated crossings that could serve as alternative routes.

46 https://www.txdot.gov/inside-txdot/division/finance/discos.html?CFC__target=https%3A%2F%2Fwww.dot.state.tx.us%2Fapps-cg%2Fdiscos%2Fdefault.htm%3Fdist%3DODA%26amp%3Bstat%3Dvm

Exhibit 87. Permian Basin At-Grade Highway-Rail Incidents by County, 2014-2018

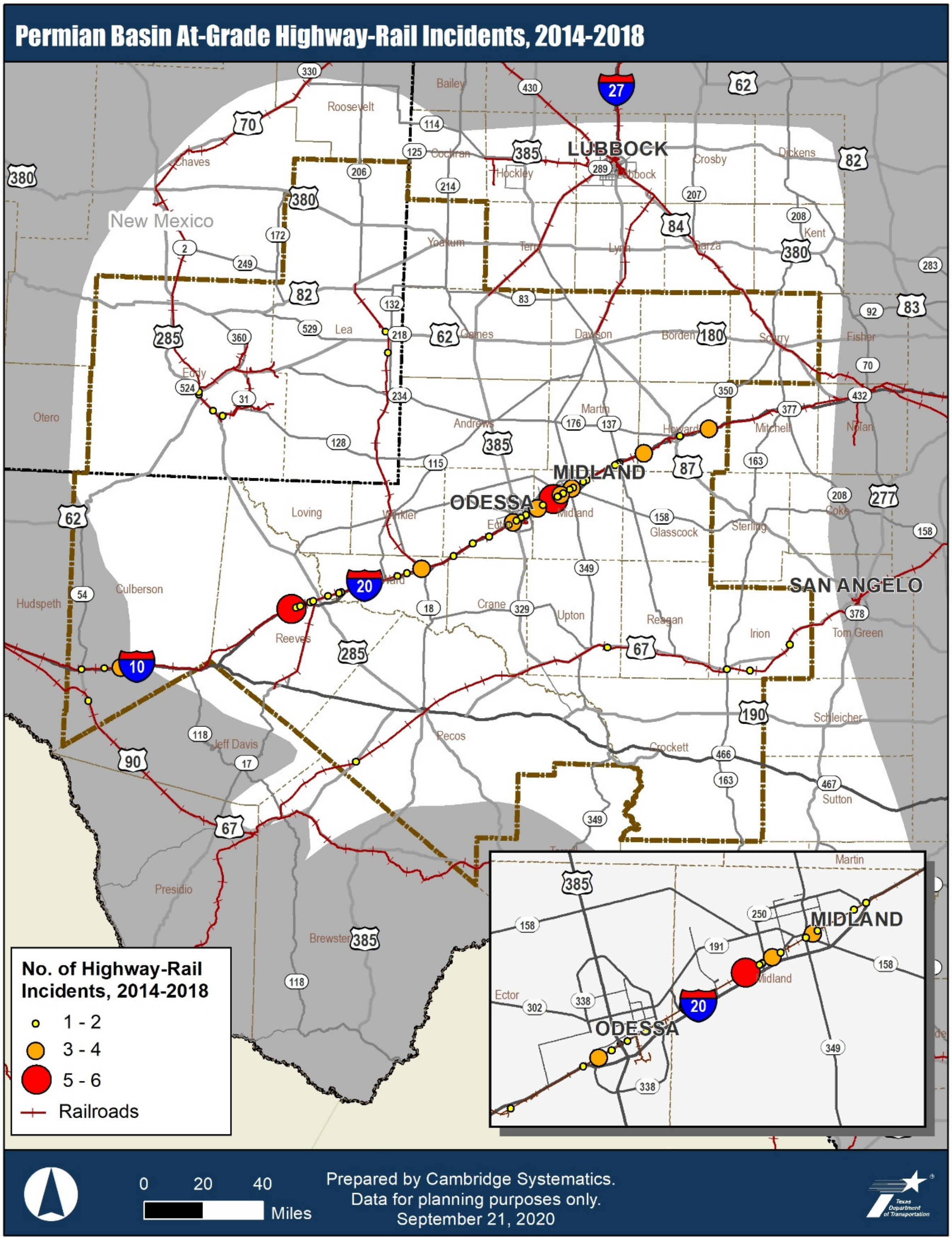
County	No. of Highway-Rail Incidents	Percent of Total
Midland, TX	24	26.1%
Ector, TX	12	13.0%
Reeves, TX	11	12.0%
Ward, TX	10	10.9%
Culberson, TX	8	8.7%
Howard, TX	8	8.7%
Martin, TX	5	5.4%
Irion, TX	3	3.3%
Pecos, TX	2	2.2%
Upton, TX	1	1.1%
Eddy, NM	5	5.4%
Lea, NM	3	3.3%
Total	92	100.0%

Source: Federal Railroad Administration, Office of Safety Analysis, Highway Rail Accidents Database, 2014-2018.

Of the 640 public at-grade highway-rail crossings in the Permian Basin, 52 (about 8%) accounted for all of the at-grade highway-rail incidents observed over the analysis period. As shown in **Exhibit** 88, at-grade highway-rail crossings in Midland and Reeves Counties, both along the UP, experienced the most crashes over the analysis period.

Crossing 796312G in Midland County at the intersection of CR 1250 with the UP experienced six incidents over the analysis period. Crossing 796225D in Reeves County at the intersection of CR 414 with the UP experienced five incidents over the analysis period. In total, the top 20 highway-rail incident locations accounted for nearly two-thirds of crashes experienced over the 2014-2018 timeframe. All of the top 20 crossings, except for one crossing in Eddy County, are on the Union Pacific network.

Exhibit 88. Permian Basin At-Grade Highway-Rail Incidents, 2014-2018



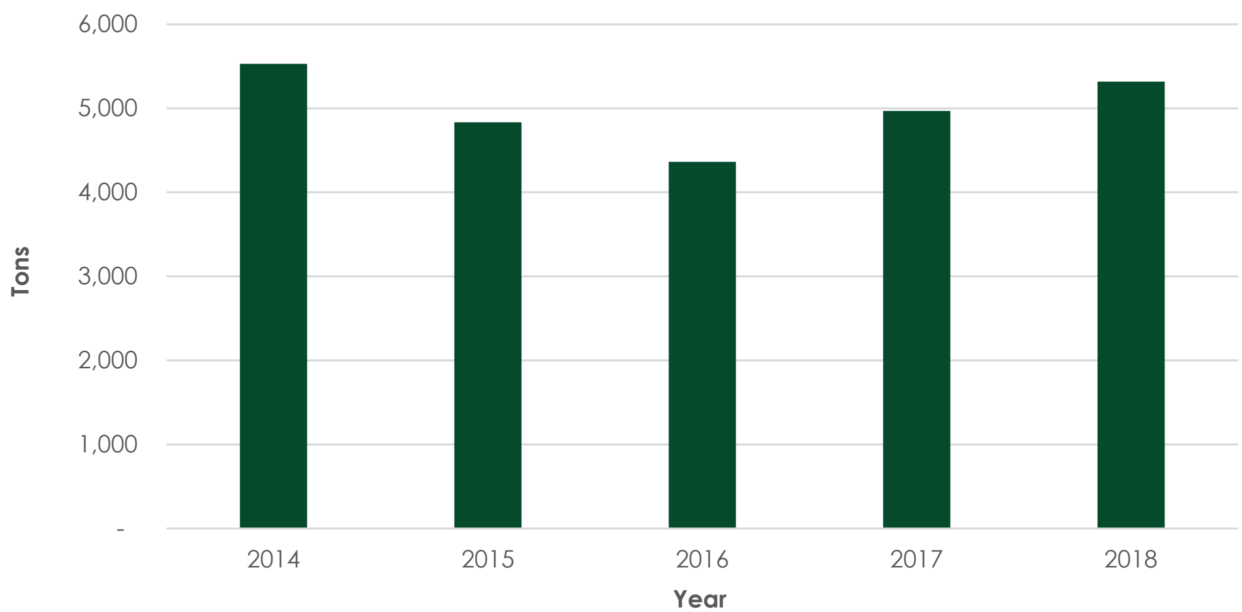
Source: Federal Railroad Administration, Office of Safety Analysis, Highway Rail Accidents Database, 2014-2018.

4.2.2 PERMIAN BASIN CARGO AIRPORTS

Based on 2018 data from the Bureau of Transportation Statistics' (BTS) Air Carrier Statistics Database, MAF is the region's only cargo airport and Federal Express (FedEx), Empire Airlines (a FedEx feeder airline), United Parcel Service (UPS), and Southwest Airlines are the region's primary cargo carriers. Nearly all air cargo transported into or out of MAF was carried by these airlines. Less than 1% of air cargo was transported by the other cargo carriers active at MAF – Mesa Airlines, Envoy Airlines, United Airlines, and Nolinor Aviation. Overall, there is very little air cargo at MAF, as FedEx and UPS each operate one plane per day. On passenger flights, Southwest Airlines carries some belly cargo, predominately fresh fish, flowers, and deceased persons for burial.[47]

As shown in Exhibit 89**Exhibit 89**, the total tonnage of air cargo enplaned (origin and destination) at MAF remained nearly constant over the 2014-2018 period with an average of about 5,000 tons per year. Air cargo activity dipped in 2016 when just over 4,300 tons of freight were shipped into or out of MAF. Similarly, several other airports in Texas experienced decreases in air cargo activity from 2015 to 2016.[48]

Exhibit 89. Tons of Freight Enplaned at Midland International Air and Space Port, 2014-2018



Source: Bureau of Transportation Statistics, TransStats Database, "Air Carriers: T-100 Market (All Carriers)", 2014-2018.

Runway length is one of the most critical characteristics that impact an airport's ability to accommodate air cargo service.[49] It determines the size of aircraft that can operate at an airport. Runway length of 8,000 feet is required for most domestic cargo operations, while 10,000 feet is preferable for international operations.

47 Interview with Justin Ruff (Director of Airports, City of Midland), June 28, 2019.

48 https://www.faa.gov/airports/planning_capacity/passenger_allcargo_stats/passenger/media/cy16-cargo-airports.pdf

49 http://ftp.dot.state.tx.us/pub/txdot/move-texas-freight/studies/freight-mobility/2018/plan.pdf

MAF has four runways: RWY 16R-34L, RWY 10-28, RWY 04-22, and RWY 16L-34R. Of the four runways at MAF, RWY 16R-34L and RWY 10-28 have lengths that exceed 8,000 feet. They measure 9,501 feet and 8,302 feet, respectively. The remaining two runways, RWY 04-22 and RWY 16L-34R, measure 4,605 feet and 4,247 feet, respectively.

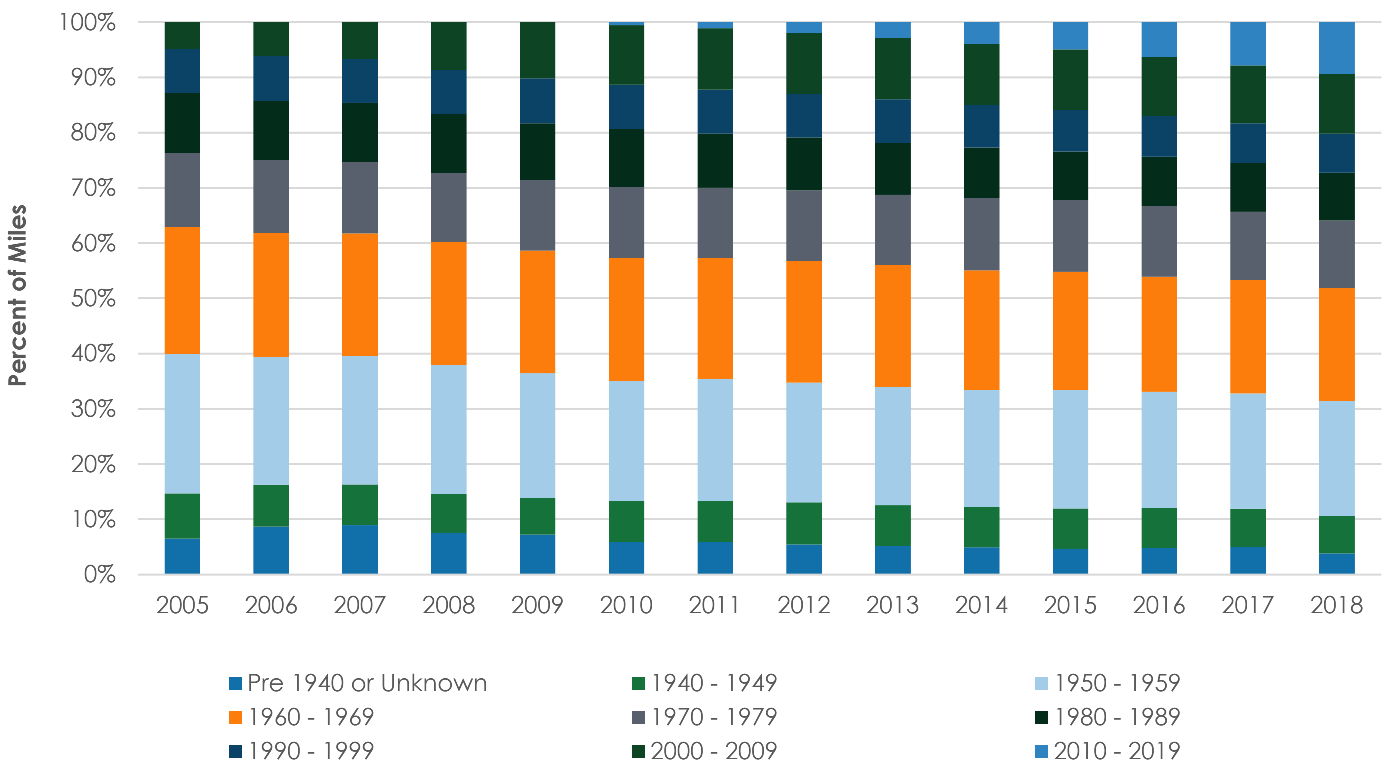
4.2.4 PERMIAN BASIN PIPELINES

To assess the condition of the pipeline network, the average age of the pipelines was examined. Though data is only available at the state level, it is still informative at the regional level, especially since the Permian Basin leads both states in terms of growth in pipeline capacity and mileage, and the related pipeline infrastructure needs.

Exhibit 90 presents the ages of natural gas transmission pipelines in Texas and New Mexico. In 2005, about 5% (i.e., under 2,700 miles) of total natural gas pipeline mileage had been built since 2000. By 2018, about 20% (nearly 11,000 miles) of total natural gas pipeline had been built since 2000.

Despite the investment in new lines, not much of the older inventory is being taken offline. Much of the oldest pipeline infrastructure in both states remains in operation. As of 2005, the share of the oldest pipeline infrastructure (i.e., those lines constructed in 1959 and before) in Texas and New Mexico was about 40% of total mileage. By 2018, that share dropped to 31%, largely because new installations increased overall capacity (e.g., gathering systems, multimodal connectivity points, and delivery points for processing and shipping) as opposed to replacing it.

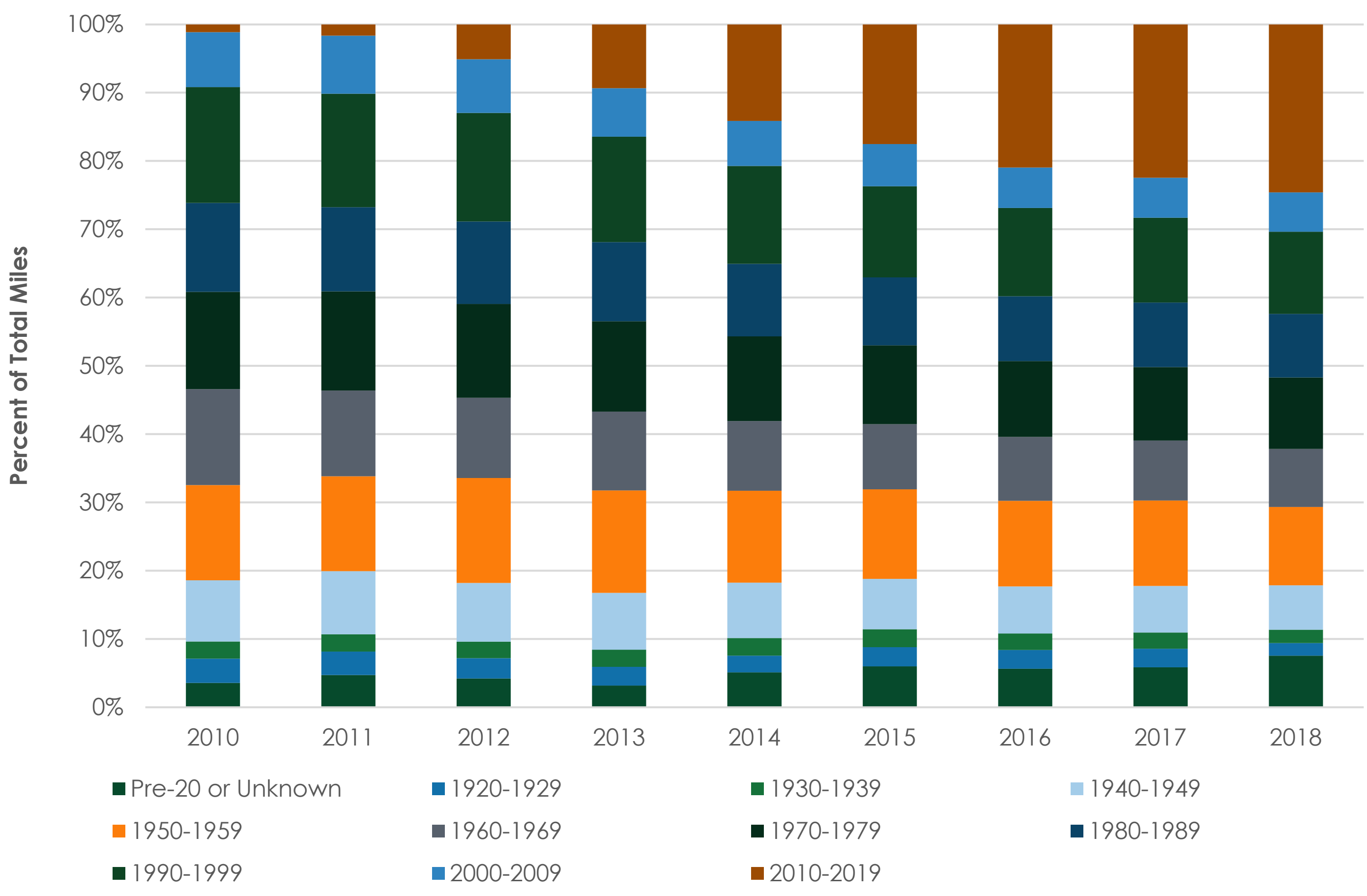
Exhibit 90. Natural Gas Transmission Pipeline in Texas and New Mexico by Installation Decade



Source: Pipelines and Hazardous Safety Administration; Cambridge Systematics analysis.

A similar analysis was performed for hazardous liquids pipelines (which transport crude oil, bitumen, butane, gasoline, diesel, and other fuels) over the 2010-2018 period as shown in Exhibit 91**Exhibit 91**. The results show that the share of hazardous liquids pipelines constructed in the most recent decades (i.e., 2000 – 2009 and 2010 – 2019) has increased greatly. In 2010, hazardous liquids pipelines built since 2000 represented about 9% of total mileage. By 2018, that share ballooned to approximately 30%. Nearly 18,000 miles of hazardous liquids pipeline was added over this time period. This represents a significant increase in capacity for this critical component of the multimodal freight network. In addition, the significant increase in total mileage and pipeline diameter indicates that the infrastructure is reaching new areas of production. With the increasing difficulties in acquisition of land for pipeline installation, large diameter pipelines are becoming the only viable option. Pipelines with size 36" (910 mm) and above are considered large diameter pipelines. Large diameter pipelines helps operators meet current and future demand and reduces the need for the installation of multiple smaller diameter pipelines.

Exhibit 91. Hazardous Liquids Pipeline in Texas and New Mexico by Installation Decades



Source: Pipelines and Hazardous Safety Administration; Cambridge Systematics analysis.

4.3 PERMIAN BASIN FREIGHT ACTIVITY AND LAND USE

Freight transportation, land use, and land use regulations can complement or conflict with each other, depending on the type, frequency, and level of interaction. Efficient and effective freight transportation depends on the availability and location of supportive land uses, such as:

- Clustering of raw materials, pickup sites, and delivery locations; and
- Appropriate land use development for truck fueling, parking, and staging.

Freight activity can also impact local land uses in negative ways, particularly by conflicting with residential and commercial development, such as:

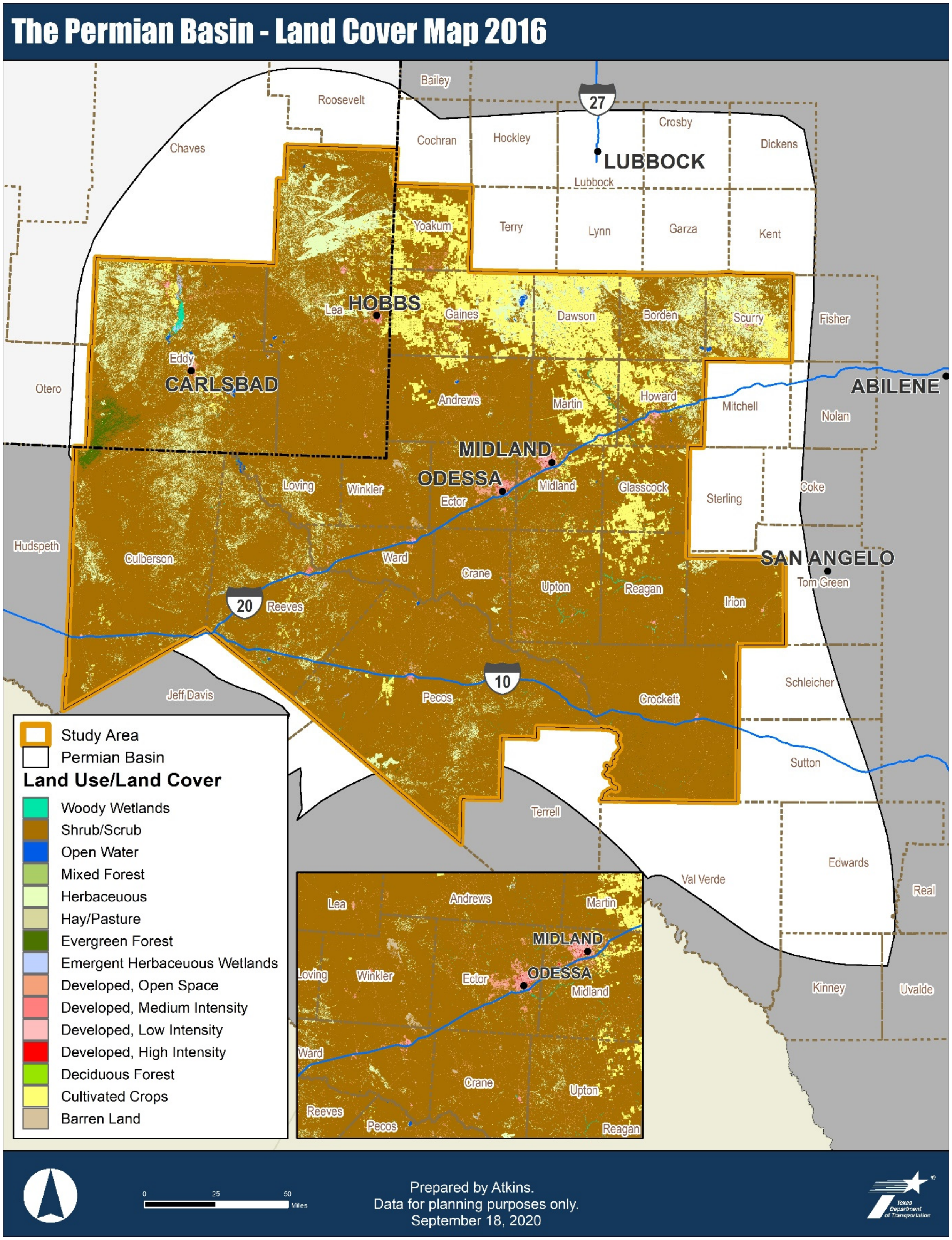
- Vehicle noise;
- Freight vehicle interactions with passenger cars, bicycles, and pedestrians;
- Heavy freight vehicles causing damage to local streets; and
- Noxious or hazardous material conveyance which is an especially sensitive issue surrounding the nuclear waste facility in Andrews.

The Permian Basin region is unique due to the high volume of energy sector-related freight activity. The magnitude and geographic dispersion of this activity makes it difficult to effectively separate any land uses from freight movement. The region is also experiencing a high level of population growth in a short amount of time, creating significant demands for infrastructure, resources, and social services.

The overall Permian Basin study area is sparsely populated. As shown in **Exhibit 92** using data from the National Land Cover Database (2016), the vast majority of the region is undeveloped shrub/scrub land. Much of this undeveloped area is dotted with energy sector activity, as described in the previous section. Areas of development, predominantly low to medium density, are visible in Midland-Odessa, Big Spring, Hobbs (New Mexico), and several smaller municipalities. Agricultural uses are concentrated in the northern portions of the study area, particularly Gaines and Dawson counties, while a swath of evergreen forest exists in the far western portion of the region, straddling the Texas/New Mexico border.

The following summary describes how land use and freight activity interact in the Permian Basin. An in-depth analysis of this interaction is provided in the Permian Basin Freight and Land Use Report.

Exhibit 92. Permian Basin Land Use Cover, 2016

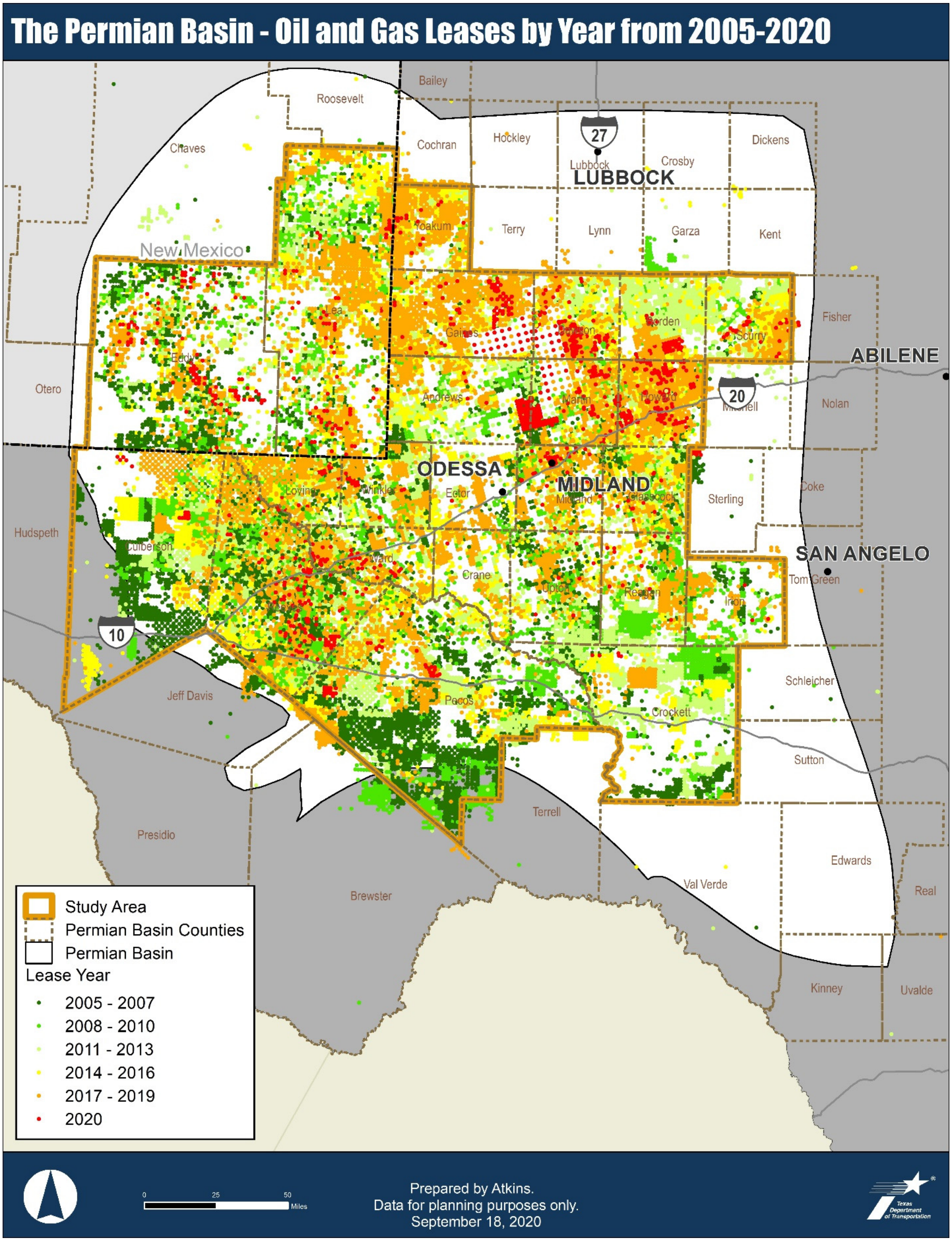


Source: Texas Parks and Wildlife Department, 2019.

4.3.1 OIL AND GAS LEASE ACTIVITY

There has been significant lease activity throughout the Permian Basin from 2005 through April 2020. Some of the more recent activity has been concentrated in the north part of the study area, including Martin, Howard, Dawson, Gaines, Borden, and Yoakum Counties. Another cluster of recent activity in the last three years occurred in the western part of the study area, including Ward, Loving, Reeves, Eddy, and Lea counties. Although some of the northern counties are not included in the Plan's study area, activity in those counties impact traffic within the study area counties. **Exhibit 93** shows oil and gas lease activity by year from 2005 to April 2020. This shows the likelihood of increased truck movement and development activity within the Delaware and Midland Basins as new oil and gas wells are established.

Exhibit 93. Permian Basin Oil and Gas Lease Activity by Year, 2005 – April 2020



Source: Enverus Drillinginfo Database, April 2020.

Overview of Oil and Gas Lease Considerations

- **Assignment:** the sale, transfer, or conveyance of all or a fraction of ownership interest or rights owned in real estate or other such property. The term is commonly used in the oil and gas business to convey working interest, leases, royalty, overriding royalty interest, and net profits interest.
- **Lease:** a contract between mineral owner (otherwise known as the Lessor) and a company or working interest owner (otherwise known as the Lessee) in which the Lessor grants the Lessee the right to explore, drill, and produce oil, gas, and other minerals for a specified primary term and as long thereafter as oil, gas, or other minerals are being produced in paying quantities. This lease gives the Lessee a working interest. The oil and gas lease is granted in exchange for a bonus consideration and royalty payments to the Lessor.
- **Lease Amendments:** a legal document to change the terms of the original lease. It allows certain terms to be changed, while leaving the rest of the lease intact and in full effect.
- **Lease Extension:** when the Lessor and/or leasehold owner extended the first number of years or months defined in an Oil, Gas, and Mineral Lease (primary term) prior to its expiration.
- **Lease Option:** a provision in an oil and gas lease which grants the Lessor and/or the leasehold owner the option to extend the initial number of years or months defined in an Oil, Gas, and Mineral Lease (primary term) prior to its expiration.
- **Lease Ratification:** the act of adopting and confirming all the terms and provisions of an existing Oil, Gas, and Mineral Lease.
- **Memo of Lease:** a contract between a mineral owner (Lessor) and the leasing party (Lessee) outlining the terms of lease in a summarized format.
- **Release of Lease:** a document filed by the leasing party (Lessee) releasing the mineral owner (Lessor) in whole or in part from the binding terms of an existing lease contract.
- **Seismic Memo:** a contract wherein the landowner (Grantor) grants to the second party (Grantee) the exclusive right and irrevocable option for a period of time, to enter upon and conduct oil and gas related geophysical operations upon, over, and across the lands, in a summarized format.
- **Seismic Option:** contract wherein the landowner (Grantor) grants to the second party (Grantee) the exclusive right and privilege of conducting all geophysical exploration, seismic or otherwise, while also conveying unto the Grantee the exclusive right and option to acquire an oil and gas lease covering all or part of the landowner’s interest in the land.

4.4.2 LOCAL ORDINANCES IMPACTING FREIGHT

In most cases, local city codes and ordinances across the region do not differ from each other substantially, each dealing with the same types of restrictions and nuisance prohibitions. Pertaining to freight transportation, local ordinances in the region include:

- **Trucks to operate on designated routes**. This ordinance was most prevalent in cities across the region, and requires that commercial vehicles operate only along designated truck routes, except in the limited cases of local pickups or deliveries.
- **Hazardous cargo routes**. Certain cities designated a subset of truck routes for hazardous cargo transportation.
- **Prohibition of commercial vehicle parking within public right of way**. There were certain variations on this theme; for example, most provided caveats for loading/unloading, and some limited restrictions only to residential areas.
- **Engine brakes prohibited**. Several cities included ordinances prohibiting the use of engine or "jake" brakes (i.e., using compressed air), which emit loud noises.

These ordinances are meant to improve safety and quality of life and protect against some of the negative externalities associated with freight. **Exhibit 94** illustrates frequently occurring ordinances by population center.

Exhibit 94. Most Common Freight Transportation Ordinances by Population Center

City/Town	Restrictions/prohibition on commercial vehicle parking on public ROW	Trucks must drive on designated truck routes	Trucks with hazardous cargo must drive on designated hazardous cargo routes	Engine/jake brake prohibited
Andrews, TX	●	●		●
Big Spring, TX				●
Carlsbad, NM				●
Fort Stockton, TX	●	●		
Hobbs, NM				●
Kermit, TX		●	●	
Lovington, NM	●			
Midland, TX	●	●	●	●
Monahans, TX	●	●		
Odessa, TX	●	●	●	
Pecos City, TX	●	●		
Snyder, TX		●		●

Source: Atkins.

Some cities include more specific, unique ordinances pertaining to freight. These include:

- **City of Midland** codes include weight restrictions on certain street segments identified in the ordinance. Vehicles with a standard load capacity exceeding one ton (loaded or unloaded) are prohibited from driving on identified street segments.
- **City of Lamesa** requires all tank trucks and trailers used for the transportation of liquefied petroleum gases within the city to be constructed and operated as to comply with the regulations approved by the National Board of Underwriters and the National Fire Protection Association.
- **City of Odessa** enacted an ordinance in January 2018 prohibiting commercial motor vehicles from traveling in the city limits. The ordinance prohibits semitrucks from traveling city streets, restricting them to Interstate 20 and Loop 338. Trucks with deliveries in the city limits are required to use the shortest route to reach their destination.
- **Pecos City** specifies that all oil/gas drilling and production operations shall be conducted in such a manner as to eliminate/minimize dust, noise, vibration, or noxious odors, and shall be in accordance with the best accepted practices.
- **City of Kermit** prohibits noise of such character, intensity, and duration that it substantially interferes with the enjoyment of private homes.
- **City of Hobbs** specifies that motor vehicles or motorcycles must not be operated on public rights of way at any time when noise from the engine and/or exhaust system is plainly audible at a distance of 50 feet, with the exception of construction or agricultural equipment on the job site or on highways.

All cities studied in the region have noise ordinances. In most cases, noise regulations are general in nature and do not pertain to commercial vehicles, nor do they apply to specific times of day. The most common noise ordinances that may have a bearing on freight transportation include prohibitions on:

- Frequent sounding of vehicle horns or other signal devices;
- Operation of out-of-repair or otherwise excessively noisy vehicles;
- Exhaust without mufflers;
- Excessive noise associated with loading or unloading vehicles; and
- Excessive noise near schools, hospitals, churches, courts in session, or other sensitive uses.

4.3.3 FREIGHT-INTENSIVE LAND USES

Population growth, employment in key industries, and distribution of energy sector land uses are all components that drive land use decisions and freight demand. The project team developed a methodology to review the levels and distribution of freight-generating land uses by selecting key criteria and quantifying their intensity across the study area. The Permian Basin Freight Plan Steering Committee provided input into the criteria selected based on their relation to freight activity and whether data were readily available. The criteria include:

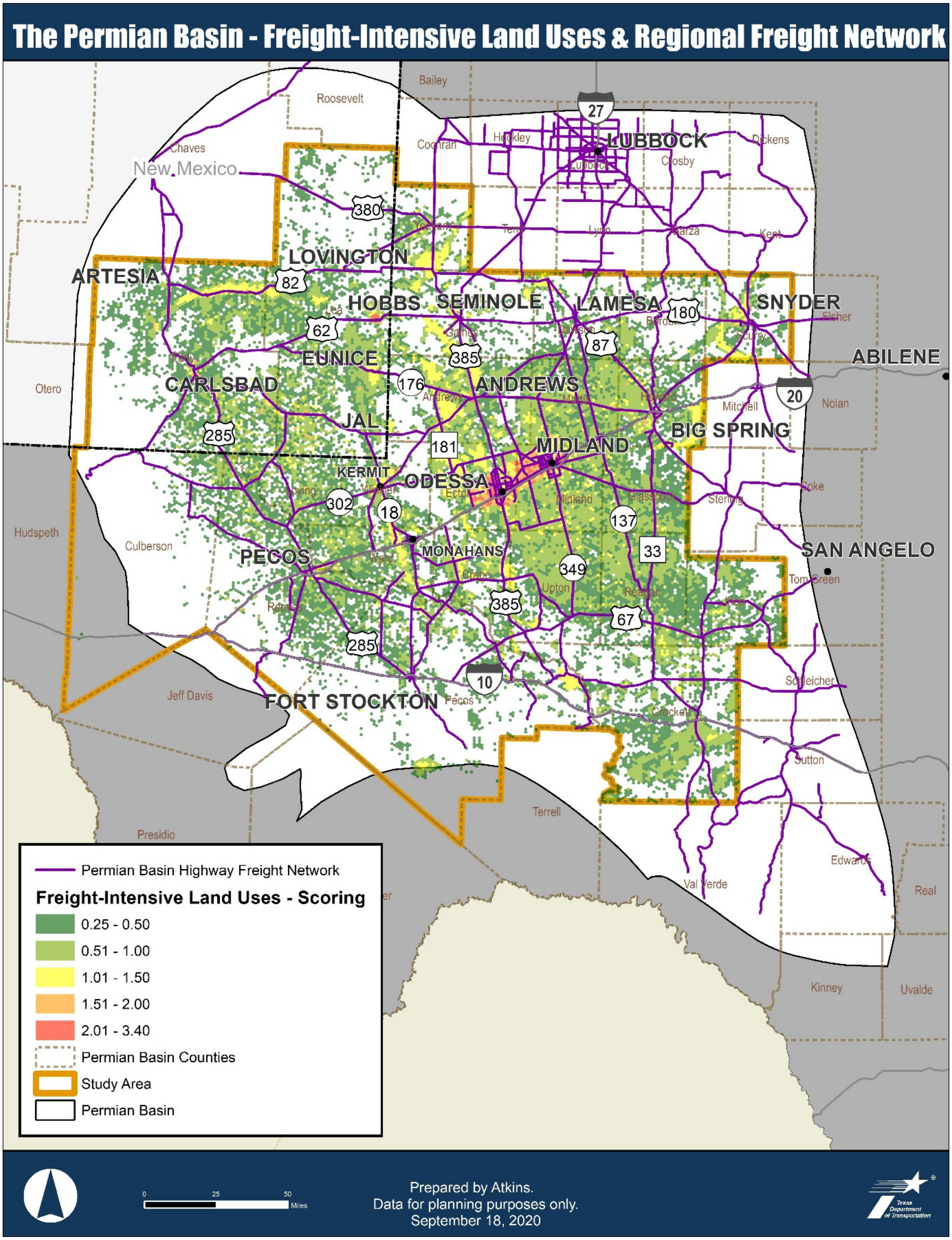
- **Projected population in 2050 (2040 for New Mexico).** This factor recognizes the importance of population centers in generating freight activity. Populated areas and their immediate surroundings were identified, and projected growth at a county level was applied to these zones (recognizing that growth is most likely to occur within and adjacent to existing population centers).

- **Employment in key industries.** This factor uses employment levels in the key industries discussed in Chapter 2 (construction; manufacturing; mining/quarrying; oil/gas extraction; retail; and transportation/warehousing) to account for levels of high freight-generating industries.
- **Active oil/gas wells.** Oil/gas wells generate considerable freight traffic, from initial site preparation to eventual extraction and disassembly. Steering Committee members felt this factor warranted additional emphasis.
- **Permits for oil/gas wells.** This factor was included to account for future as well as existing oil/gas wells. The number of approved permits for wells that have not been drilled provides an assumption of where future activity is most likely to occur.
- **Sand mines.** Sand mines in the study area take up large swaths of land and generate large amounts of freight traffic, as trucks bring sand for fracing to numerous well sites.

Exhibit 95 shows the levels and distribution of freight-intensive land uses across the study area based on the above scoring criteria, with orange and red as the most-intense areas and green as less intense. The Midland and Odessa area shows the highest intensity, due to a confluence of population, employment, and industrial activity. Other areas of moderate to high intensity occur in bands running north/south, particularly between Odessa and the Andrews area, as well as through Ward, Winkler, and Lea (NM) Counties. A similar band of activity occurs east/west across northern Eddy County. The majority of Martin, Howard, Midland, Glasscock, Upton, and Reagan Counties show moderate levels of freight intensity. Some significant levels of activity are present in the Delaware Basin area, as reflected by the presence of wells and permits in the area, but few population or employment centers.

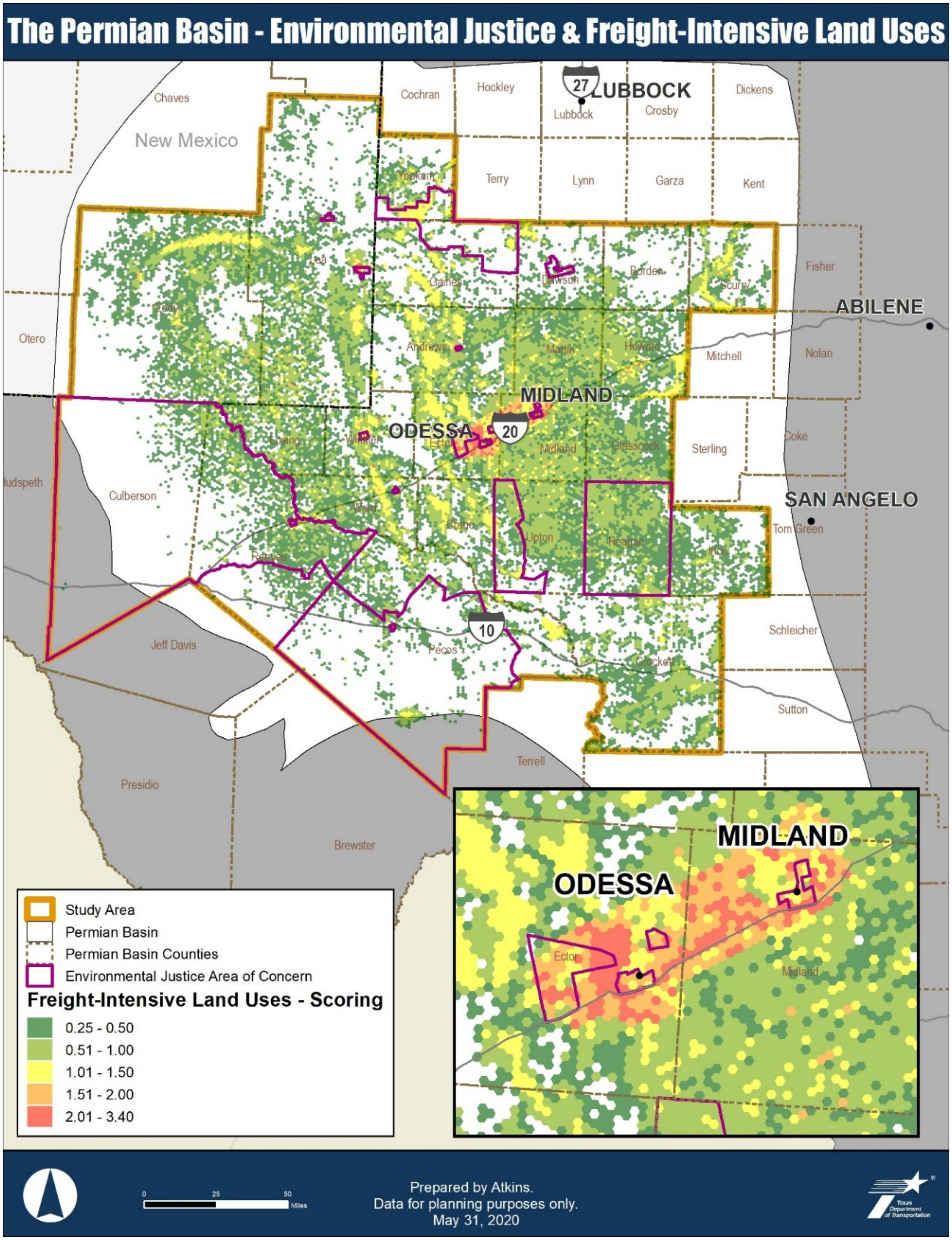
Exhibit 96 overlays the locations that are above the regional average for the three environmental justice indicators (low income, English language proficiency, and minority) on the intensity map. This provides insight into how these environmental justice communities are impacted by freight-intensive land uses and can help guide future freight-intensive developments to avoid disproportionately impacting areas of high environmental justice populations. Within the cities of Midland and Odessa, high freight-intensity land uses coincide with concentrated areas of environmental justice populations. Additionally, there are small pockets in Lea County, NM, as well as Andrews County and Winkler County, where freight-intensive land uses and environmental justice populations overlap. The southern part of Yoakum County also contains moderately heavy freight land uses and environmental justice populations. It is important to try to improve the quality of life and mitigate the impacts that these land uses may have on these vulnerable populations.

Exhibit 95. Permian Basin Freight-Intensive Land Uses and Highway Freight Network



Source: Atkins analysis of local land use plans, U.S. Census data, Texas RRC drilling activity data, Enverus DrillingInfo, and stakeholder input.

Exhibit 96. Permian Basin Environmental Justice and Freight-Intensive Land Uses



Source: Atkins analysis of local land use plans, U.S. Census data, Texas RRC drilling activity data, Enverus DrillingInfo, and stakeholder input.

4.3.4 LAND USE FINDINGS

Land use and freight in the Permian Basin are inextricably linked. As the largest oil and gas producing region in the U.S., there are thousands of wells and associated infrastructure located throughout the Permian Basin. The Permian Basin's economy is energy based, so freight related to the energy industry must be accounted for in all land use planning—accommodation of freight is integral to the well-being of the Permian Basin. Land use planning and energy sector development need to be conducted in a coordinated way. The rapid growth in population and employment due to increased energy production creates challenges for providing adequate, affordable, and available housing and community services.

Land use in the Permian Basin involves balancing residential, commercial, and industrial development with oil and gas exploration in the region. Oil and gas production require many truck trips to establish and maintain wells, pipelines, distribution lines, and related infrastructure. The location and intensity of wells, pressure stations, pumps, pipelines, sand mines, water disposal sites, and hazmat sites impact where and what types of land use development are feasible. Land use and energy sector development need to be conducted in a coordinated way. There should be mechanisms across the region to ensure this coordination takes place, bringing together energy-related companies and governmental entities that regulate and plan for land use and energy exploration.

While integral to the region's economy, the energy industry infrastructure and related trucks bring road congestion and increased deterioration of pavements, noise, pollutants, and sometimes the shipment of hazardous materials. Fracing uses water from local supplies, especially ground water, that cannot at present be restored to potable use, and produced water needs to be stored and managed separately. Lack of housing needed for the energy sector labor force or support services has resulted in "staff camps"—temporary villages with limited services that generally are located away from existing population centers and commercial, institutional, medical, community, and emergency services.

The benefits and negative impacts of the energy industry in the Permian Basin are not distributed evenly to all areas. The freight-intensive land use map shows relatively high current or expected freight intensity near population centers, especially Midland and Odessa, but also in sparsely populated or remote areas near the location of active wells, sand mines, and areas where permits have been issued for oil and gas well development. These areas of high freight intensity and the roads connecting them are where investments for improving freight movement should focus, both to expedite freight movement and to ameliorate the negative consequences associated with them. The environmental justice index map shows census tracts of vulnerable populations—low income, low English language proficiency, and minority households. These areas and the populations within them should be considered to ensure that energy development and related public infrastructure do not place additional burden on their communities.

As the Permian Basin continues to grow, it is critical to balance the freight needs of the energy industry with the continued land use development of population centers that support it.

Chapter 4 summarized the conditions and performance of the Permian Basin's multimodal freight network and the interaction between freight intensive land uses, transportation, and community development. The findings form the foundation for the needs assessment which is presented in **Chapter 5**.

CHAPTER 5 Permian Basin Freight Transportation Challenges and Needs

5.1 PERMIAN BASIN FREIGHT TRANSPORTATION CHALLENGES AND NEEDS

The process for identifying freight-related transportation needs is both data-driven and stakeholder informed. Technical analyses completed as part of developing the Permian Basin Regional Freight Profile Report, the Freight and Land Use Report, and the Permian Basin Multimodal Network Designation Report formed the foundation for the data-driven component of the needs assessment. This section presents a summary of the freight challenges and needs in the Permian Basin. Additional detail can be found in the Trends, Forecasts, and Needs Assessment Report.

5.1.1 PERMIAN BASIN CHALLENGES AND NEEDS OVERVIEW

Freight transportation system needs and challenges in the Permian Basin cover a wide range of issues, from increasing capacity to exploring alternative funding mechanisms. These needs and challenges provide the rationale for recommendations and are an integral part of the development of the state's freight improvement strategy. Freight transportation needs were identified through the following considerations:

1. **Safety.** Addressing safety issues consists of adequate truck parking, including overnight/rest stops; reducing the number of at-grade highway-rail crossings; improving and updating roadway geometrics; addressing vertical clearance issues; and increasing education/awareness of the public and truck drivers about commercial vehicle needs.
2. **Mobility and Reliability.** Issues related to multimodal network include capacity constraints, congestion, and bottlenecks on key freight corridors, exploring alternative parallel corridors/redundancy, and improving merging lanes at interstate interchanges.
3. **System Operations.** Efficient system operations require investing in transportation infrastructure, developing comprehensive incident management systems, accommodating oversize/overweight/over-dimensional trucks, and updating and maintaining aging infrastructure.
4. **Multimodal Connectivity.** Identifying regional corridors, and improving and increasing intermodal connections will improve multimodal connectivity throughout the region and the state.
5. **Rural Connectivity.** Increasing rural access to the TMFN and the PBMFN and improving rail availability and connectivity in rural areas will enhance rural connectivity.
6. **Trade Gateway Connectivity.** Challenges that must be addressed for improved connectivity to trade gateways including maritime ports, border crossings and inland ports include congestion at ports and international border crossings, multimodal access including pipelines and rail, and safe truck parking along key highway corridors.
7. **Freight Asset Preservation and Modernization.** Maintaining the PBMFN in good condition and modernizing of the system are top priorities with TxDOT and freight stakeholders. Poor pavement conditions and obsolete designs impact operating conditions for commercial vehicles and the motoring public, leading to traffic slow-downs, vehicle, and cargo damage and safety concerns.

8. **Education/Public Awareness.** Communicating the importance of freight movement to the public, improving the public's understanding of freight operational needs, expanding communication between the public- and private-sectors, and clarifying their roles and responsibilities related to funding and maintaining infrastructure are all crucial to public awareness of freight needs.
9. **Funding/Financing.** Focusing on funding for high-priority multimodal freight corridors, balancing existing transportation funding needs between highway and other modes, and creating alternative measures for allocating funding are key to addressing funding/financing issues.
10. **Land Use.** Efficient and effective freight travel depends on the location and availability of supporting land use and supportive and effective regulations. Ordinances related to prohibition of commercial vehicle parking within public right-of-way, truck routes, truck/weight restrictions, hazardous cargo routes, and driveway permits are critical to addressing land use challenges.
11. **Planning Processes.** One of the most significant challenges facing the Permian Basin region is the lack of local data on freight activity, especially as it pertains to the energy sector. Developing processes by which these data may be collected and implemented in long-range transportation planning and decision-making is critical for the region going forward.

While needs in all these areas have significant implications, the remainder of the chapter focuses on infrastructure needs on the PBHFN. The infrastructure needs and challenges are organized by mobility and reliability, safety, truck parking, asset preservation and modernization, and rural roads and connectivity. This chapter concludes with a look at the combined needs across all of these categories.

5.1.2 STAKEHOLDER INPUT ON CHALLENGES AND NEEDS

Recognizing that data alone does not tell the entire story of the region, stakeholder feedback was obtained to better understand the challenges facing the Permian Basin. The feedback from stakeholders collected as part of multiple outreach efforts helped to fill in the gaps from the technical analyses where adequate data may not have been available or simply did not convey the entire story.

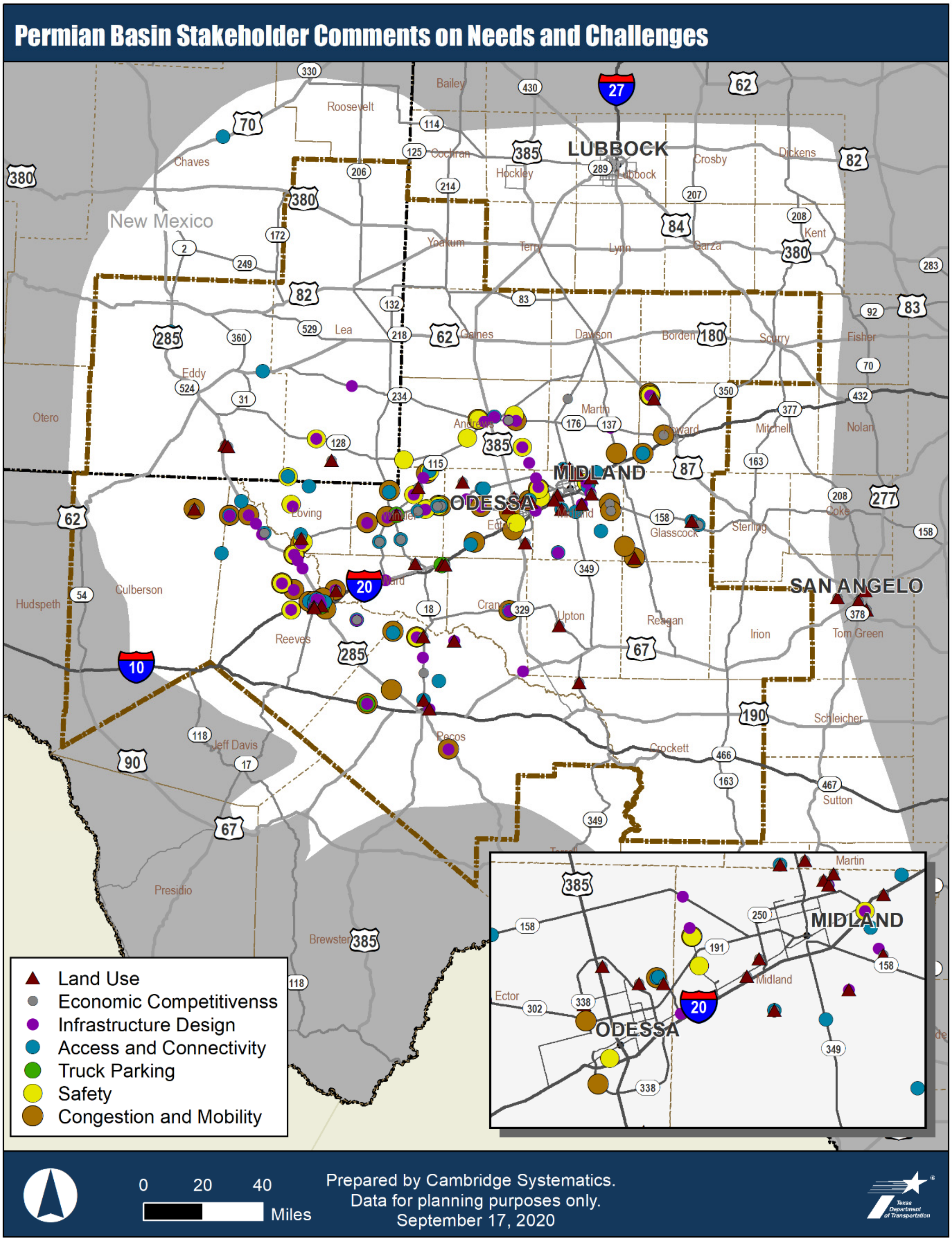
Through an interactive mapping exercise, stakeholders identified roadways that suffer from congestion or other performance challenges, portions of the region experiencing growth in terms of energy production, portions of the region experiencing growth in residential and commercial development, and areas where truck parking is a concern, among other challenges. The locations of needs noted by stakeholders are depicted in **Exhibit 97**. A summary of the major takeaways from the stakeholder workshops is provided below:

- **Congestion and Mobility** – Stakeholders perceived congestion to be a challenge on many of the region's major corridors, including SH 128, SH 302, Loop 250, I-20, U.S. 285, SH 191, and SH 338, among others. Challenges arise out of the lack of passing lanes, lack of overpasses, absence of dedicated truck lanes, short Interstate ramps, and the high volume of trucks, among other factors. Congestion and mobility challenges inhibit the productivity or the energy sector. Companies must provide more trucks and drivers to do the same amount of work.
- **Safety** –Stakeholders identified safety issues throughout the region, including speeding, lack of lanes for safe passing, lack of signage/wayfinding for leased roads, distracted driving, impatient/aggressive drivers, and the perceived prevalence of driving under the influence violations that stakeholders

attributed to the 24/7 nature of the energy industry. Also, stakeholders noted that some roadways, U.S. 285 and SH 302 for example, are avoided if possible due to safety concerns.

- **Infrastructure**– Stakeholders noted that a high number of access points in the form of driveways and leased roads is a challenge for the region. The relatively high number of access points contributes to the region's safety problems. For rural communities, at-grade rail crossings were a concern as stopped trains have hindered first responders and generally inhibit mobility. Humped rail crossings were also identified as a hindrance to truck movement, especially OS/OW loads being moved on low trailers.
- **Access and Connectivity** – Production is moving towards the northwest portion of the region near the Texas-New Mexico border. Stakeholders observed that this portion of the region suffers from poor connectivity with only three main roadways (U.S. 285, SH 302, and SH 18) providing access to that part of the Permian Basin. This contributes to poor performance and high incident response times, particularly for rural communities such as Culberson County. Furthermore, stakeholders conveyed that in general the current infrastructure is for the region of yesterday, not the region of today or tomorrow.
- **Land Use/Future Development** – As the region grows in population, stakeholders conveyed that northeast Midland (near the Martin County border), west Midland (near Loop 250 and SH 191), northeast Odessa (near SH 588 and SH 191), and Pecos are areas that are expected to be sites of residential and commercial development. In addition, though outside the study area, it was noted that some companies are choosing to locate in San Angelo for purposes of operating in the Permian Basin.
- **Economic Competitiveness** – Stakeholders expressed that the transportation network impacts the cost of business for everyone. Transportation system efficiency dictates the number of trucks, drivers, service times, and other aspects of energy production, which increase costs. They further stressed that, unless action is taken, at some point the cost of transportation will tip the balance and investment in the Permian Basin will no longer be viable.

Exhibit 97. Permian Basin Stakeholder Comments on Needs and Challenges



Source: Cambridge Systematics analysis of stakeholder input, June 2019.

5.2 PERMIAN BASIN SYSTEM CAPACITY AND MOBILITY CHALLENGES AND NEEDS

As documented in the Regional Freight Profile, Issues, Challenges and Opportunities Report, capacity-driven challenges to freight mobility largely center on the region's largest urban areas – Midland and Odessa. Outside of the urban core of the region, freight mobility challenges appear to be driven by factors other than capacity constraints, including infrastructure limitations, safety issues, and interactions between trucks and passenger vehicles, among others. Region-wide, several key corridors on the PBHFN do not provide for consistent travel times, implying a relatively high degree of unreliability. This component of the Needs Assessment identifies system capacity and mobility needs using data on travel time reliability and congestion.

Reliability-driven needs on the PBHFN were identified using NPMRDS and ATRI data to calculate the Truck Travel Time Reliability (TTTR) performance metric over the January 2018 to February 2019 period.[50] All PBHFN roadway segments with TTTR values higher than 1.50 are designated as High need. Tier 1 roadway segments with TTTR value between 0.75 and 1.50 are classified as High need, while Tier 2 and Tier 3 values in this range are designated as Medium needs. All segments with TTTR values less than 0.75 are classified as Low need.

Portions of the PBHFN with capacity-driven needs were identified using the PM peak period volume-to-capacity ratio (V/C) results from a run of the statewide travel demand model (i.e., SAM). The model run used for the Needs Assessment was enhanced using Enverus DrillingInfo data to account for the significant number of truck trips associated with oilfield activity (primarily attributed to shipments of sand and water) not captured in traditional transportation data sources. Relatively high V/C ratios (e.g., near or exceeding 1.0) indicate that the traffic volume on a roadway segment is at or near the capacity for that segment. Capacity-constrained conditions on the highway network lead to poor performance in terms of average travel speeds, increased idling of trucks (which negatively impacts air quality), and other negative impacts. On the other hand, relatively low V/C ratios (e.g., 0.5 or below) indicate that a roadway segment has sufficient capacity for the volume of traffic it handles.

Capacity and Mobility need ratings were weighted by PBHFN Tier and distributed as follows:

Need Rating	Tier 1 Score	Tier 2 Score	Tier 3 Score
High	>0.5	>0.75	>0.75
Medium		0.5 – 0.75	0.5 – 0.75
Low		<0.5	<0.5

Exhibit 98 presents the prioritized freight capacity and mobility needs in the Permian Basin. Congestion is a growing concern throughout the Permian Basin region, and it is impacting mobility and reliability on both urban and rural routes. Notable concerns include I-20 between Midland and Odessa and rural areas along U.S. 285 in Reeves County, U.S. 87 in Howard County, U.S. 385 south of Odessa, and FM 652 from 62 into New Mexico.

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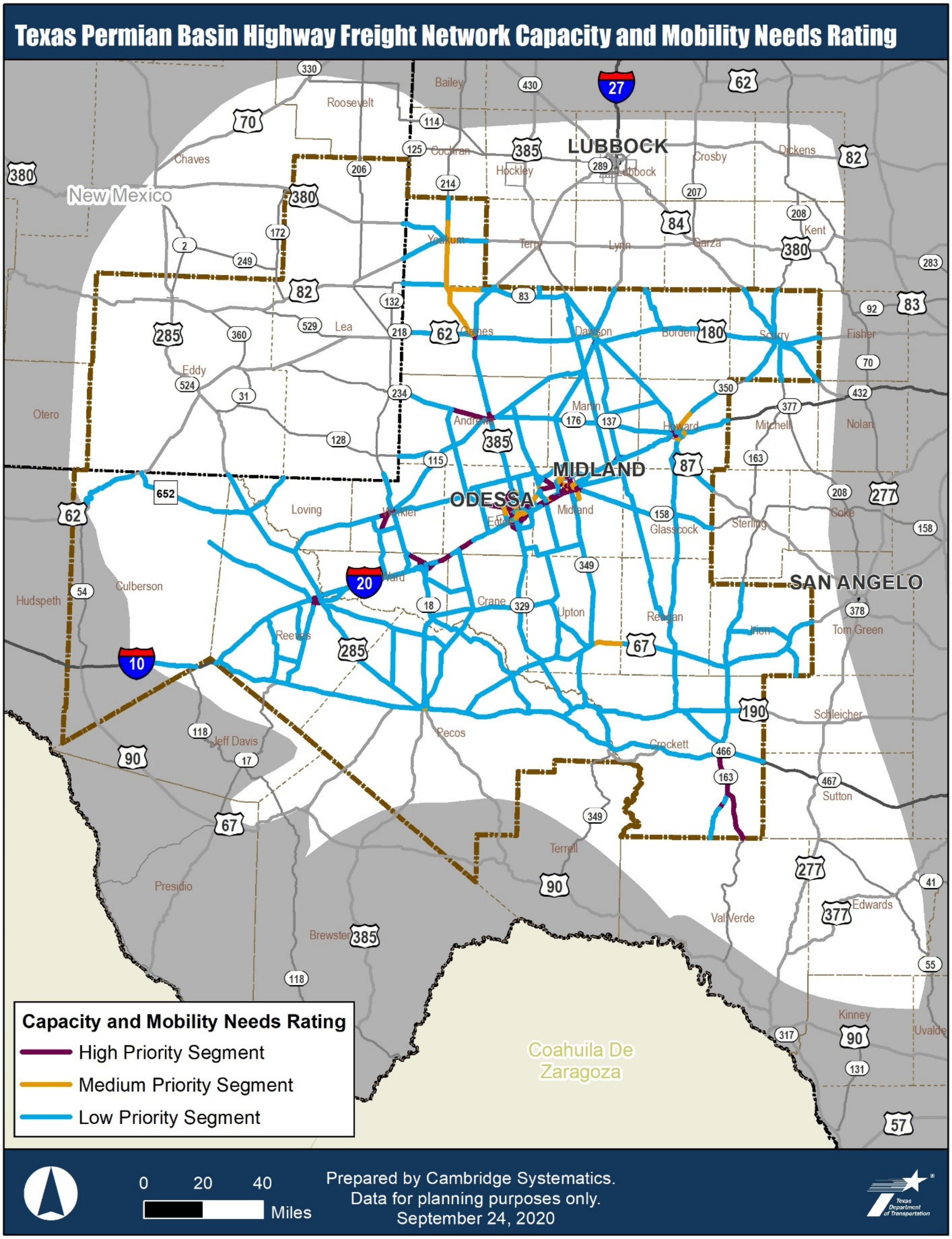
50 ATRI data was used to supplement the NPMRDS data because the NPMRDS only covers National Highway System roadways. The ATRI GPS data used in the analysis was collected over 61 days from four time periods in 2018: February 1-15, May 1-15, July 16-30, and October 16-31. The reliability metrics were calculated for each period. The weighted average of the metrics was then calculated and is assumed to be representative of 2018 performance.

Exhibit 98. Texas Permian Basin Highway Freight Network Capacity and Mobility Needs Rating



Source: Cambridge Systematics analysis.

5.3 PERMIAN BASIN SAFETY CHALLENGES AND NEEDS

Safety is the primary freight need identified by both public and private sector stakeholders in the region. As part of the technical analysis conducted for the Needs Assessment, the PBHFN, in combination with several factors, was used to determine a safety needs score. The PBHFN is classified into three tiers. Tiers 1 and 2 identify routes that are critical for freight movement for the Permian Basin. Tier 3 routes are also important as these facilities provide access to the Tier 1 and Tier 2 routes and represent facilities that may realize growth in freight volumes in the future. The following performance measures were used to determine the safety need scores for roadway segments on the PBHFN:

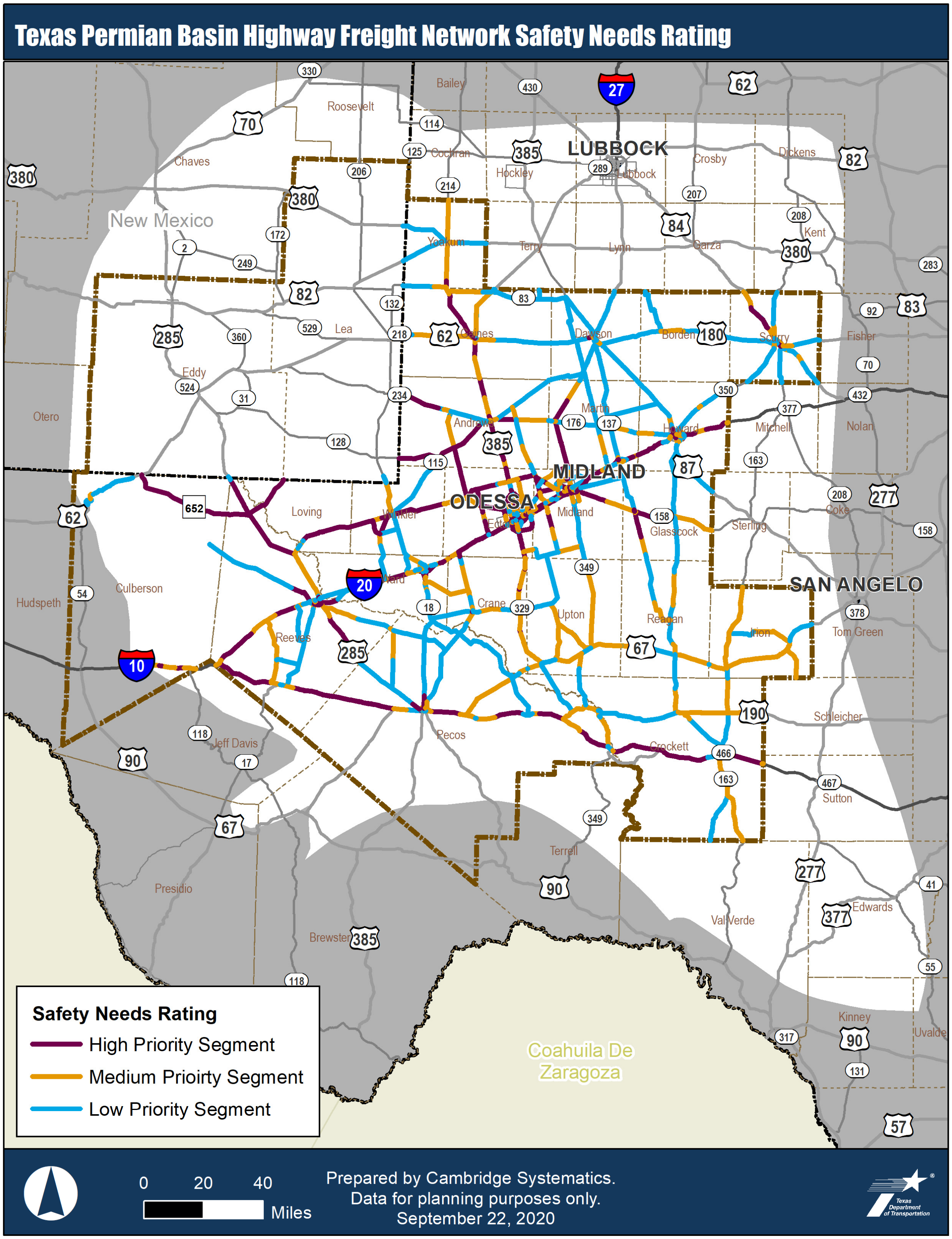
- Crash Severity;
- Hard braking events;
- Truck stops exceeding 8 hours in the public right-of-way; and
- Daily truck volumes.

Once segments on the PBHFN were scored according to each of the individual safety criteria, those individual scores were summed to develop a combined score. For each of the criteria, segments that received a High, Medium, or Low need rating were assigned a score of 3, 2 or 1, respectively. Those scores were then summed across the safety criteria to develop the combined score. Thus, all the safety criteria were weighted equally. Segments on the PBHFN with a combined score greater than 7 were classified as High need. Segments scoring between 5 and 7 were classified as Medium need, while the remainder received a classification of Low need. **Exhibit 99** shows the combined safety need score for routes on the PBHFN.

High and medium safety needs are prevalent throughout the region and across all roadway functional classifications. Some of the notable high safety need routes include:

- I-10 and I-20 throughout the Permian Basin;
- U.S. 285 and U.S. 385;
- SH 128, SH 158, SH 285 and SH 302; and
- FM 652.

Exhibit 99. Texas Permian Basin Highway Freight Network Safety Needs Rating



Source: Cambridge Systematics analysis.

5.4 PERMIAN BASIN TRUCK PARKING CHALLENGES AND NEEDS

With the abundance of freight activity in the Permian Basin region, truck parking is an important consideration for the safe and efficient movement of freight. The lack of adequate truck parking makes freight movements more costly, less safe, and inefficient.

As observed in the August 2015 publication, FHWA Jason's Law Truck Parking Survey Results and Comparative Analysis report,[51] an inadequate supply of truck parking capacity can result in tired drivers continuing to drive because they have difficulty finding authorized parking. It may also result in drivers feeling compelled to park at unsafe locations, such as on the shoulder of the road, exit ramps, or vacant lots. In addition, federal HOS regulations require truck drivers to rest at defined intervals. In a location where parking is scarce, drivers must search for parking well before their allowable drive time expires or while staging for their pick-up and delivery, leading to lost productivity and higher shipping costs.

Truck parking needs were assessed by using truck GPS data from ATRI and examining stops of one hour or more on TxDOT right of way. Mapping the locations of trucks parked on the right of way and the locations of authorized parking provides a comparison of where truck parking is currently needed versus where the region's authorized truck parking is located.

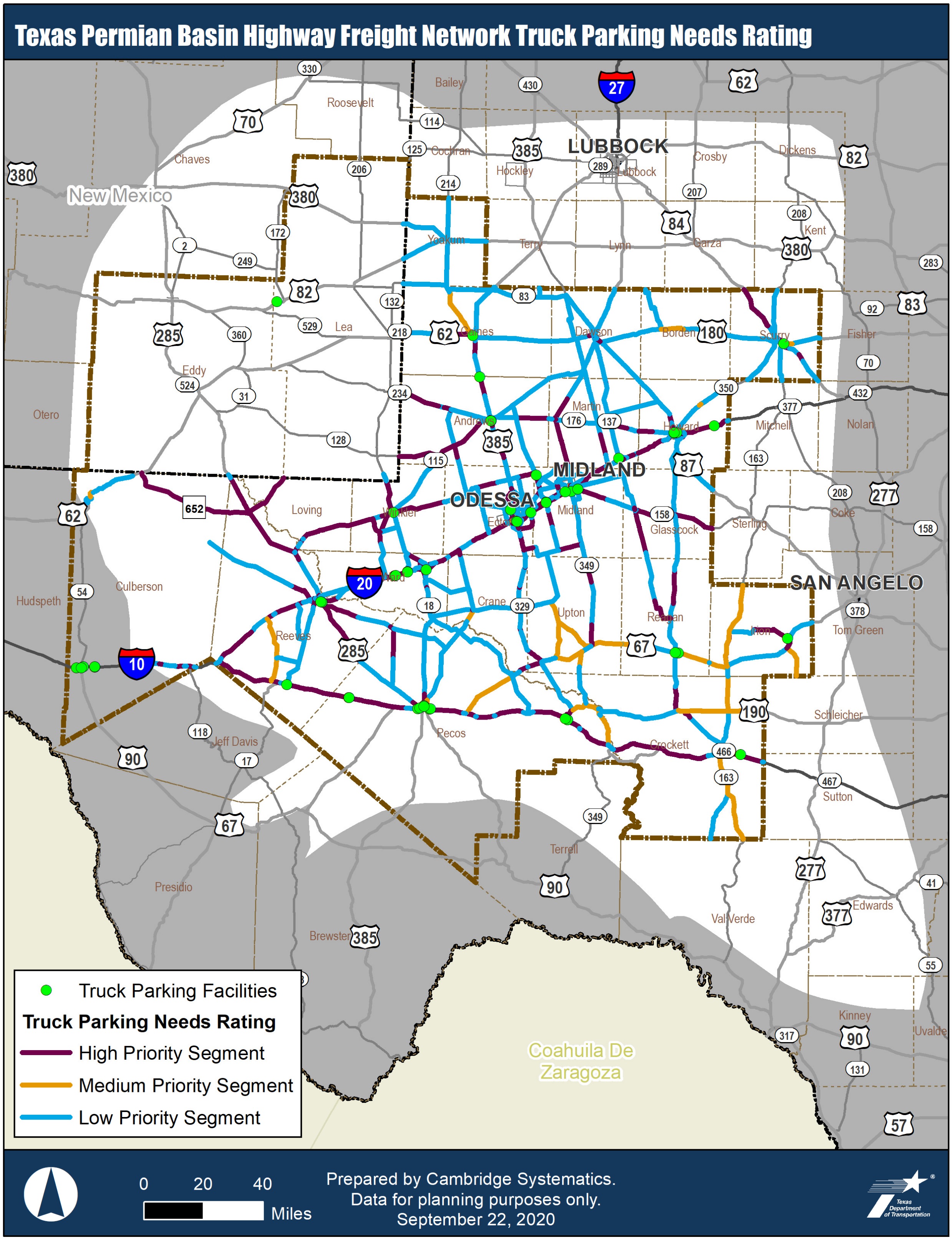
Truck parking need ratings were distributed across the PBHFN Tiers as follows:

Needs Rating	Tier 1	Tier 2	Tier 3
High	Stops over 1 hour observed	Stops over 1 hour observed	-
Medium	-	-	Stops over 1 hour observed
Low	No stops over 1 hour observed	No stops over 1 hour observed	No stops over 1 hour observed

Truck parking need ratings across the PBHFN are shown in Exhibit 100**Exhibit 100.** Truck parking need along I-10 is largely due to long haul needs for overnight parking while the truck parking need along I-20 in the region is a combination of long haul and parking for staging (while awaiting pick-up or delivery) and the mandated 30 minute break period. Truck parking need along the rural routes is primarily driven by short-term staging and rest breaks for sand and water haulers.

[51] Jason's Law Truck Parking Survey Results and Comparative Analysis, August 2015, https://ops.fhwa.dot.gov/freight/infrastructure/truck_parking/jasons_law/truckparkingsurvey/es.htm

Exhibit 100. Texas Permian Basin Highway Freight Network Truck Parking Needs Rating



Source: Cambridge Systematics analysis.

5.5 PERMIAN BASIN ASSET PRESERVATION AND MODERNIZATION CHALLENGES AND NEEDS

Pavement roughness and bridge conditions on the PBHFN were used for the asset preservation and modernization needs. Roadway pavement condition can impact the cost and safety of travel for passengers and freight.[52] Cracked and rutting roadway surfaces can cause additional wear and tear on freight vehicles as well as damage the freight they are transporting. Poor pavement conditions can also impact travel times if trucks must decrease their speeds to avoid potholes or other condition-related hazards. Pavement conditions may also impact safety performance. For example, worn roadway surfaces with reduced friction limit a vehicle's stopping ability and maneuverability, which can lead to a crash.

Pavements with an IRI value less than 95 are considered to be in good condition. Those with IRI values between 95 and 170 are considered to be in fair condition, while those with IRI values exceeding 170 are rated as being in poor condition. Pavement conditions were factored into asset preservation and modernization needs and distributed across the PBHFN Tiers as follows:

Needs Rating	Tier 1	Tier 2	Tier 3
High	IRI >170	IRI >170	-
Medium	IRI 95-170	IRI 95-170	-
Low	IRI <95	IRI <95	IRI <95

Bridges which cannot handle typical truck sizes or weights may contribute to congestion and lead to significant re-routing, as trucks must find alternative routes. If a truck cannot pass over a bridge and does not have a close alternative route, the detour can prove costly in both time and money. Using data from the 2018 National Bridge Inventory, the Regional Freight Profile, Issues, Challenges, and Opportunities Report identified 23 bridges in the Permian Basin rated as being in "poor" condition. Bridge conditions were factored into asset preservation and modernization needs and distributed across the PBHFN Tiers as follows

Needs Rating	Tier 1	Tier 2	Tier 3
High	Bridge in poor condition	Bridge in poor condition	-
Medium	-	-	Bridge in poor condition
Low	Bridge in good condition	Bridge in good condition	Bridge in good condition

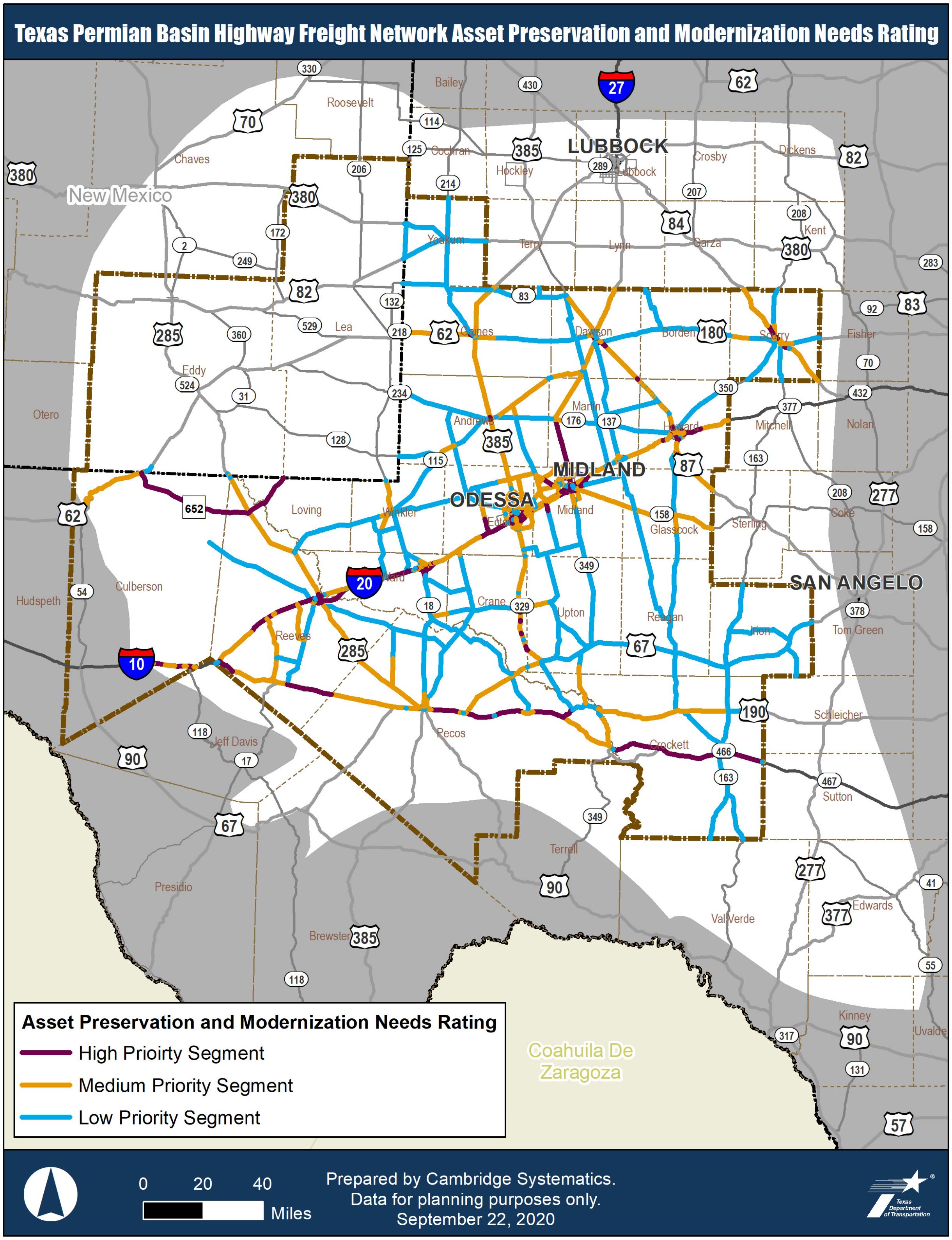
Vertical clearance is another issue that can impact freight mobility. As mentioned in Section 4.2.3, TxDOT is in the process of implementing a new minimum vertical clearance standard of18.5 feet for all bridges and other overhead structures on the THFN. This standard applies to any bridges and overhead structures passing over a THFN corridor. Thus, bridges that provide less than 18.5 feet of vertical clearance along the PBHFN should be addressed as part of future projects. Bridges on higher volume truck routes are a higher priority. Vertical clearance was factored into asset preservation and modernization needs and distributed across the PBHFN Tiers as follows:

52 Federal Highway Administration, 2013 Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance, https://www.fhwa.dot.gov/policy/2013cpr/chap3.cfm#1.

Needs Rating	Tier 1	Tier 2	Tier 3
High	Vertical clearance <15’	Vertical clearance <15’	-
Medium	-	-	Vertical clearance <15’
Low	Vertical clearance >16.5’	Vertical clearance >16.5’	Vertical clearance >16.5’

The scores across the individual asset preservation and modernization criteria are summed to prioritize the needs as high, medium, or low. For example, segments receiving high rating for 2 or more metrics are rated as high and those receiving a medium rating for at least 2 factors are rated as medium. The resulting prioritized asset preservation and modernization needs across the PBHFN are shown in **Exhibit 101**. The highest scoring asset preservation and modernization needs are located along the interstate routes in the region, with nearly the entirety of I-10 and I-20 displaying medium or high needs. Routes that are heavily traveled by sand and water trucks as well as oilfield equipment such as U.S. 285, U.S. 385, SH 302, and FM 652 display significant medium asset preservation and modernization needs. The oversize and overweight trucks contribute significantly to the asset preservation and modernization needs as they require higher and wider bridges and stronger bridges and pavements. Needs related to OS/OW truck trips are presented in the next section.

Exhibit 101. Texas Permian Basin Highway Freight Network Asset Preservation and Modernization Needs Rating



Source: Cambridge Systematics analysis.

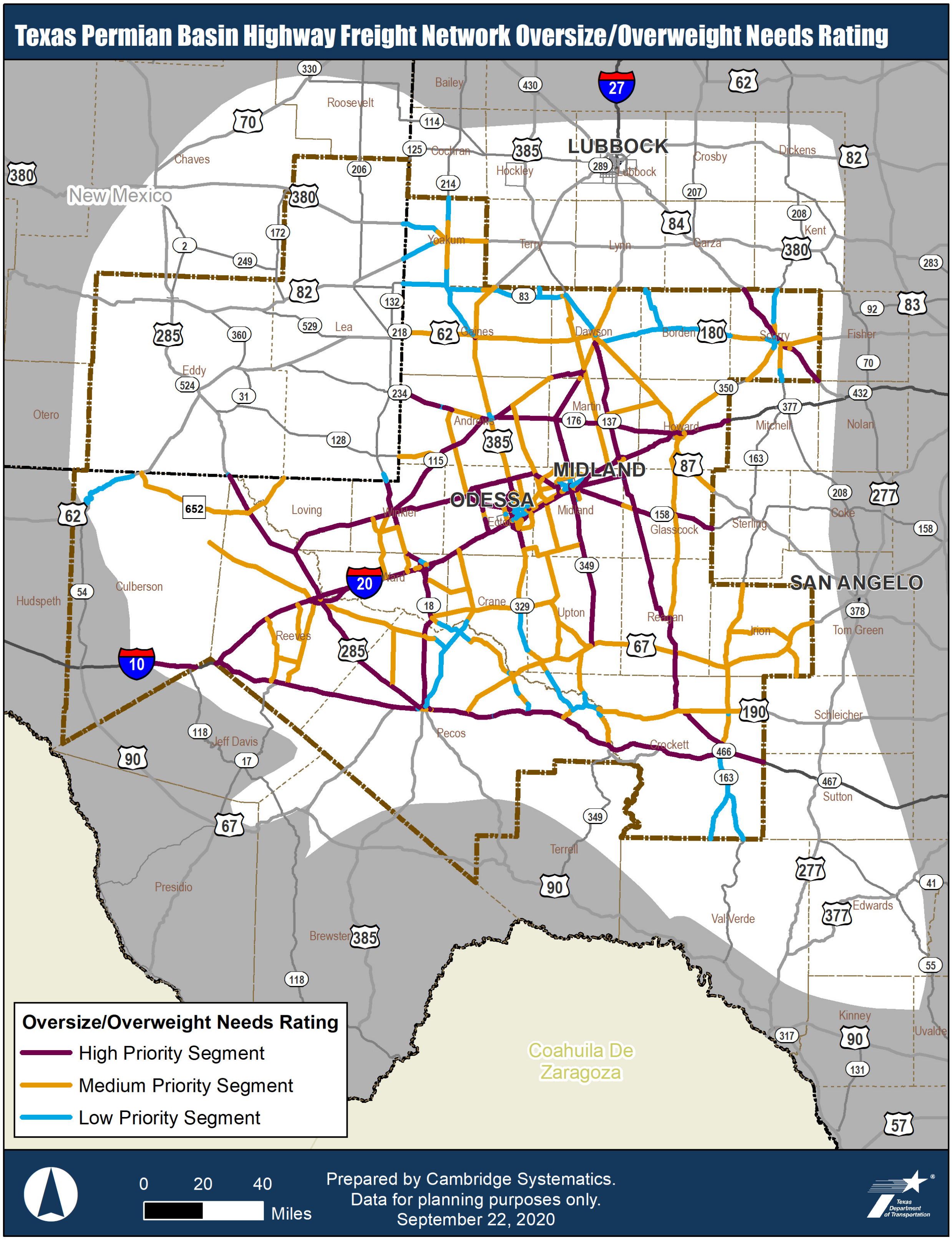
5.6 PERMIAN BASIN OVERSIZE/OVERWEIGHT TRUCK ACTIVITY CHALLENGES AND NEEDS

The prevalence of oversize/overweight (OS/OW) vehicle activity has implications for both the asset preservation and operational needs of the PBHFN. While all vehicle traffic causes wear and tear to roadways, trucks cause considerably more damage due to their size and weight. Particularly, trucks that exceed state and federal legal limits for size and weight, requiring permits before they can operate legally on public roads (commonly referred to as OS/OW vehicles), cause even more damage. The accelerated deterioration of roadways from OS/OW vehicle activity increases maintenance costs and directly impacts the condition and performance of the highway system.

In addition to impacts to the condition of pavements and bridges, OS/OW vehicles also pose operational challenges. Generally, these vehicles must travel at slower speeds (to account for the greater amount of time and distance needed to come to a full stop) and may require the accompaniment of escort vehicles. These factors can pose challenges to travel time-related performance measures, such as congestion and reliability.

The needs assessment accounted for OS/OW related needs by examining the prevalence of this activity on the PBHFN. The needs assessment quantified the percentage of routed OS/OW trips carried by segments of the PBHFN. Tier 1 PBHFN segments carrying more than 50% of routed OS/OW loads in the region were categorized as High need, while Tier 2 and Tier 3 segments carrying more than 50% of routed OS/OW loads were rated as Medium need. Tier 1 and Tier 2 PBHFN segments carrying 25%-50% of routed OS/OW loads were also rated as Medium need. Tier 3 segments carrying 25%-50% of routed OS/OW loads were rated as Low need. The prioritized needs ratings arising from OS/OW loads across the PBHFN are shown in **Exhibit 102**.

Exhibit 102. Texas Permian Basin Highway Freight Network Oversize/Overweight Needs Rating



Source: Cambridge Systematics analysis.

5.7 PERMIAN BASIN RURAL CONNECTIVITY CHALLENGES AND NEEDS

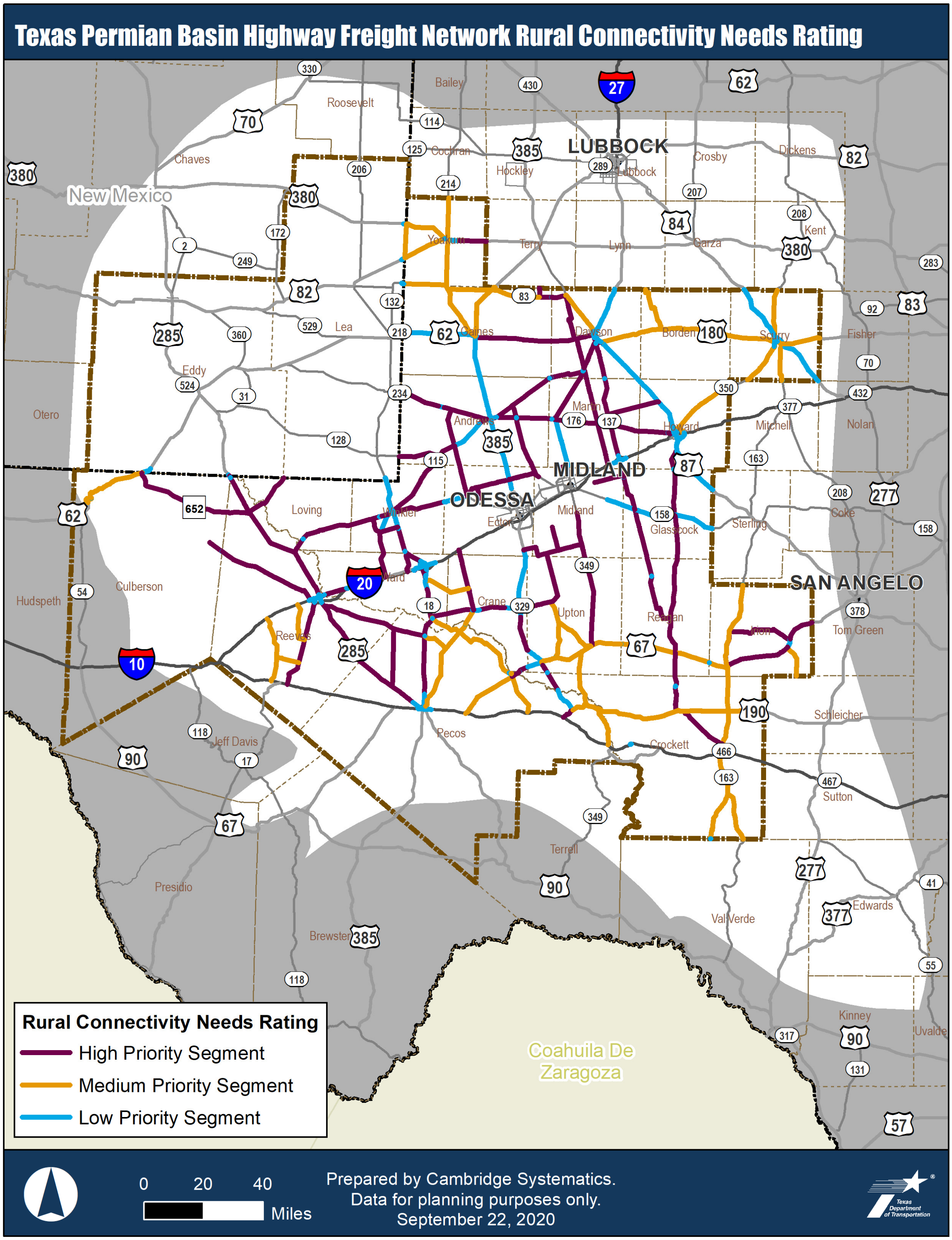
During multiple engagement activities, stakeholders stated that poor connectivity in the region, especially rural areas, was a contributing factor to poor system performance. The perception of poor connectivity as a driving factor of poor performance was especially stressed for the northwest portion of the region, where only three highways (i.e., U.S. 285, SH 302, and SH 18) provide primary access to that part of the Permian Basin. The analysis of travel time reliability, crash data, and hard braking events corroborated that sentiment. Those results demonstrated that there is often significant overlap in the areas with high crash rates, hard braking events, and poor travel time reliability. This suggests that the Permian Basin's travel time challenges are driven, in part, by the lack of alternative routes if a crash restricts the capacity of an existing route.

Rural connectivity needs ratings were distributed across the PBHFN Tiers as follows:

Needs Rating	Tier 1	Tier 2	Tier 3
High	2 or fewer lanes	2 or fewer lanes	-
Medium	3 or 4 lanes	-	2 or 3 lanes
Low	4 or more lanes	3 or more lanes	3 or more lanes

Rural road and connectivity needs are systemic throughout the region. This category of needs had the largest number of roadway miles identified as high priority. This was the result of the significant percentage of Tier 1 and Tier 2 PBHFN routes having only two lanes with limited shoulder width. The combined score across PBHFN segments is shown in **Exhibit 103**.

Exhibit 103. Texas Permian Basin Highway Freight Network Rural Connectivity Needs Rating



Source: Cambridge Systematics analysis.

5.8 SUMMARY OF PERMIAN BASIN FREIGHT CHALLENGES AND NEEDS

5.8.1 COMBINED QUANTITATIVE CHALLENGES AND NEEDS

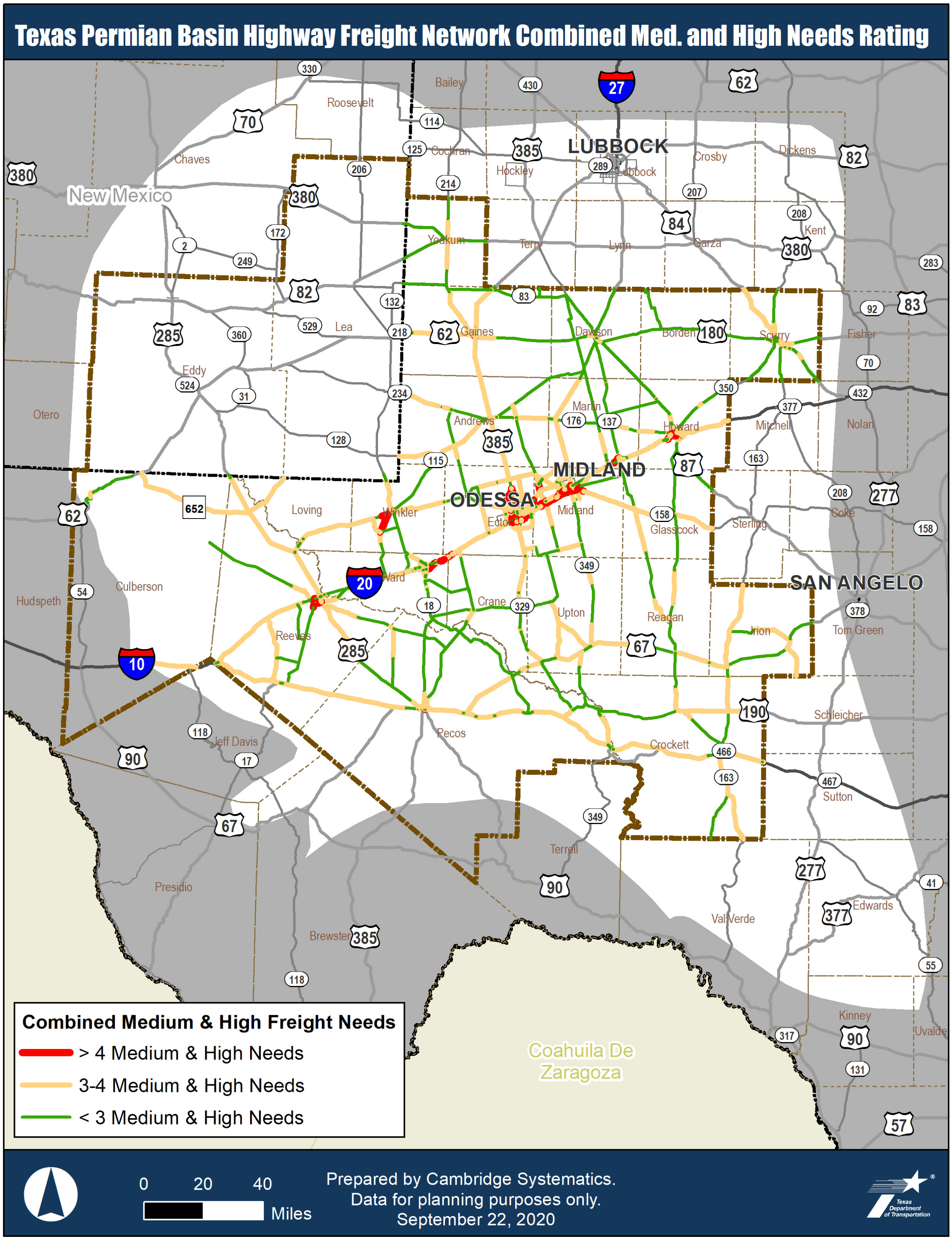
This section focuses on the findings from the data-driven assessment of needs. The needs assessment indicates that challenges are prevalent throughout the region and most facilities on the PBHFN have multiple issues, including:

- Capacity and Mobility;
- Safety;
- Truck parking;
- Asset preservation and modernization;
- Oversize/overweight; and
- Rural road connectivity.

Exhibit 104 displays the combined Medium and High priority needs across the PBHFN. **Exhibit 105** displays the combined High priority needs across the PBHFN. This analysis reveals that nearly 80% of the network has Medium or High needs in at least one category and many roadways have Medium and High needs in three or more categories across most of their mileage, including:

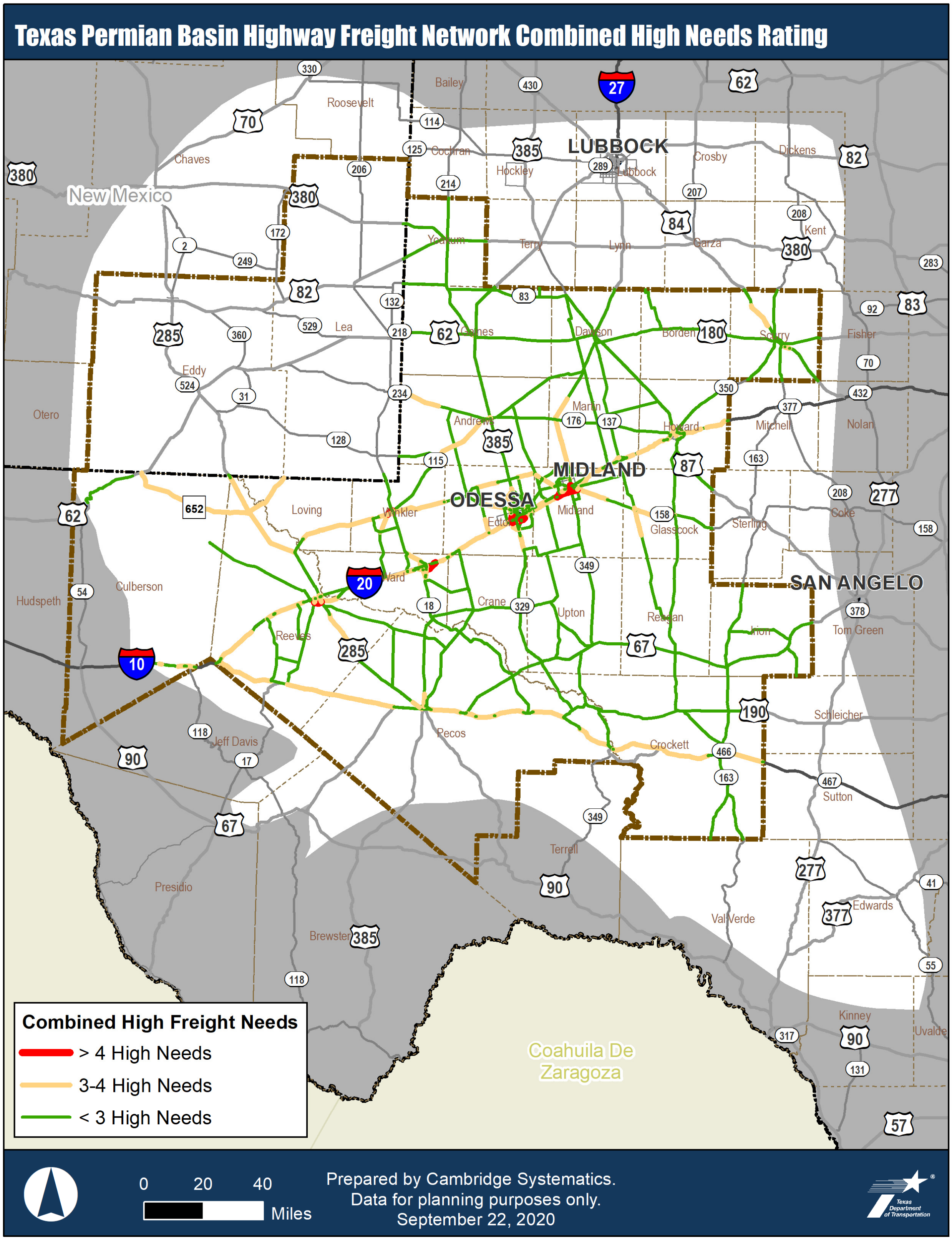
- I-10 and I-20;
- U.S. 285, 385, 67, 87 and 84;
- SH 302, 349, 158, 176, 118 and 191; and
- FM 652.

Exhibit 104. Texas Permian Basin Highway Freight Network Combined Medium and High Needs Rating



Source: Cambridge Systematics analysis.

Exhibit 105. Texas Permian Basin Highway Freight Network Combined High Needs Rating



Source: Cambridge Systematics analysis.

5.8.2 QUALITATIVE CHALLENGES AND NEEDS

In addition to categorical data-driven needs presented in the previous sections, other infrastructure, outreach, and policy challenges and needs were identified through qualitative means such as stakeholder engagement and review of notable practices. The qualitative needs and challenges include:

- Efficient **multimodal and international trade gateway connectivity** within the Permian Basin and outward to key markets, including Gulf Coast, East Coast, and West Coast marine ports; intermodal rail terminals in Dallas and Houston; and international border ports of entry such as in El Paso, Presidio, Del Rio, Laredo, and the Rio Grande Valley.
- Active **technological operations** with continuous monitoring, communications, and response programs that allow for safer and more predictable operations on the region's network.
- Improved **urban and rural connectivity** between areas with increasing oilfield activities and the urban areas where the majority of the region's population and workforce live.
- Increased **education and public awareness** of the importance of freight and energy sector transportation to the region, state, and nation.
- Increased **funding** for transportation in the Permian Basin through dedicated revenue and increased public private partnerships.
- Coordinated **land use and transportation planning** to preserve the integrity of the transportation networks and mitigate the potential negative community impacts of freight intensive land uses.
- Enhanced **planning processes** that promote data collection/sharing and integrate freight and energy sector transportation needs into regional and local planning processes and investment decision-making.
- Enhanced awareness of the **causes of traffic incidents** in the Midland and Odessa area, surrounding rural areas, and the region as a whole.
- On-going **data collection program** focused on collecting primary data related to energy sector freight movements.
- Continued **coordination between stakeholders** including but not limited to the PB MPO, Permian Basin Regional Planning Commission, MOTRAN, Permian Strategic Partnership, Permian Basin Petroleum Association, and Permian Road Safety Coalition on further planning and studies as well as the establishment of a **regional Freight Advisory Committee**.
- **Security and resiliency planning** to mitigate negative impacts of natural and man-made disruptions.
- **Access management** to include private lease roads to facilitate more efficient and safer travel throughout the region.

The needs summarized in this chapter and detailed in the Permian Basin Freight Plan Trends, Forecasts, and Needs Assessment Report suggest that there are multiple opportunities for the Permian Basin region to enhance its multimodal freight system. Extensive infrastructure challenges and needs exist throughout the region.

There are opportunities to improve freight mobility through targeted capacity enhancements, new roadway connections, the optimization of intersection and corridor operations, state of good repair investments, and technology investments, among others. Investments in the region's freight network can lead to improved travel times, enhanced safety, and improved travel time reliability on major corridors. This, in turn, contributes to an improved quality-of-life for residents and business environment for companies. For Texas and the U.S., these investments present an opportunity to lower the transportation costs of delivering oil and gas to market, making U.S.-produced energy more competitive in the global market.

While the region is currently witnessing a contraction in economic and energy sector activity arising from the global pandemic and the over-supply of global oil, expectations are that oil demand and prices will stabilize and then grow over the next several decades. Therefore, while the region may see improved transportation performance in the short-term, the need for investment continues to exist and will become more critical for the region to remain competitive as the global and national economies and oil markets recover.

Collaboration among the region's stakeholders and the State of Texas is critical to take advantage of opportunities for improvement. Policies and programs that promote data sharing and greater consistency in design guidelines, operational strategies, and land use strategies across the region are an important component of the region's path moving forward. Greater collaboration among stakeholders for meeting the region's current needs helps strengthen its position for pursuing future funding from state and federal sources such as competitive federal infrastructure grants.

The information gleaned from the needs assessment in **Chapter 5** is combined with input from the regional stakeholders to develop strategies and recommendations to address those needs and leverage the region's opportunities. These are presented in the **Section 3** of the Plan, which includes policy, program, technology, operations, and infrastructure strategies.

SECTION 3 Addressing the Permian Basin's Freight Transportation Needs

This Plan identifies numerous challenges to the Permian Basin's freight transportation network including aging infrastructure, congestion and bottlenecks, safety, systems management and operations issues, rural and multimodal connectivity challenges, insufficient public education and awareness, insufficient institutional coordination, and funding challenges. Addressing these challenges requires the strategies to be multimodal, multifaceted, and comprehensive to provide infrastructure, operational, policy, and programmatic recommendations. By moving forward with these strategies, TxDOT can support its goals of a safer, more reliable, and competitive freight network throughout the Permian Basin.

Section 3 of this Plan presents the strategies, recommendations, and actionable steps for addressing the Permian Basin's freight and energy sector transportation needs and challenges. Chapter 6 provides an overview of the strategy development process and a summary of policy and programmatic strategies. Chapter 7 presents operational and technology strategies. Chapter 8 summarizes infrastructure strategies. Finally, Chapter 9 presents short, medium, and long-term recommendations, and a call to action for TxDOT and the region.

CHAPTER 6 Policy and Programmatic Strategies to Address Freight Challenges in the Permian Basin

6.1 IDENTIFYING AND DEVELOPING STRATEGIES

The Permian Basin Freight Plan development process led to a robust and comprehensive set of strategies addressing the freight and energy sector transportation needs and challenges presented in the previous chapters. This process provided a transparent, data-driven, and stakeholder-informed approach to decision-making for freight transportation improvements. It leveraged a variety of stakeholder engagement activities to gain varied perspectives. This input was combined with an assessment and prioritization of needs to develop a comprehensive and cost-effective approach for recommended actions. The approach includes three broad-based strategy categories for addressing freight and energy sector transportation needs and challenges in the Permian Basin:

- Policies and Programs: Broad policy, coordination, outreach, and programmatic recommendations to help change the way Permian Basin freight and energy sector transportation needs are addressed.
- Infrastructure: Project specific and general infrastructure strategies that enhance the safety, maintenance, and efficiency of the PBMFN.
- Technology and Operations: A collection of technology and operation strategies that can be undertaken to improve the efficiency, safety, and mobility of the PBMFN for freight and the motoring public.

The policy and program, infrastructure, and technology and operations recommendations are not exclusive. Instead, the success of one strategy may significantly depend on the success of another, thus underscoring the need for a well-coordinated and simultaneous advancement of the recommendations.

Exhibit 106 summarizes the approach for identifying the strategies to meet the needs discussed in **Chapter 5**. After identifying and prioritizing the needs, the next step was to develop a comprehensive list of strategy recommendations.

Exhibit 106. Process for Developing Permian Basin Freight Plan Strategies

Strategies were identified from several sources, including stakeholder input from 10 workshops and industry meetings held in the region, on-line surveys, and meetings with TxDOT and NMDOT districts, the Steering Committee, and the Permian Basin MPO (See the Stakeholder Outreach and Engagement Summary Report).

The remainder of this chapter presents the policy and program strategies for addressing the freight and energy sector transportation needs in the Permian Basin, drawing on strategies from the 2018 TFMP, best practices, data analysis, and stakeholder input.

6.2 POLICY, COORDINATION, AND OUTREACH STRATEGIES

Over 90% of freight movement in the Permian Basin is driven by the energy sector. As a result, addressing freight challenges and needs in the region will require significant outreach and coordination with the energy sector, including development of policies aimed at facilitating public private partnerships. Based upon stakeholder and industry engagement, several policies, coordination efforts, and education and outreach opportunities were developed to help meet the region's freight needs. TxDOT can lead many of these strategies while others will require TxDOT to play a supporting role. The next section provides a summary of the these strategies. More detail can be found in the Permian Basin Freight Plan Strategies, Recommendations and Implementation report.

6.2.1 TXDOT LED POLICY STRATEGIES

Five policy strategies to be led by TxDOT are recommended. These focus on areas under the control of TxDOT and include planning, operations, project development, and right of way acquisition. The TxDOT led policy strategies are summarized below. Additional detail can be found in the Permian Basin Freight Plan Strategies, Recommendations and Implementation report.

TxDOT Led Policy Strategy 1: Develop driveway separation and consolidation guidelines for improved access management

Access management in urban and suburban areas has long proven to be a method of decreasing the likelihood of crashes and improving traffic flows. The dramatic growth in the Permian Basin has caused traditionally urban-area problems in rural areas throughout the region. In addition to the operational impacts, the crash patterns in the area are heavily influenced by the large number of closely spaced access points that are often poorly designed and poorly signed. TxDOT should develop and implement access management concepts to include improved, properly designed driveways (defined as access points that connect private property to public roads), improved access point spacing, turn lanes, and shared driveways where possible. TxDOT should incorporate private lease roads and other major freight generators into access management concepts for the PBHFN.

TxDOT Led Policy Strategy 2: Integrate freight considerations into the transportation project development process

While the planning and programming of projects in the Permian Basin must be done within the standards and policies of TxDOT, the application of traditional practices has not yielded the very best results. This has been driven by the ebb and flow (or assumption that it will return to "normal" at some point soon) of the oil and gas industry and the use of inadequate assumptions for future traffic volumes and truck percentages. This has yielded designs of intersections, roadway cross-section elements, pavement designs for truck parking, inspection locations, turning radii, acceleration/deceleration lanes, etc., that have not kept pace with the growth in demand. TxDOT should develop a freight considerations toolkit to be referenced during several stages of the transportation project development process.

TxDOT Led Policy Strategy 3: Collaborate with the Railroad Commission of Texas on adding transportation information to permit applications

Data from the RRC is invaluable in the planning activities in the Permian Basin. However, the data must be supplemented with other data sources to develop inferences to capture the full transportation impact of the drilling activity in the region. The state should coordinate with the RRC to add additional reporting requirements to the permit application and updating process to include estimated truck trip generation and commodity flow information.

TxDOT Led Policy Strategy 4: Monitor Railroad Commission of Texas energy sector permits for scheduling and location conflicts with highway projects

Aligning roadway construction activity with drilling activity can help mitigate conflicts and impacts across the PBHFN. The state should integrate RRC drilling permit data into the letting and construction schedules to potentially avoid increased safety and mobility impacts arising from roadway construction. TxDOT should include tracking of RRC permit data in the development of construction and work zone management plans to avoid or mitigate significant conflicts.

TxDOT Led Policy Strategy 5: Develop truck traffic impact analysis guidelines to include freight considerations in urban and rural areas

Many cities and counties have policies or guidelines in place to evaluate the potential traffic impacts of large development projects. Often, these guidelines do not include important freight related impacts including, but not limited to, truck parking, truck queuing, and truck operations and inspection locations. State and local agencies should ensure their policies and guidelines also require that a proposed project expected to generate notable truck trips be evaluated for the potential increase in freight transportation impacts. By identifying the truck traffic needs before a project is constructed, design changes or mitigation strategies can be incorporated to address the potential impacts and help meet truck traffic needs. TxDOT should play a lead role in developing guidance or sharing best practices with local communities.

6.2.2 TXDOT SUPPORTED POLICY STRATEGIES

Because more than 90% of the region's freight movements arise from the energy sector and are unique to the Permian Basin region, it is necessary that other stakeholders take the lead on some policies aimed at addressing the regional freight transportation challenges. TxDOT can serve in a supporting role and sometimes be the catalyst for initiating action. There are eight policy strategies deemed important by regional stakeholders that TxDOT should support. These strategies are summarized below.

TxDOT Supported Policy Strategy 1: Conduct research on human factors impacting transportation safety in the Permian Basin to aid in developing training for drivers operating in the region

Driver behavior in the study area was reported anecdotally by TxDOT staff, private sector representatives, and via direct observation by the study team with many examples of high risk, high speed behaviors (passing on shoulders, passing in wrong direction of passing lane, etc.). It is unclear if this behavior is driven primarily by frustration with the traffic conditions or other factors. While very difficult to quantify, it is clearly a consideration in the introduction of new design concepts, planning work zones, education efforts, and enforcement. The state should undertake efforts to study the human factors associated with this phenomenon and coordinate with the private sector to incorporate the findings into driver training.

TxDOT Supported Policy Strategy 2: Assess the feasibility of off-peak truck operations

The goal of voluntary off-peak or off-hour truck operation programs is to reduce congestion and pollution from truck traffic by providing incentives for companies to shift daily transportation related operations to off peak hours. If more businesses could operate in off peak times when there is less traffic congestion, trucks could transport goods more efficiently. This would reduce congestion and cost of goods and yield safety, economic, and environmental benefits. The state should work with oilfield service providers to develop a pilot program to assess the opportunities and challenges associated with off-peak energy sector freight delivery operations.

TxDOT Supported Policy Strategy 3: Develop regional land use guidelines for mitigating freight and energy sector conflicts with residential and commercial land uses

Freight supportive land use guidelines can assist municipalities in integrating freight movement considerations into land use planning. Specifically, it shows how public officials can improve freight mobility to make businesses more competitive and improve the overall economic health of their municipalities. The state should work with local officials to develop comprehensive land use guidelines focused on mitigating the potential conflicts between freight and energy sector intensive land uses, the region's transportation system, and local communities.

TxDOT Supported Policy Strategy 4: Collaborate with truck stop operators and local stakeholders to develop new or expand existing truck parking

The state should meet with truck stop operators and other local public and private sector stakeholders in the region to discuss a program and process for supporting development of new or expanded truck parking. Working on guidelines to help the private sector maneuver permitting and public comment processes related to truck parking is an example of a collaborative program.

Several truck stop operators have indicated that permitting requirements can increase the cost of construction and make development at a site infeasible, or that public opposition can kill a project. More important to them than financial support is assistance with the permitting process and gaining public support for the project. Cities and counties have voiced concerns on behalf of their residents about the potential negative implications of increased truck parking in their communities. TxDOT should conduct joint meetings between city and county officials, fleet operators, and private truck stop operators in the region to discuss the importance of truck parking, community mitigation strategies, and ways to achieve sufficient and properly located truck parking capacity.

TxDOT Supported Policy Strategy 5: Collaborate with regional and local stakeholders to encourage truck parking at non-TxDOT public facilities and private commercial and industrial sites

Fairgrounds, stadiums, and other event venues with large amounts of parking close to the highway in areas with high truck parking needs should be identified and owners contacted to investigate the potential of providing truck parking. These types of locations have schedules that are known far in advance, often have significant downtime, and are used to accommodating large numbers of vehicles and people in a condensed period. Sites owned by cities, counties, and state agencies can be especially attractive as potential truck parking venues.

Additional research would be necessary to identify areas of opportunity in the Permian Basin to examine utilization patterns and confirm that the pavement and geometry of the lot can accommodate large trucks for hours or days at a time.

TxDOT Supported Policy Strategy 6: Collaborate with Texas DMV to investigate the feasibility of an OS/OW load reporting program that includes annual permit usage information

The Permian Basin has a disproportionately large share of annual OS/OW permits that allow operators to move OS/OW loads without filing specific information for each load. While there are advantages of annual permits for both the private and public sector, the shortcoming is the lack of information that would be useful to support enhanced planning and maintenance processes. The state should coordinate with the DMV to assess the feasibility of additional reporting guidelines for operators using annual permits in the Permian Basin to aid in the collection of volume and routing data for OS/OW loads.

TxDOT Supported Policy Strategy 7: Establish sustainable funding for transportation investments in the Permian Basin

The region should investigate additional options for funding and financing flexibility for transportation projects that impact freight and energy sector transportation in the Permian Basin. The objectives of this policy are to:

- Encourage a unified list of projects with clearly identified funding schemes, including private sector investment.
- Work with elected officials and other stakeholders to identify funding for existing freight and energy sector investments, such as the severance and royalty taxes generated in the region.
- Pursue additional federal funding through the full return of the state-generated motor fuel tax.

TxDOT Supported Policy Strategy 8: Explore opportunities for public-private partnerships for projects and programs

TxDOT should coordinate with international, national, state, regional, and local agencies, and private sector stakeholders, to improve communication to streamline project delivery and build consistency among various jurisdictions in regulations, permitting, planning, and preservation of the freight network. Private energy sector and transportation groups such as the Permian Strategic Partnership, Permian Basin Petroleum Association, Permian Road Safety Coalition, and MOTRAN are active within the region and have a history of collaboration and investment that can serve as a foundation for expanding opportunities.

6.3 PROGRAM STRATEGIES

The programmatic recommendations support the policies outlined above and address the freight transportation challenges identified in this Plan. These challenges include system capacity constraints, system operations, safety issues, rural connectivity, congestion and reliability, data collection and freight planning, institutional coordination, education, public awareness, and capacity building. The following recommendations include seven TxDOT-led program strategies and seven TxDOT-supported strategies.

6.3.1 TXDOT LED PROGRAM STRATEGIES

Seven programmatic strategies to be led by TxDOT are recommended. These programs focus on areas under the purview of TxDOT and include various aspects of enhancing freight planning and project development, public awareness programs, and programs to enhance operations of the PBHFN. TxDOT-led program strategies are summarized below.

TxDOT Led Program Strategy 1: Develop a freight data collection and repository program to address the Permian Basin freight data gap

Many data sources and systems exist to serve freight applications, both public and private, but the lack of a freight data collection and storage program makes it complicated to effectively use these resources and/or develop new services. Additionally, the absence of a single data use policy dis-incentivizes the sharing of data between public and private sources. The state should implement a Permian Basin data collection and repository system for data collection, processing, storage, and sharing, with formulated rules for data access, use, and privacy. The proposed strategy helps TxDOT make better use of industry data to inform transportation planning and network maintenance, and to incorporate new data sources and services into one simplified location.

TxDOT Led Program Strategy 2: Develop a freight transportation public education and awareness program

Everyone relies on trucks to deliver food, medicine, clothing, and all personal and household goods. Employers also depend on trucks to deliver materials and supplies to keep factories, offices, and places of employment open. However, few consider how purchases increase the demand for truck trips and thus the need for amenities and infrastructure capacities like truck parking facilities and adequate roadway geometries. Trucks, like much of the freight system that supports the region's and state's economy, are often considered a problem rather than a necessity. Changing this public perception is a critical piece of outreach for TxDOT, in partnership with other agencies and the private sector.

TxDOT Led Program Strategy 3: Develop a regional technology-based freight safety and operations (TSM&O) program

TSM&O is designed to optimize the performance of existing and future programmed transportation infrastructure. TSM&O activities focus on a set of strategies such as Transportation Systems Management (TSM) and Transportation Demand Management (TDM). Intelligent Transportation Systems (ITS) are a major part of this strategy. As TSM strategies focus on improving efficiency and TDM strategies focus on modifying behavior, it is often beneficial to use both strategies simultaneously. In coordination with TxDOT District TSM&O planning, the state should develop a Permian Basin TSM&O program for the PBHFN.

TxDOT Led Program Strategy 4: Develop and implement Permian Basin freight-centric design guidelines

The energy sector impacts are unique and do not match well with standard roadway classifications. The multiple roles that many corridors on the PBHFN are required to support require specialized considerations. TxDOT is currently developing freight-centric design guidelines as part of the update to the TxDOT Design Manual. In addition, the Texas Transportation Institute (TTI) completed a study for the TxDOT Odessa District in September 2019, which recommended numerous design considerations tailored to the unique and specialized roadway uses in the Permian Basin. The state should implement the design guidelines developed as part of the Design Manual update as well as the specific recommendations for the Odessa District from the TTI study.

TxDOT Led Program Strategy 5: Develop multimodal freight planning, programming, and implementation guidelines for integrating freight into the investment decision-making process

TxDOT should implement multimodal freight planning, programming, and implementation guidelines for integrating freight into the TxDOT investment decision-making process. The objectives of this strategy are to:

- Address freight movement challenges confronting the state through a holistic approach, reflecting the diverse private and public sector roles in improving freight movement, safety, and efficiency.
- Develop public and private sector partnerships that target the various modes and users of the freight transportation network.
- Integrate freight considerations into TxDOT District and MPO planning, project development, programming, and implementation efforts.
- Ensure freight considerations are included in the Unified Transportation Program (UTP) project development and prioritization processes.
- Participate in freight planning training sponsored by TxDOT Transportation Planning and Programming Division.

TxDOT Led Program Strategy 6: Develop wayfinding and signage guidelines for urban and rural areas to include private lease roads and major freight generators

Reference Location Signs, including milepost markers, supplemented with increased signing of private lease roads and entrances to major freight generators, will greatly enhance the ability of drivers to find proper turning locations with less risk of stopping in the through lanes to read signs or requiring a U-turn to return to a missed turn. Specific characteristics should include:

- Refence Location Signs: Place reference location signs (such as two-side milepost markets) at one-mile intervals on one side of the roadway.

- Commercial Driveway Signing: While there is no specific standard sign for commercial driveways, using the letter height and green color from a standard street name sign keeps the design within standard practice.

TxDOT Led Program Strategy 7: Develop a regional Incident Management Program with a focus on commercial vehicles

Incident management can have significant impacts on the safety and reliability of the PBHFN, especially given the frequency of incidents throughout the region. The state should develop a regional incident management program for the PBHFN, supported by high-resolution, real-time data to provide information and guidelines for responding to and clearing incidents in a timely manner. The program should be coordinated with freight ITS programs, and include training and periodic operational meetings. Coordination should include local and regional planners and transportation network operators, including TxDOT, Texas Department of Public Safety (DPS), emergency response, Permian Basin MPO, PRSC and other relevant stakeholders.

6.3.2 TXDOT SUPPORTED PROGRAM STRATEGIES

Seven program strategies for which TxDOT would play a supporting role are recommended as summarized below. Additional detail can be found in the Permian Basin Freight Plan Strategies, Recommendations and Implementation report.

TxDOT Supported Program Strategy 1: Establish a Permian Basin Freight Advisory Committee with public and private sector stakeholders

The Permian Basin Freight Plan Steering Committee has proven to be an invaluable resource in the development of this Plan. Building on the success of the Steering Committee and the Texas Freight Advisory Committee, regional stakeholders, with support from TxDOT, should transition the Steering Committee into a regional Freight Advisory Committee to advise on this Plan's implementation and to coordinate on freight-related issues in the region.

TxDOT Supported Program Strategy 2: Implement comprehensive, multimodal regional freight planning

The stakeholders should continue to support freight planning capacity and activities to include:

- Expand the region's support and technical capacity roles in modes other than highways by integrating the needs of the entire multimodal freight transportation system into the planning and project development processes.
- Continue to develop and administer a comprehensive and multimodal freight-planning program that integrates freight considerations and needs within the region's performance-based project selection process.
- Ensure effective implementation of the Permian Basin Freight Plan through a commitment to appropriate staffing and resources, subject to legislative appropriations.
- Promote the region's long-term freight planning efforts through internal and external outreach efforts, including continued engagement of the freight industry and businesses.
- Mitigate the potential negative community impacts arising from freight-intensive land uses.

Establishing the Permian Basin Freight Advisory Committee

Why?

Coordination among regional stakeholders on freight issues, priorities, projects, and funding needs for freight improvements, and elevate freight transportation as a critical component of the Permian Basin's economic vitality and competitiveness.

Who?

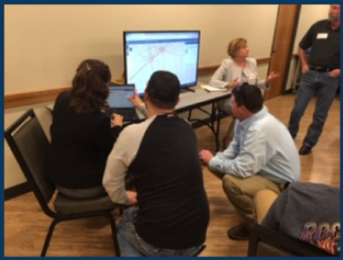
Public and private sector stakeholders to include cities, counties, economic developers, energy sector (including sand and water) representatives; trucking, rail, airport, and pipeline representatives; waste management, warehousing and distribution, and agricultural representatives; TxDOT, RRC, DPS, and DMV; and regional and national freight and energy sector associations.

What?

The role of the committee should include:

- Ensuring the participation of private sector freight stakeholders in the region's transportation planning process.
- Ensuing that freight transportation needs are addressed in the region's transportation planning, programming, investments, and implementation processes.
- Providing input into the implementation and update of the Permian Basin Freight Plan.
- Helping TxDOT, the MPO, and other decision makers identify and target freight investments.
- Assisting TxDOT, the MPO, and other decision makers in prioritizing freight investments by identifying high priority and strategic freight transportation projects that facilitate safe and efficient movement of freight throughout the Permian Basin.




TxDOT Supported Program Strategy 3: Develop a regional multimodal thoroughfare plan

The state should support the region in developing a multimodal thoroughfare plan (inclusive of vehicular, transit, pedestrian, bicycle, and freight) that:

- Coordinates planning among multiple cities and counties.
- Plans for improvements to major corridors to enhance connectivity and spur development.
- Accounts for community services including emergency response, utilities, and fiber/telecommunications.
- Facilitates context sensitive street design for each major corridor.
- Plans for right-sizing of streets and reallocation of right-of-way to enhance public realm.
- Supports increased multimodal connectivity between neighborhoods and throughout the region.
- Aligns sidewalk, bikeway, and transit investments with key freight corridors.
- Prioritizes improvements related to the community's goals and objectives.

TxDOT Supported Program Strategy 4: Explore opportunities, regulations, and policies for intraregional mass transit or van-pool programs servicing major employment sites

Employment growth in the Permian Basin has outpaced the state as a whole. Along with employment growth comes increased commuter traffic. In addition, the energy sector gives rise to thousands of oilfield service provider trips, often referred to as "white pickup" trips, because they typically use white light duty trucks. The white pickups traverse the region as they travel between storage yards and offices to the oilfields. Reducing single occupancy commuter traffic can be a key strategy in enhancing the safety and mobility on the PBHFN. The state should support the MPO, local planning partners, and the private sector in overcoming challenges and exploring opportunities for developing intraregional transit and van-pool programs to service major freight generators and employment sites.

TxDOT Supported Program Strategy 5: Convene a biennial regional freight and energy sector transportation summit in partnership with regional stakeholders

Maintaining visibility and providing updates on the latest freight and energy sector transportation activity, trends, and impacts is critical to the implementation of the strategies put forth in this Plan. To ensure strategies continue to advance, and to foster regional transportation planning and collaboration, the stakeholders should convene a biennial summit to bring together the region's public and private sector and associations with leaders and policy makers from the regional, state, and national levels.

TxDOT Supported Program Strategy 6: Explore opportunities to expand Permian Basin freight rail capacity while avoiding negative impacts to public safety and congestion.

Freight rail transportation can provide a safe, cost effective way to move large volumes of bulk commodities into and out of the Permian Basin. Traditionally, rail is the mode of choice for transporting steel, pipe, heavy equipment, agricultural goods, and construction materials over longer distances. Freight in the Permian Basin is characterized primarily by the types of commodities that typically move by rail. However, as noted in the Section 3.1, rail moves only about one percent of the region's total tonnage. This means that a greater share of these heavy commodities is moved on the region's roadways leading to increased wear and tear, decreased safety, and increased congestion on the roadway network. It also means that shippers are likely paying more to move these goods by truck than they could by rail.

Freight rail has the potential to offer increased access to domestic and global markets and enhance the economic competitiveness of the region. The state, railroads, and local stakeholders should continue work to build freight rail capacity while avoiding negative impacts to public safety and congestion at rail-highway crossings. The state should determine the most beneficial locations for future highway bridges over rail based on projected freight growth.

TxDOT Supported Program Strategy 7: Coordinate with the Permian Basin MPO, Permian Basin Regional Planning Commission, and other regional stakeholder groups on further freight planning and study.

The objective of this strategy is to support future freight planning, study, and network analysis, including the following:

- Study the feasibility of a corridor that connects northeast Odessa (Loop 338) to the Craddick Highway.
- Study the feasibility of extending the Craddick Highway from SH 349 (north of Midland) eastward to FM 1208 and then to cross I-20 and connect to SH 158.
- Study the feasibility of a corridor from the south leg of Loop 338 in Odessa, extending eastward through FM 1788, SH 349, and SH 158 in Midland County onto I-20.
- Analyze primary east-west corridors in West Odessa from 42nd to I-20 and north-south corridors from FM 866 to FM 1936 for freight transportation safety and mobility needs.
- Study the feasibility of operational improvements, needed interchanges, and capacity improvements along SH 349 between I-20 and I-10, SH 191 between Midland and Odessa, and SH 158 in Midland County, to accommodate current and future traffic growth and development along the corridor.
- Conduct a feasibility study of a more direct connection from US 385 in McCamey to I-10.
- Study locations for direct connections on the interstate system to improve freight transportation safety and mobility.
- Study the impact of adding Spur type roads where connections between highways are improved by simple redirection and may improve congested interchanges.
- Study the impact and feasibility of converting non-freeway to freeway facilities in higher use freight corridors.
- Consider utility relocation and drainage issues associated with project development.
- Examine existing and potential freight routes for designation to the PBHFN or NHFN.

Chapter 6 put forth policy and program strategies addressing institutional, outreach and education, freight planning capacity building, and operations and project development processes. **Chapter 7** presents operations and technology strategies and **Chapter 8** presents infrastructure strategies to include planned and strategic projects to address current and future freight needs in the Permian Basin.

CHAPTER 7 Operational and Technology Strategies to Address Freight Challenges in the Permian Basin

This chapter describes several operational and technology strategies that TxDOT could deploy to help address Permian Basin freight needs. Although these approaches will not physically increase transportation network capacity, they can enhance the safety and efficiency of the freight network by mitigating congestion, bottlenecks, and safety hotspots.

7.1 OPERATIONAL STRATEGIES

Following are five operational strategies for addressing freight needs in the Permian Basin. TxDOT would take the lead for operations on the state system. However, given that the PBHFN consists of state and local roadways, and the prevalence of private lease roads impact the operations of the state system, operational strategies in the Permian Basin will likely require collaboration between state and local officials and the private sector. The strategies are summarized below and additional detail can be found in the Permian Basin Freight Plan Strategies, Recommendations and Implementation report.

TxDOT Led Operational Strategy 1: Ensure all roadways on the PBHFN have adequate road markings, lighting, and signage

The lack of adequate road markings, lighting, and signage leads to increased crashes, safety concerns, and traffic delay, as evidenced by the IVMS data analyzed as part of this Plan. The state should ensure that all facilities on the PBHFN have adequate road markings, lighting, and signage. Long, straight rural corridors and corridors supporting significant operations during overnight hours should be examined.

TxDOT Led Operational Strategy 2: Increase signage and wayfinding on the PBHFN, including signage for lease roads and mile markers on TxDOT routes

Particularly along corridors accessing the oilfields, existing site signing is very limited in quality and quantity. Signage with small print and limited reflectivity reduces visibility and can cause drivers to slow to a near stop to verify turning locations. A lack of mile markers (albeit consistent with TxDOT practice) and street signs (common in an urban area) challenge a driver's ability to easily find a specific location. In the Permian Basin, there is currently a private sector initiative to address signing/milepost issues. While not typically placed on non-Interstate highways, milepost markers, supplemented with driveway signing, will provide drivers advanced notice of upcoming turning locations. TxDOT should assess the effectiveness and feasibility of increasing mile markers and wayfinding signage on PBHFN routes, with an emphasis on routes providing first and last mile connections to major freight generators.

TxDOT Led Operational Strategy 3: Increase signage and ITS on freight routes for locations of truck parking, safety hotspots, queuing, blocked rail crossings, etc.

Dynamic, real-time routing is a key component of efficient freight movement. Truck dispatchers and/or drivers plan routes for their daily deliveries. As truck drivers investigate their route, the ability to re-route in real-time to avoid congestion and incidents can have a significant impact on overall efficiency. The state should utilize more smart signage and ITS infrastructure along the PBHFN to provide highway conditions and traffic information. This could be expanded to include web and mobile applications that support trucking companies and drivers in making informed pre-trip and on-the-road routing decisions.

TxDOT Led Operational Strategy 4: Deploy additional Weigh-in-Motion and Automated Vehicle Classification/Count systems throughout the Permian Basin

Weigh in Motion (WIM) and vehicle classification (VC) data is a valuable tool for transportation planning, commercial vehicle enforcement, pavement design, and preservation of assets. The data generated can also be used as an aid for traffic operations and increasing safety, mobility, and economic competitiveness for Texas. Given the disproportionately large share of OS/OW permits issued for the Permian Basin and the rapidly growing truck volumes, there are inadequate WIM and VC devices deployed on the PBHFN. The state should assess the need for additional WIM and VC technology in the region and deploy additional WIM and VC devises accordingly.

TxDOT Led Operational Strategy 5: Conduct traffic signal timing study for urban arterials on the PBHFN

With the consideration of heavy mixed traffic congestion on multimodal corridors, the prevalence of traffic crisscrossing the region with multiple daily trips between businesses and oilfields, and the importance of having safe and efficient freight movements, properly timed traffic signals can mitigate congestion and enhance safety. The state should conduct a traffic signal timing study. As part of that study, regional coordination should occur to identify corridors with traffic signal timing needs, develop and implement traffic signal timing recommendations, and evaluate the effectiveness of signal timing on improving freight movements and passenger vehicle travel. An emphasis should be placed on strategic first and last mile connections to major freight generators.

7.2 TECHNOLOGY STRATEGIES

Following are four technology strategies for addressing freight needs in the Permian Basin. They vary greatly in complexity but all would improve the performance of the PBHFN. The state will need to collaborate with regional stakeholders to identify the needs of the impacted users and to determine optimal locations for and magnitude of deployment. Additional details can be found in the Permian Basin Freight Plan Strategies, Recommendations and Implementation report.

TxDOT Led Technology Strategy 1: Establish a regional Traffic Management Center with a focus on improving truck safety and mobility

Most state roads within some large urban areas are closely monitored by a regional Traffic Management Center (TMC). Many freight routes, however, utilize rural roadways that are not currently monitored or managed. In the Permian Basin, consistent, single-source road conditions and performance information is absent along both urban and rural corridors across the PBHFN. A regional TMC could provide critical information for freight operators to make strategic route decisions during major disruptions. It would also provide real-time information to TxDOT to improve the safety and efficiency of the existing network. A regional TMC in the Permian Basin would communicate with other TMCs across the state (e.g., Dallas, Houston, and El Paso) and in adjacent states to exchange information on major events disrupting Interstates and major supply chain corridors.

TxDOT Led Technology Strategy 2: Deploy advance warning systems on critical PBHFN routes and at safety hotspots

Preserving an infrastructure's lifespan is critical for maintaining safety and mobility along the highway network throughout Texas. In some instances, a freight vehicle may be operating outside of desirable parameters (e.g., too fast, too big, too heavy) without awareness of an upcoming potential hazard, such as a low overpass, a sharp curve, or a blind intersection. Lack of awareness of these hazards can result in crashes or other safety issues as well as the costs associated with damaged infrastructure (e.g., bridge strike repairs). The state should install advanced warning systems at strategic locations along the PBHFN, including for overheight, overweight, overspeed, blocked rail crossings, and turning/stopped vehicles. Locations with a high-incidence of truck-related crashes or critical infrastructure (bridges, etc.) should be prioritized.

TxDOT Led Technology Strategy 3: Deploy incident management system

Disruptions on key freight routes can cause massive delays for both trucks and passenger vehicles. They can lead to increased severity and fatality rates for crashes that go undetected or require extended access and clearance times. When attempting to avoid major disruptions, truck drivers are not always aware of alternate parallel routes that are approved for and capable of handling truck traffic. When alternate routes are available, they often lack ITS to help manage the increased traffic volumes caused by the rerouted traffic. The state should implement advanced technologies along key corridors with adjacent parallel freight routes that experience high traffic volumes and high rates of incidents, congestion, and/or disruptive events. In addition, they should utilize traffic management solutions to operate the freight corridor more comprehensively across multiple parallel routes to improve freight mobility.

TxDOT Led Technology Strategy 4: Deploy Truck Parking Availability System along PBHFN

Truck Parking Availability System (TPAS) is an ITS application to assist truck drivers in locating available parking spaces in real-time. This allows for informed decisions about where to park based on their needs and federal HOS requirements. The TPAS strategy includes monitoring real-time parking availability at strategic truck parking areas and publishing parking availability data for freight industry use. Building on the ongoing multistate I-10 TPAS, the state should:

- Instrument public State Rest Areas (SRAs) with detection technology to monitor truck parking availability in real-time.
- Implement a processing and evaluation platform (TxDOT Advanced Traffic Management System or a third-party software) from which the truck parking data from the field can be processed into usable information.

- Publish real-time truck parking availability data on roadside signs at key decision points to help truckers make informed decisions on where to park.
- Utilize a public data feed to make truck parking availability data available to other systems and groups, such as DriveTexas, private sector truck parking apps, and freight companies' Truck Management Systems.
- Store availability and utilization data in a database to support future freight planning projects and studies.

Building on the policy and program strategies in **Chapter 6**, **Chapter 7** put forth operations and technology strategies for enhancing the safety, efficiency, and competitiveness of the freight and energy sector transportation network in the Permian Basin. **Chapter 8** presents infrastructure strategies to include planned and strategic projects to address current and future freight needs in the Permian Basin.

CHAPTER 8 Infrastructure Strategies to Address Freight Transportation Challenges in the Permian Basin

8.1 FREIGHT PROJECT IDENTIFICATION

The PBHFN is composed of facilities critical to freight movement throughout the region. This network was used as the basis for identifying and prioritizing recommendations for the Permian Basin Freight Plan. This network facilitates most of the freight movement in and through the region and connects freight generators and gateways with statewide, national, and global markets. Two project lists were used to identify projects on the PBHFN: the 2021 Unified Transportation Program (UTP) and projects submitted by the TxDOT Districts within the region. The UTP is a 10-year plan that is updated annually and approved by the Texas Transportation Commission before the end of each fiscal year. The 2021 UTP contains projects for which partial or complete funding has been identified from certain funding categories and which are anticipated to begin within 10 years.

Projects which are not funded by the categories included in the UTP were provided by District staff. These include a broader range of projects being developed by TxDOT and they are updated as they progress. Projects already under development by TxDOT can be implemented within a shorter timeframe than new projects. Many early project development processes, such as right-of way acquisition or environmental clearances, may have already been initiated or completed for these projects. Selecting these projects allows TxDOT to review them based on Freight Plan policies. TxDOT can thus ensure that the projects meet the Freight Plan’s goals by addressing the region’s freight transportation needs.

In addition, strategic freight mobility projects were identified. These are freight related projects but are not included in any TxDOT funding plans or program elements at this time. These include projects proposed by stakeholders during development of the Permian Basin Freight Plan.

Exhibit 107 summarizes the highway freight project identification process. The needs assessment identified safety, mobility and reliability, rural road and connectivity, truck parking, and asset preservation needs on the PBHFN. These were compared to the projects in the 2021 UTP and Districts’ project list to match planned TxDOT projects to the identified freight needs. This comparison also identified gaps where there are needs but no projects are currently planned to address them.

Exhibit 107. Highway Freight Project Identification Process

8.2 THE PERMIAN BASIN FREIGHT INVESTMENT PLAN

Planned projects in the Permian Basin are derived from two sources: the 2021 UTP and TxDOT District planned projects not included in the UTP. As summarized in the following sections, there are currently 954 total planned TxDOT projects (UTP and TxDOT District lists) in the Permian Basin costing an estimated $10.9 billion. Combined, these planned projects comprise the Permian Basin Freight Investment Plan.

Permian Basin Freight Investment Plan

954 planned projects in the 2021 UTP and TxDOT districts

Total cost of **$10.9 billion** over next 10 years

8.2.1 2021 UNIFIED TRANSPORTATION PROGRAM

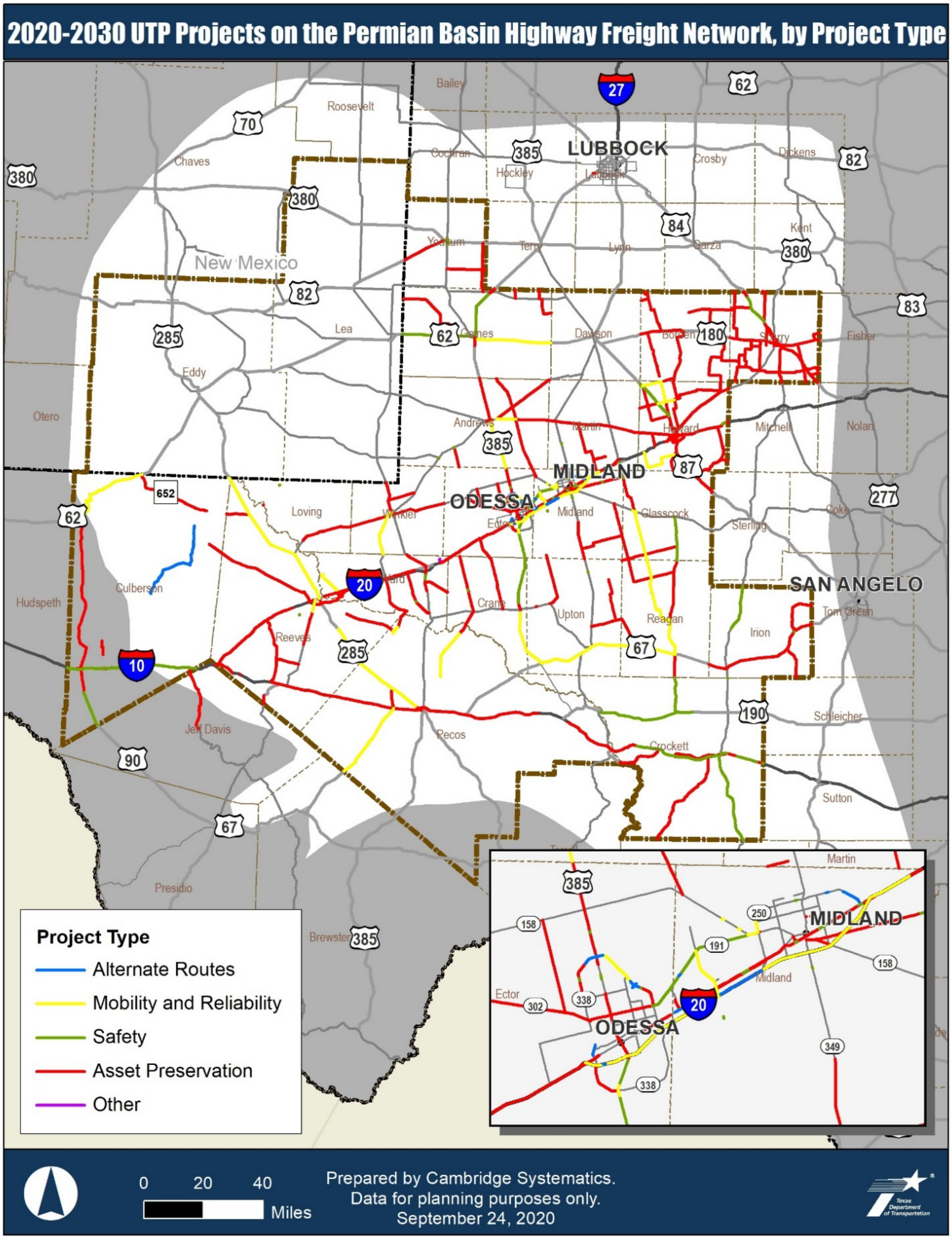
In the 2021 UTP, there are 718 projects at an estimated cost of nearly $8.6 billion planned for the Permian Basin region. **Exhibit 108** and **Exhibit 109** display the UTP projects by type. Asset preservation projects represent the majority, with 412 projects, or 57% of the total. This is followed by 137 mobility and reliability projects, or about 19% of the total and123 safety projects, or about 17% of the total.

Exhibit 108. UTP Projects on the Permian Basin Highway Freight Network by Type, 2020-2030

Project Category	No. of Projects	Total Authorized Funding (Millions $)
Alternate Routes	37	$1,111.0
Asset Preservation	412	$1,775.2
Mobility and Reliability	137	$5,489.8
Safety	123	$143.8
Other	9	$64.3
Total	**718**	**$8,574.1**

Source: 2021 TxDOT Unified Transportation Program, Cambridge Systematics analysis.

Exhibit 109. UTP Projects on the Permian Basin Highway Freight Network by Type, 2020-2030



Source: 2021 TxDOT Unified Transportation Program, Cambridge Systematics analysis.

It is important to note that there is no guarantee that all projects in the UTP will be fully funded or implemented. In fact, most projects in the UTP for the Permian Basin are only partially funded. **Exhibit 110** presents data on UTP projects based on funding status. Despite 69% of the projects being fully funded, the amount of funding represented by those projects represents only 36% of the total costs. The funding gap for the partially funded projects represents over 43% of the total project costs, totaling over $2 billion.

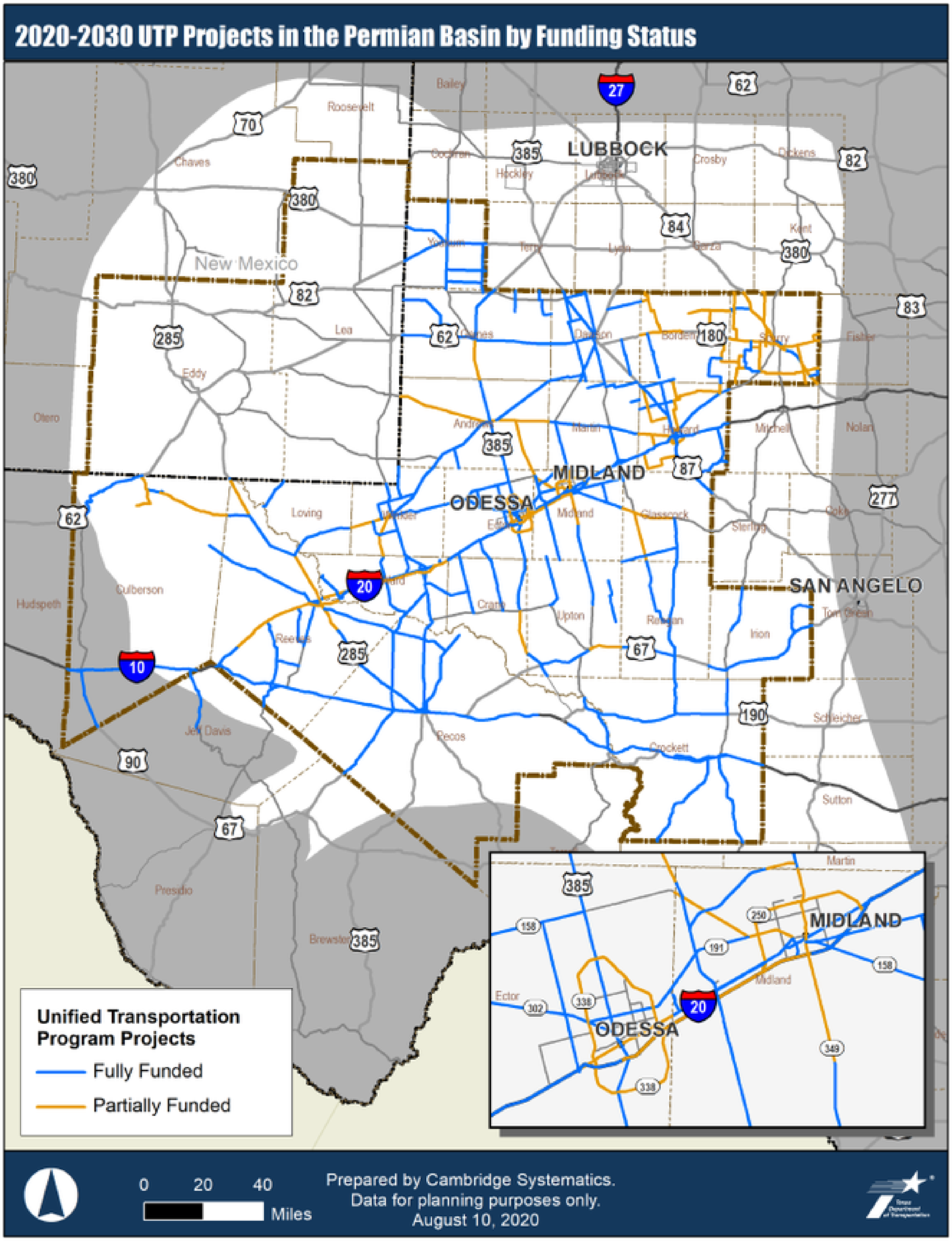
Exhibit 110. 2021 UTP Project on the Permian Basin Highway Freight Network by Funding Status, 2020-2030

	Fully Funded		Partially Funded			Total Combined	
Project Category	No. of Projects	Authorized Funding (Millions $)	No. of Projects	Authorized Funding (Millions $)	Funding Gap (Millions $)	No. of Projects	Total Cost (Millions $)
Alternate Routes	2	$34.8	35	$292.1	$784.1	37	$1,111.0
Asset Preservation	324	$1,294.4	88	$229.6	$251.2	412	$1,775.2
Mobility and Reliability	53	$1,241.4	84	$1,330.4	$2,918.0	137	$5,489.8
Safety	95	$131.3	28	$2.6	$9.9	123	$143.8
Other	8	$24.0	1	$0.4	$39.9	9	$64.3
Total	**482**	**$2,726.0**	**236**	**$1,855.1**	**$4,003.1**	**718**	**$8,584.1**

Source: 2021 TxDOT Unified Transportation Program, Cambridge Systematics analysis.

Exhibit 111 displays the location of the 2020-2030 UTP projects in the Permian Basin based on funding status. Notable is the fact that many of the partially funded projects are on key rural roadways throughout the region including U.S. 67, U.S. 285, U.S. 385, SR 302, SR 115, SR 118, SR 176, and FM 652.

Exhibit 111. UTP Projects on the Permian Basin Highway Freight Network by Funding Status, 2020-2030



Source: 2021 TxDOT Unified Transportation Program, Cambridge Systematics analysis..

8.2.2 ADDITIONAL DISTRICT PROJECTS

In addition to the UTP projects, the TxDOT Districts have 236 projects valued at $2.3 billion with the Odessa District accounting for 126 projects. The majority of these projects are scheduled to be implemented between 2020 and 2024. The projects, summarized in **Exhibit 112**, include 170 asset preservation projects, such as seal coats, and 47 mobility and reliability projects. The combined estimated cost of the District projects is over $2.3 billion, with Odessa District projects accounting for $1.6 billion.

Exhibit 112. Summary of Planned Projects for TxDOT Districts in the Permian Basin, 2020-2024

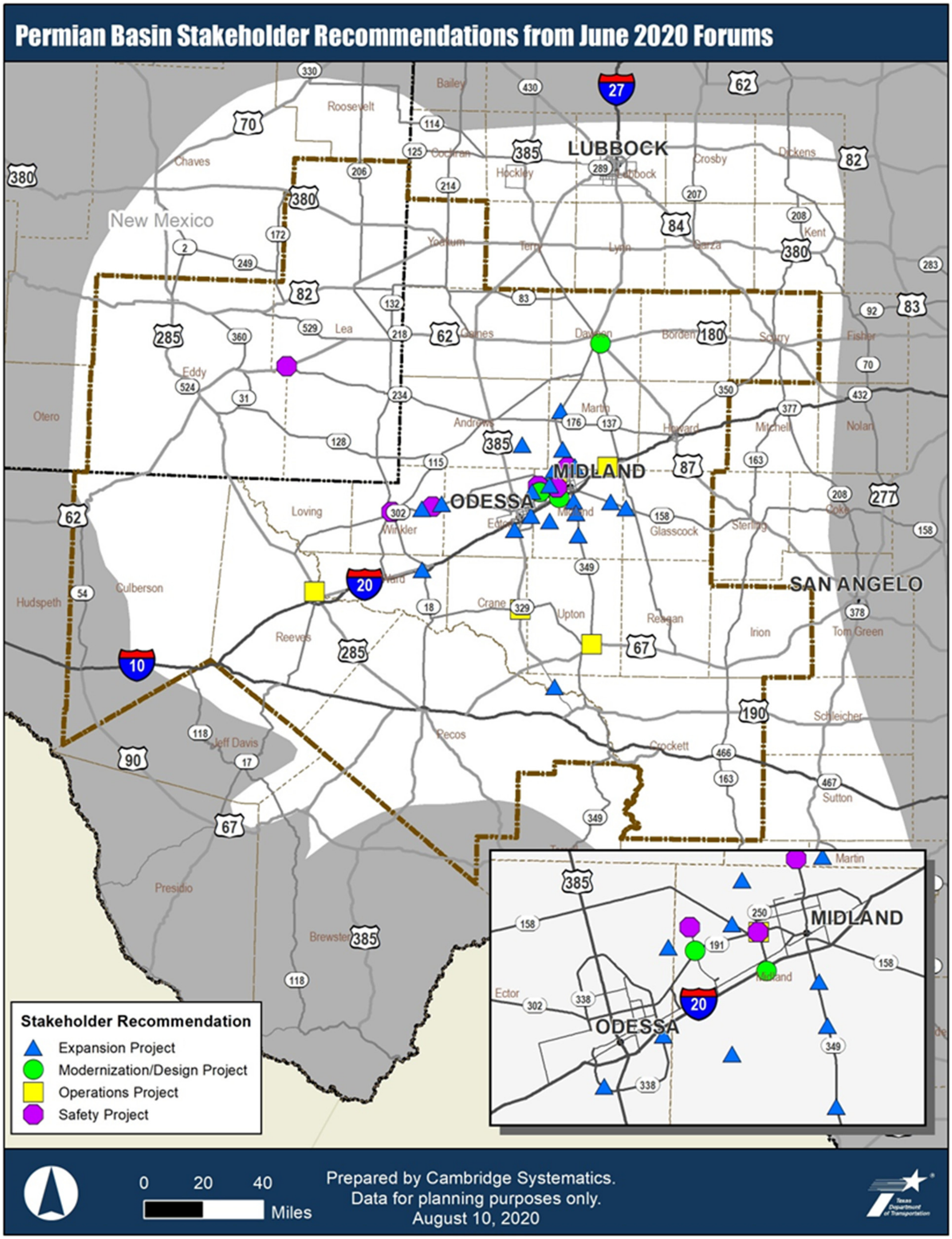
Project Category	No. of Projects	Total Cost
Alternate Routes	6	$ 215,194,447
Asset Preservation	170	$1,155,606,343
Mobility and Reliability	47	$894,339,623
Safety	13	$69,208,671
Total	**236**	**$ 2,334,349,084**

Source: TxDOT Abilene, El Paso, Odessa, and San Angelo Districts.

8.3 STAKEHOLDER PROPOSED FREIGHT PROJECT RECOMMENDATIONS

During the stakeholder forums and Steering Committee meeting conducted in June 2020, attendees were given the opportunity to provide input on strategies and recommendations. **Exhibit 113** displays the stakeholder proposed projects by type and **Exhibit 114** provides a list of the proposed projects. There is a total of 33 projects, of which 19 are expansion projects, six are safety projects, five are operational projects, and three are modernization or design projects.

Exhibit 113. Permian Basin Stakeholder Proposed Freight Project Recommendations, June 2020



Source: Stakeholder forums and Steering Committee, June 2020

Exhibit 114. Permian Basin Stakeholder Proposed Freight Project Recommendations, June 2020

Improvement Type	Location	Description
Expansion Project	SH 349 south of City of Midland	Expand capacity on SH 349 south of the City of Midland.
Expansion Project	SH 349 between I-20 and I-10	Expand SH 349 to 4-lane divided between I-20 and I-10.
Expansion Project	Loop 338 in Odessa	Expand capacity on Loop 338 in Odessa.
Expansion Project	SH 349/Craddick Highway in Midland and Martin Counties	Expand SH 349 to 4-lane divided between SH 349 (Martin County) and SH 158 (Midland County).
Expansion Project	SH 302 between U.S. 285 and SH 158	Expand SH 302 to a 4-lane divided highway.
Expansion Project	FM 305 between U.S. 67 (Upton County) and U.S. 190 (Pecos County)	Upgrade FM 305 to provide more direct connectivity between I-20 and I-10.
Expansion Project	SH 158 between I-20 and Midland-Glasscock County line	Convert SH 158 to a 4-lane divided highway.
Expansion Project	SH 158 in Glasscock County	Convert SH 158 to a 4-lane divided highway.
Expansion Project	FM 1788 between I-20 and FM 1787 in Midland County	Add passing lanes to FM 1788 south of I-20.
Expansion Project	FM 1788 between SH 176 (Martin County) and SH 158 (Midland County)	Add passing lanes to FM 1788 between SH 176 (Martin County) and SH 158 (Midland County).
Expansion Project	SH 349/Craddick Highway terminus at SH 349 in Martin County	Create a new roadway by extending Craddick Highway from its current eastern terminus east and south to I-20 between Midland and Stanton.
Expansion Project	SH 349/Craddick Highway terminus at FM 1788 in Midland County	Create a new roadway by extending Craddick Highway from its current western terminus west and south to SH 191 between Midland and Odessa.
Expansion Project	I-20 Business between its western and eastern I-20 interchanges in the City of Monahans	Construct a reliever route to freeway design standards around the City of Monahans.
Expansion Project	SH 302 between U.S. 285 and SH 158	Expand SH 302 to a 4-lane divided highway.
Expansion Project	SH 349 between Midland and Rankin	Convert SH 349 to a 4-lane divided highway.
Expansion Project	SH 158 between Midland and Sterling City	Convert SH 158 to a 4-lane divided highway.
Expansion Project	SH 349 between Midland and Lamesa	Convert SH 349 to a 4-lane divided highway.

Improvement Type	Location	Description
Expansion Project	SH 158 between SH 191 and SH 349/Craddick Highway in Midland County	Expand SH 158 from 2 lanes to 4 lanes.
Expansion Project	Loop 338 in Odessa	Expand Loop 338 so that the entire corridor is a 4-lane divided highway. This would help to handle increased truck traffic.
Modernization/Design Project	Loop 250 western terminus at I-20 in the City of Midland	Extend Loop 250 from its current western terminus south and east to connect to SH 349 in Midland County.
Modernization/Design Project	FM 1788 at SH 191 in Midland County	Upgrade the SH 191-FM 1788 interchange.
Modernization/Design Project	SH 349 and U.S. 180 Interchange in Lamesa	Rehabilitate and modernize the SH 349-U.S. 180 interchange.
Operations Project	Loop 250 at SH 191 in the City of Midland	Upgrade the interchange to include flyovers and braided ramps.
Operations Project	U.S. 385 in the City of Crane	Construct a reliever route around the City of Crane to reduce travel and wait times.
Operations Project	SH 576 Spur in Rankin	Complete the reliever route around Rankin to improve freight mobility.
Operations Project	I-20 Business between its western and eastern I-20 interchanges in the City of Pecos	Construct a reliever route around the City of Pecos.
Operations Project	FM 829 at I-20 in Dix	Convert the intersections of FM 829 with the I-20 service roads to one-way.
Safety Project	U.S. 62 in Lea and Eddy Counties, NM	Improve safety on the U.S. 62 corridor in New Mexico.
Safety Project	SH 18 north of Kermit	Improve safety on the SH 18 corridor north of Kermit in Winkler County.
Safety Project	SH 302 between U.S. 285 and SH 158	Improve safety on the SH 302 corridor.
Safety Project	FM 1788 at SH 349 in Midland County	Construct a grade-separated interchange at the SH 349 - FM 1788 intersection.
Safety Project	SH 349/Craddick Highway at SH 349 in Martin County	Construct a grade-separated interchange at the SH 349/Craddick Highway-SH 349 intersection in Martin County.
Safety Project	Loop 250 at SH 191 in the City of Midland	Expand capacity to alleviate vehicle queueing at this interchange. Consider providing direct connections between SH 158 and Loop 250.

8.4 STRATEGIC PROJECTS AND STUDIES

The final group of projects or studies focus on major corridor upgrades that would significantly impact freight movement in the Permian Basin. The five strategic projects or studies, summarized in **Exhibit 115**, include the Ports to Plains Corridor, Reeves County Truck Reliever Route, I-14 Interstate Corridor Study, I-20 Corridor Improvements, and the Permian Promise Program. These projects are in various stages of development, ranging from interstate feasibility analysis for the Ports to Plains Corridor to design and right-of-way acquisition for the I-20 Corridor Improvements.

Additional information on these strategic projects is available at:

- Ports to Plains Corridor (see project profile in Section 9.3)
- Reeves County Truck Reliver Route
- I-14 Corridor
- I-20 Corridor
- Permian Promise

Exhibit 115. Strategic Projects Impacting Freight and Energy Sector Transportation in the Permian Basin

Ports-to-Plains Corridor	Reeves County Truck Reliever Route	I-14 Corridor	I-20 Corridor	Permian Promise
Interstate feasibility study completed June 2020	Alternate route to bypass the Pecos central business district	West Texas to the Texas-Louisiana border generally following U.S. 190	40+ miles from FM 1936 to FM 1208	Upgrades to key energy sector corridors
Upgrade to interstate standard portions of U.S. 87, U.S. 227, SH 349, and SH 158	Proposed loop bisector that aligns with FM 2119 on the north side of Pecos to SH 17 on the south side	Provide improved access to Beaumont, Port Arthur, and Corpus Christi	Convert frontage roads to one-way, add traffic lanes, and reconstruct interchanges	Add traffic lanes, reconstruct interchanges, relief routes, loops, and passing lanes

8.5 HIGHWAY NEEDS WITHOUT PLANNED PROJECTS

In addition to the $6.4 billion in planned projects in the Permian Basin, which has a $2.1 billion funding shortfall, there are still freight needs on the PBHFN with no planned projects. Unmet needs, identified through the needs assessment and project identification process discussed in Chapters 5 and 8, provide the opportunity for information from the Permian Basin Freight Plan to inform the project development process carried out by TxDOT and the Permian Basin MPO, leading to the identification and planning of projects to address the unmet needs. Unmet needs on the PBHFN include corridor segments where a need is identified but there is no planned project under development. Most freight transportation needs on the PBHFN are located along corridors connecting the Midland-Odessa metropolitan area to the oilfields in the Delaware and Midland Basins, freight generators such as marine ports and international border crossings, and areas experiencing high population growth. This reflects the need for continued planning for transportation improvements at freight generators, including marine ports, international border crossings, and energy and agricultural regions in the Permian Basin.

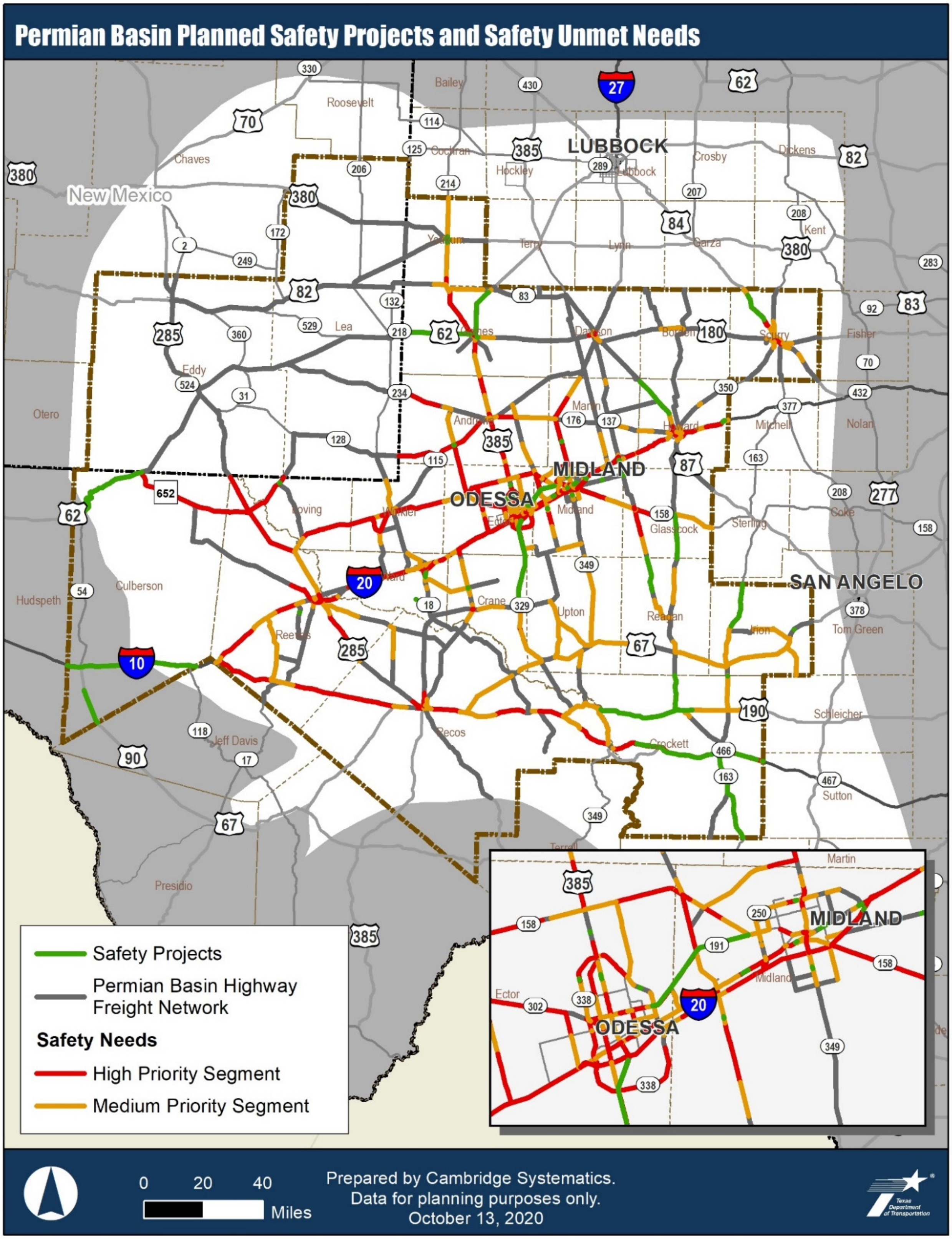
Exhibit 116, Exhibit 117, and **Exhibit 118** display the portions of the PBHFN with unmet needs in the three highest weighted goal areas of safety, mobility and reliability, and asset preservation and utilization, respectively. In total, there are 4,284 miles on the PBHFN. There are about 2,400 miles on the PBHFN with unmet medium and high priority safety needs. I-10, U.S. 87, U.S. 385, SR 329, and SR 302 are among the notable corridors with significant unmet safety needs (see **Exhibit 116**) without a planned project to address them. There are about 200 miles on the PBHFN with medium and high priority mobility and reliability needs with no identified projects. A majority of these miles are in the urban areas of Midland and Odessa and are on or connecting to I-20 (see **Exhibit 117**). There are about 250 miles on the PBHFN with unmet asset preservation needs with no identified project. As shown in **Exhibit 118**, U.S. 286 and U.S. 385 are notable corridors with significant medium and high priority unmet asset preservation needs.

Unmet Needs on the Permian Basin Highway Freight Network

- 2,400 miles with unmet high and medium priority **safety** needs
- 200 miles with unmet high and medium priority **mobility** needs
- 250 miles of unmet high and medium **asset preservation** needs

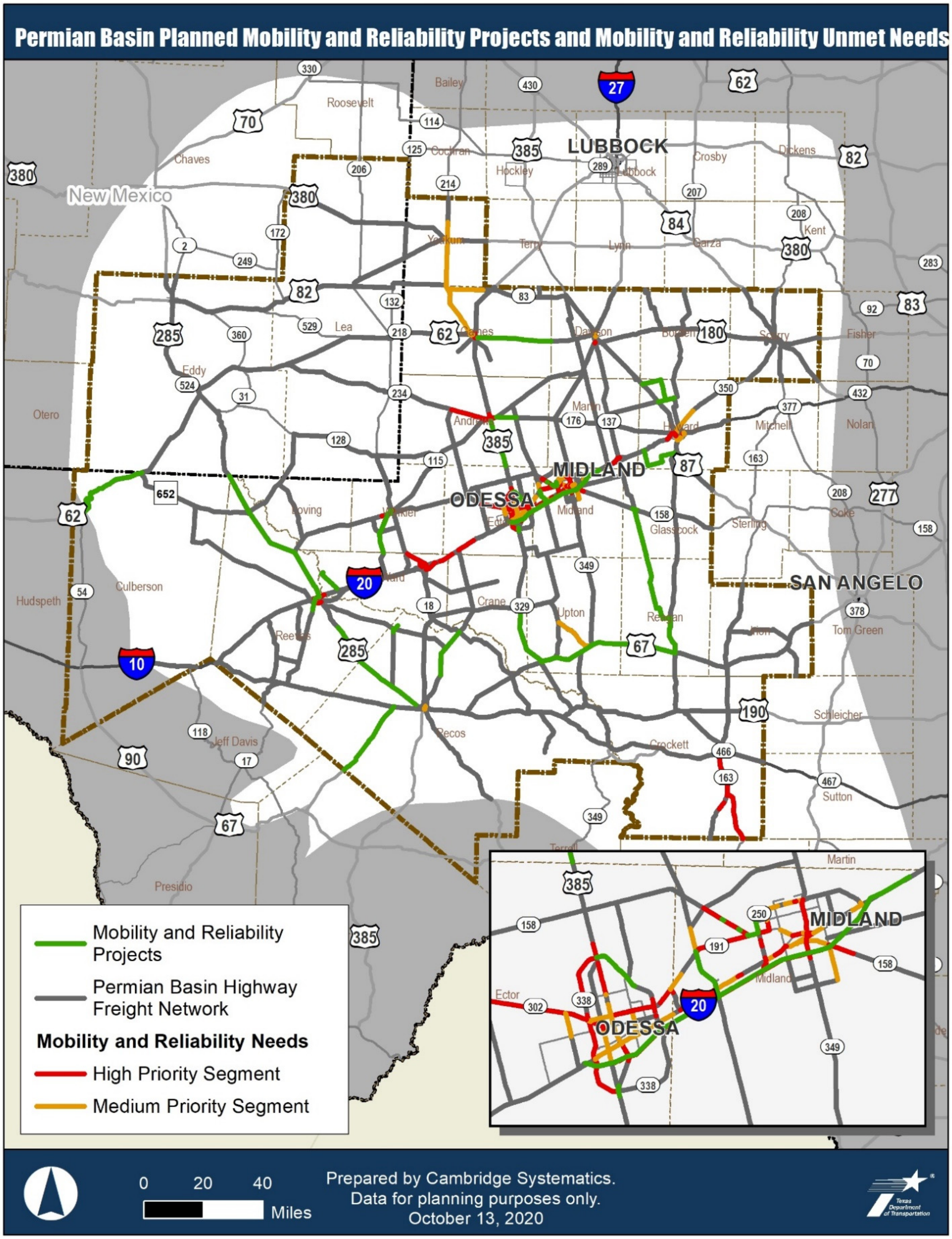
The unmet needs have a direct impact on the Permian Basin's economic competitiveness and connectivity to markets.

Exhibit 116. Permian Basin Planned Safety Projects and Unmet Safety Needs



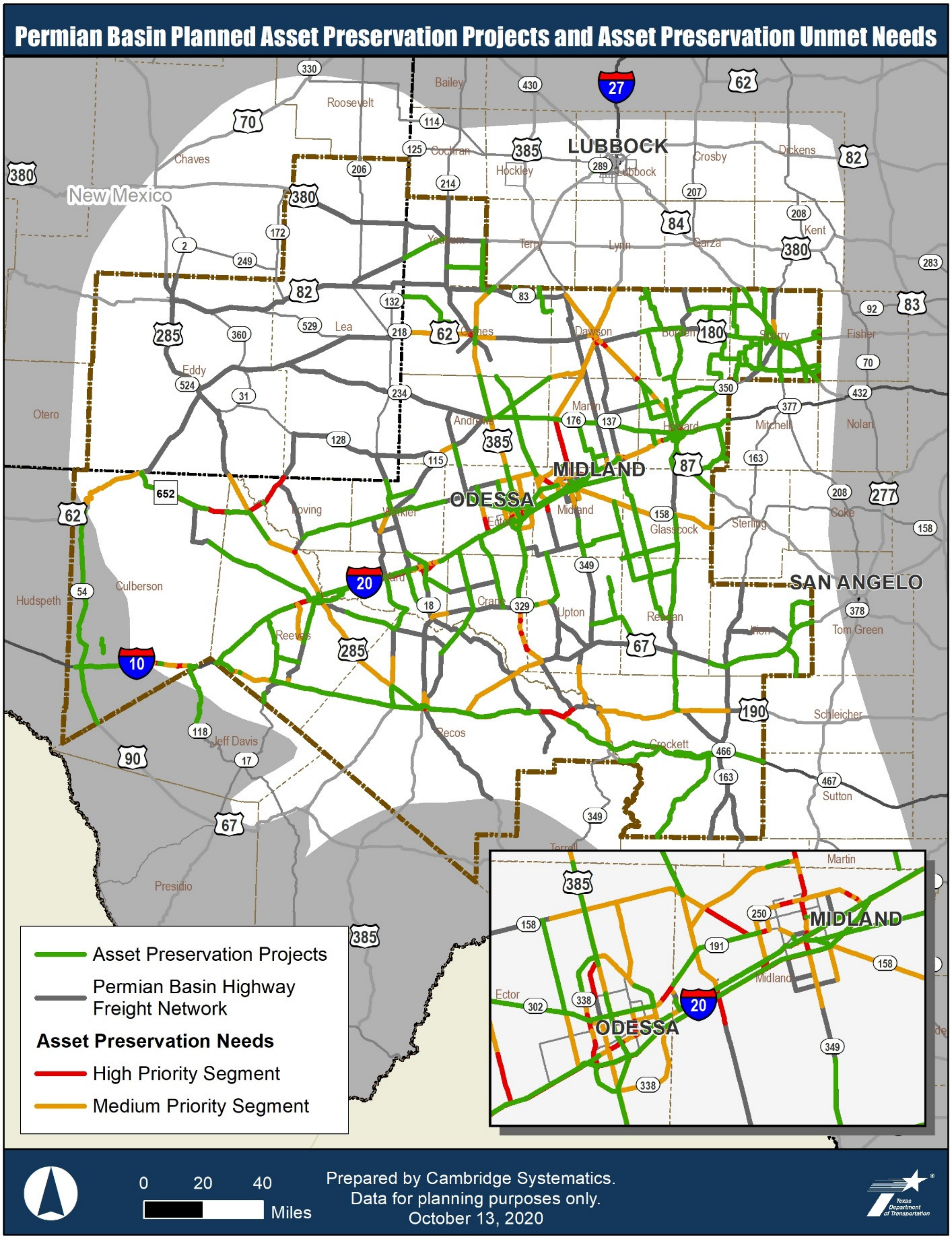
Source: TxDOT 2021 Unified Transportation Program, Cambridge Systematics analysis.

Exhibit 117. Permian Basin Planned Mobility and Reliability Projects and Unmet Mobility Needs



Source: TxDOT 2021 Unified Transportation Program, Cambridge Systematics analysis.

Exhibit 118. Permian Basin Planned Asset Preservation Projects and Unmet Asset Preservation Needs



Source: TxDOT 2021 Unified Transportation Program, Cambridge Systematics analysis.

The combination of unfunded planned projects and the significant number of needs with no planned projects highlights the importance of a continued focus on developing policies, programs, technology, operation, and infrastructure strategies to address freight and energy sector transportation challenges in the Permian Basin.

Chapters 6, 7, and 8 have put forth a comprehensive set of policy, programs, operations and technology and project strategies for enhancing the safety, efficiency and competitiveness of freight and energy sector transportation in the Permian Basin. Advancing these strategies will require a continuous, collaborative effort by TxDOT, their planning partners and the private sector. **Chapter 9** presents an implementation plan for advancing the highest priority recommendations.

CHAPTER 9 Permian Basin Freight Mobility Implementation Plan

The strategies and recommendations discussed in **Chapters 6, 7, and 8** were developed to ensure the safe and efficient movement of freight throughout the Permian Basin in the short term and in the future by addressing the needs identified in Chapter 5. An effective implementation plan ensures that the Permian Basin Freight Plan is dynamic and offers a continuous cycle of improvements based on the recommendations outlined. The implementation plan should be re-evaluated on a regular basis to adapt to freight user needs and changes in priorities, funding sources, and resources. This chapter provides a summary of the implementation plan, which categorizes the recommendations as short, medium, and long term.

This chapter breaks down the action plan for infrastructure projects, operations and technology strategies, and policies and programs into short and long-term actions to address freight and energy sector transportation needs across the Permian Basin. Additional details are provided in Permian Basin Freight Plan Strategies, Recommendations and Implementation report.

9.1 RECOMMENDATIONS FOR IMPLEMENTATION OF PERMIAN BASIN POLICY AND PROGRAM STRATEGIES

The implementation of freight policy and program recommendations begins with the adoption of the Permian Basin Freight Plan and immediate establishment of the Permian Basin Freight Advisory Committee. Short-term actions to advance the policy strategies should begin right away and be completed within the next 12-18 months. Medium-term actions should begin within the next year. Full implementation should be completed within the next three to five years.

9.1.1 IMPLEMENTATION OF PERMIAN BASIN POLICY STRATEGIES

The Permian Basin Freight Plan’s 13 policy recommendations presented in Section 6.2 are broad-based strategies designed to meet the region’s institutional, regulatory, and systemic challenges and bottlenecks. Five of these strategies are TxDOT led and the remaining eight are TxDOT supported. These policies were developed using extensive stakeholder input, especially from the Steering Committee, private-sector stakeholders, TxDOT Districts, and the Permian Basin MPO, and through rigorous data analysis and system evaluation. **Exhibit 119** provides an implementation timeline for the actions the state should take to implement these policies based on overall need, input from the stakeholders, and feasibility.

Exhibit 119. Recommended Actions to Implement Permian Basin Freight Plan Policies

Short-term Permian Basin Freight Plan Policy Actions (Complete in 12-18 months)
Action 1: The state should implement the recent Permian Basin Access Management guidelines completed by TTI for the Odessa District for driveway spacing and design for new and consolidation of existing driveways.
Action 2: The state should integrate the freight infrastructure design considerations currently under development by TxDOT into the Permian Basin project development process for future infrastructure improvements.
Action 3: The state should meet with the RRC to discuss 1) the feasibility of incorporating additional data reporting requirements into the permit application and updating processes, to include truck trip generation and commodity flow information; and 2) methods for obtaining RRC drilling data to inform construction letting and work zone planning.
Action 4: The state should coordinate with local planners to assess the feasibility of integrating freight and truck considerations into traffic impact analyses for industrial and commercial developments.
Action 5: The state should undertake research on the human factors associated with the transportation safety challenges in the Permian Basin. The research should focus on truck and general public driver behavior as well as the local industry transportation safety culture.
Action 6: The state should develop and share freight land use considerations and mitigation factors related to the energy sector with local leaders. The considerations could be developed in cooperation with the MPO and Regional Planning Commission through input from their boards and technical and policy committees.
Action 7: The state should convene a meeting with existing truck stop operators and regional stakeholders owning facilities with significant surface parking availability to exchange ideas and information on expanding safe truck parking along the PBHFN.
Action 8: The state should meet with Texas DMV and users of OS/OW permits to exchange ideas on collecting, submitting, and sharing additional data for multi-use permits to aid in local transportation network maintenance, construction, and investment planning.

Medium-term Permian Basin Freight Plan Policy Actions (Initiate within in next 12 months and complete within 3-5 years)
Action 1: The state should develop and implement driveway separation and consolidation guidelines on PBHN facilities.
Action 2: The state should develop freight and energy sector transportation investment funding guidelines that explore innovative funding and financing to include local, state, federal, and private sector funding opportunities.
Action 3: The state should coordinate with state, regional, and local agencies to streamline project delivery and build consistency among various jurisdictions in regulations, permitting, planning, and preservation of the freight network.
Action 4: The state should implement actions arising from collaboration with the RRC with regards to truck trip generation data collection and sharing and integrating real-time drilling data into construction and work zone planning from Short-term Policy Action 3.
Action 5: The state should work with energy sector stakeholders to incorporate the findings from the safety research from Short-term Policy Action 5 into company driver training and safety programs.
Action 6: The state should undertake a study to examine the feasibility and impact of off-peak truck operations for freight intensive activities, including oilfield operations, warehousing and distribution deliveries, and OS/OW movements.

9.1.2 IMPLEMENTATION OF PERMIAN BASIN PROGRAM STRATEGIES

Most of the freight program recommendations presented in Section 6.3 are identified as high priority by stakeholders and can begin implementation immediately. Some of these include developing wayfinding and signage guidelines, technology based TSM&O programs, freight transportation planning and data collection programs, and freight education and awareness campaigns. **Exhibit 120** presents the short- and medium-term actions necessary to advance the program recommendations presented in Chapter 6.

Exhibit 120. Recommended Actions to Implement Permian Basin Freight Plan Programs

Short-term Permian Basin Freight Plan Program Actions (Complete in 12-18 months)
Action 1: The state should support the formation of the Permian Basin Freight Advisory Committee and provide ongoing regional freight planning support, including as part of statewide freight planning efforts and through participation on the MPO policy and technical committees.
Action 2: The state should address freight data collection in the Permian Basin by addressing the lack of WIM and VC devices in the region. This includes repairing or replacing malfunctioning equipment and deploying additional equipment in locations identified in the TxDOT WIM and VC Strategic Plan (under development).
Action 3: The state should use the findings from the Permian Basin Freight Plan to develop public outreach materials for use at regional, statewide, and national levels.
Action 4: The state should develop a standardized signage program for the Permian Basin to include reference location signs (mile markers) and commercial and leased roads driveway signing.
Action 5: The state should deliver freight transportation planning training to local, regional, and district transportation planners in the Permian Basin.
Action 6: The state should develop freight planning, programming, and implementation guidelines for transportation investment decision-making in the Permian Basin.
Action 7: The state should incorporate private lease roads and other major energy sector freight generators into access management guidelines for the PBHFN.
Action 8: The state should work with the MPO, the Permian Basin Freight Advisory Committee, local leaders, and private sector transportation stakeholders to convene a planning session for the first biennial Permian Basin Freight and Energy Sector Transportation Summit.
Medium-term Permian Basin Freight Plan Program Actions (Initiate within next 12 months and complete within 3-5 years)
Action 1: The state should develop district level TSM&O plans with a focus on technology-based freight safety and operations.
Action 2: The state should develop a comprehensive freight data collection, repository, and reporting program that includes formulated rules, agreements, and guidelines for obtaining, sharing, and using public and private sector data sources.
Action 3: The state should implement the enhanced access guidelines for private lease roads and major freight generators developed in short-term Program Action 7.

Action 4: The state should participate in discussions with the MPO, Regional Planning Commission, other local planning partners, and the private sector to develop programs promoting intraregional transit and van-pool services to major freight generators, staff camps, and employment sites.

Action 5: The state should provide planning support for conducting regional multimodal thoroughfare plans.

Action 6: The state should undertake a Permian Basin Freight Rail Infrastructure Assessment to identify opportunities to build freight rail capacity while avoiding negative impacts to public safety and congestion at rail-highway crossings.

Action 7: The state and regional stakeholders should convene biennial Permian Basin Freight and Energy Sector Transportation Summits to facilitate an ongoing dialogue, information exchange, and Permian Basin Freight Plan implementation in the region.

9.2 RECOMMENDATIONS FOR IMPLEMENTATION OF PERMIAN BASIN OPERATIONAL AND TECHNOLOGY STRATEGIES

The Permian Basin Freight Plan's five operational strategies and four technology strategies presented in **Section 7.1** and **Section 7.2**, respectively, are designed to meet the region's infrastructure and congestion challenges by enhancing the conditions and performance of the existing network. All the strategies were rated as important to very important in terms of priority by regional stakeholders and the Steering Committee, indicating that operational and technology strategies can represent cost-effective, short-term opportunities to significantly improve freight movements.

9.2.1 IMPLEMENTATION OF PERMIAN BASIN OPERATIONAL STRATEGIES

Exhibit 121 provides an implementation timeline for the actions the state should take to implement operational strategies based on overall need, input from the stakeholders, and feasibility. Based on the favorable rating of these strategies by stakeholders, the state should take steps in the next 12 months to advance all of these in the short-term, with full implementation completed within the next five years.

Exhibit 121. Recommended Actions to Implement Permian Basin Freight Plan Operational Strategies

Short-term Permian Basin Freight Plan Operational Actions (Complete in 12-18 months)
Action 1: The state should develop a plan for ensuring adequate road markings, lighting, and signage on all PBHFN corridors.
Action 2: The state should develop guidance for adding increased signage, including mile markers and private lease road signing, on the PBHFN.
Action 3: In conjunction with short-term Technology Action 3 and medium-term Program Action 1, the state should conduct a feasibility study and develop a concept of operations for deploying ITS to

address general freight challenges and needs, such as truck parking locations, safety hotspots, blocked rail crossings, and real-time travel times on Tier 1 PBHFN corridors.

Action 4: In conjunction with short-term Program Action 2, the state should address the shortage of functioning WIM and VC devices in the Permian Basin by repairing or replacing malfunctioning equipment and deploying additional equipment in locations identified in the TxDOT WIM and VC Strategic Plan.

Action 5: The state should identify corridors with traffic signal timing needs, develop and implement traffic signal timing recommendations, and evaluate the effectiveness of the signal timing enhancements to improve freight movements and passenger vehicle travel.

Medium-term Permian Basin Freight Plan Operational Actions

(Initiate in next 12 months and complete within 3-5 years)

Action 1: The state should implement the plan developed by short-term Operational Action 1 to ensure adequate marking, lighting, and signage on PBHFN corridors.

Action 2: The state should implement the guidance for mile markers and private lease road signs developed in short-term Operational Action 2.

Action 3: The state should deploy a pilot project of the concept of operations for ITS developed under short-term Operational Action 3 on selected Tier 1 PBHFN corridors.

Action 4: Based upon the guidelines developed under short-term Operational Action 5, the state should conduct signal timing studies for the most critical PBHFN corridors.

9.2.2 IMPLEMENTATION OF PERMIAN BASIN TECHNOLOGY STRATEGIES

Exhibit 122 provides an implementation timeline for the actions the state should take to implement technology strategies based on overall need, input from the stakeholders, and feasibility. Based on the favorable rating of these strategies by stakeholders, the state should take steps in the next 12 months to advance all of these in the short-term, with the full implementation completed within the next five years.

Exhibit 122. Recommended Actions to Implement Permian Basin Freight Plan Technology Strategies

Short-term Permian Basin Freight Plan Technology Actions (Complete in 12-18 months)
Action 1: The state should explore funding and partnership opportunities for a Permian Basin regional traffic management center (TMC) concept of operations and feasibility study.
Action 2: The state should assess and identify the highest priority routes on the PBHFN for deploying advance warning systems.
Action 3: The state should conduct a feasibility study and develop a concept of operations for a high-resolution, real-time incident management program for the PBHFN to provide information and guidelines for detecting, responding to, and clearing incidents in an efficient manner.
Action 4: The state should assess the feasibility and effectiveness of a Truck Parking Availability System (TPAS)on I-20 and other Tier 1 PBHFN corridors.
Medium-term Permian Basin Freight Plan Technology Actions (Initiate in next 12 months and complete within 5 years)
Action 1: The state and potential partners should initiate the TMC concept of operations and feasibility study following the short-term Technology Action 1.
Acton 2: The state should develop a concept of operations for deploying advance warning detection systems on the corridors identified in the short-term Technology Action 2.
Action 3: The state should implement a regional incident management program pending the outcomes of the short-term Technology Action 3.
Action 4: Based on the outcome of short-term Technology Action 4, the state should develop a concept of operations for deploying TPAS on I-20 and other Tier 1 PBHFN corridors.

9.3 RECOMMENDATIONS FOR IMPLEMENTATION OF PERMIAN BASIN INFRASTRUCTURE STRATEGIES

The implementation of the infrastructure strategies starts with the development of the Permian Basin Freight Investment Plan, a critical freight planning tool for TxDOT and the region. The Permian Basin Freight Investment Plan includes both funded and partially funded projects, and includes only the TxDOT planned projects in the UTP and additional TxDOT District project lists. There is a total of 954 planned projects in the Permian Basin Freight Investment Plan, costing an estimated $10.9 billion. A complete project list is available in the Permian Basin Freight Strategies and Recommendations report.

In addition to the planned projects, five strategic projects having significant impact on the region were identified in **Section 8.4**, including the Ports-to-Plains interstate feasibility study, which identifies projects and recommendations for upgrading portions of U.S. 87, U.S. 277, SH 158, and SH 349 to interstate standards. For the segment passing through the Permian Basin, the projects required to upgrade this corridor combine for a total estimated cost of $12 billion. A Ports-to-Plains profile is included at the end of **Section 9.3**.

Finally, there were high priority needs identified through data analysis and stakeholder input for which projects have yet to be developed. These needs represent opportunities for the districts and MPO to identify new projects that will address the needs and improve freight mobility, safety, asset conditions, and connectivity. Implementation of the Freight Investment Plan will require prioritization of the projects, monitoring of funding availability for the planned projects, and an implementation schedule.

9.3.1 PERMIAN BASIN FREIGHT INVESTMENT PLAN PRIORITIZATION

Prioritization of projects was only completed for the UTP projects as the UTP provides the data necessary for prioritization. The prioritization process for the UTP projects planned for the Permian Basin started with the identified needs on the PBHFN described in **Section 5.4**. "High", "Medium", and "Low" ratings were converted to a numerical rating to enable comparison of segments with different need types. Projects addressing "High" needs received 5 points while those addressing "Medium" needs received 3 points. One point was assigned for projects addressing "Low" needs.

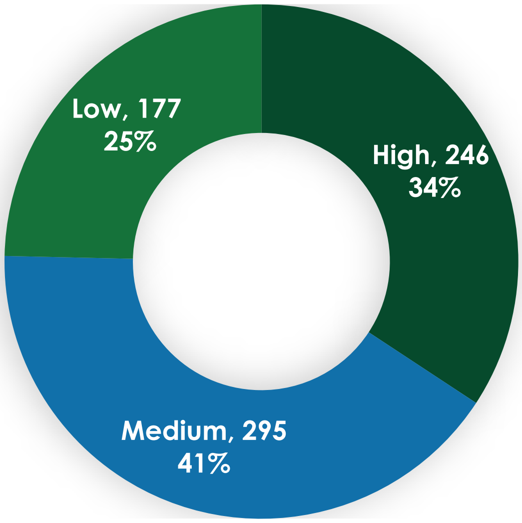
The goals of the Permian Basin Freight Plan. presented in **Section 1.2**, served as the foundation for project prioritization criteria. The final criteria were based on stakeholder and Steering Committee input on the relative importance of the goal areas. Per this input, the following goal areas were assigned weights as noted:

- Safety – 30%
- Mobility and reliability – 30%
- Economic competitiveness – 20%
- Asset preservation – 20%

Roadway projects are awarded points based on the severity of need being met. For example, a project addressing a high priority safety need receives five points, a project addressing a medium priority safety need receives three points, and a project addressing a low priority safety need receives one point. Projects often address more than one need and goal, and this is recognized within the prioritization process. For example, a project addressing a high priority safety need and a medium priority asset preservation need receives five and three points respectively. The five points for safety is weighted by 30% and three points for asset preservation is weighted by 20% based on the prioritization weighting.

Based on the distribution of final weighted scores, the highway projects in the UTP are categorized as high, medium, and low priorities (i.e., a reflection of needs addressed and goals supported). Additional detail on project scoring can be found in the Recommendations and Strategies Report. **Exhibit 123** summarizes the results of the prioritization of highway freight projects. In total, 246 projects are high priority, 295 are medium priority, and the remaining 177 projects are low priority.

Exhibit 123. Planned Permian Basin Freight Infrastructure Projects by Prioritization Rating



Source: Cambridge Systematics analysis based on stakeholder input.

9.3.2 PERMIAN BASIN FREIGHT INVESTMENT PLAN FUNDING AND IMPLEMENTATION SCHEDULE

From an implementation perspective, the Permian Basin Freight Investment Plan demonstrates a $4.0 billion funding gap between the planned UTP projects and the available funding. There are high and medium needs on the PBHFN with unfunded projects, partially funded projects, or no planned projects. Unfunded projects face high risk of not being implemented and will require more focus on the part of TxDOT and the Permian Basin stakeholders in terms of ensuring any projects critical to freight movement remain in the UTP, on TxDOT District project lists and in other project development plans.

Exhibit 124 summarizes partially funded projects by freight priority and type. Of the 718 projects in the UTP in the Permian Basin, 236 are only partially funded. The funding gap for those projects totals more than $4 billion.

Exhibit 124. Partially Funded Permian Basin UTP Freight Investment Plan Projects by Type, 2020-2030

	High Priority		Medium Priority		Low Priority		All	
Project Category	# of Projects	Funding Gap	# of Projects	Funding Gap	# of Projects	Funding Gap	# of Projects	Funding Gap
Safety	15	$5.3	10	$2.9	3	$0.9	28	$9.1
Mobility and Reliability	16	$903.6	14	$999.0	54	$1,015.4	84	$2,918.0
Asset Preservation	36	$104.7	31	$87.4	21	$59.1	88	$251.2
Alternative Routes	-	-	24	$535.4	11	$248.7	35	$784.1
Other	-	-	-	-	1	$39.9	1	$39.9
Total	**67**	**$1,013.6**	**79**	**$1,624.7**	**90**	**$1,364.0**	**236**	**$4,002.3**

Source: TxDOT 2021 Unified Transportation Program.

Addressing the freight transportation needs identified in this Freight Investment Plan will require a concerted effort and framework. There are **57 partially funded high freight priority** projects, **79 partially funded medium freight priority** projects, and **90 partially funded low freight priority** projects. In addition, there are **116 fully funded medium freight priority** and **87 fully funded low freight priority** projects. In order to fund all the high freight priority projects, existing funds may need to be repurposed from low and medium freight priority projects to high freight priority projects. Other options include identifying new revenue sources from TxDOT, regional planning partners, and the private sector. There may be additional opportunities for TxDOT to use the freight priorities to help refocus existing funds and incorporate freight considerations into future funding decisions to ensure that all high priority freight projects are fully funded.

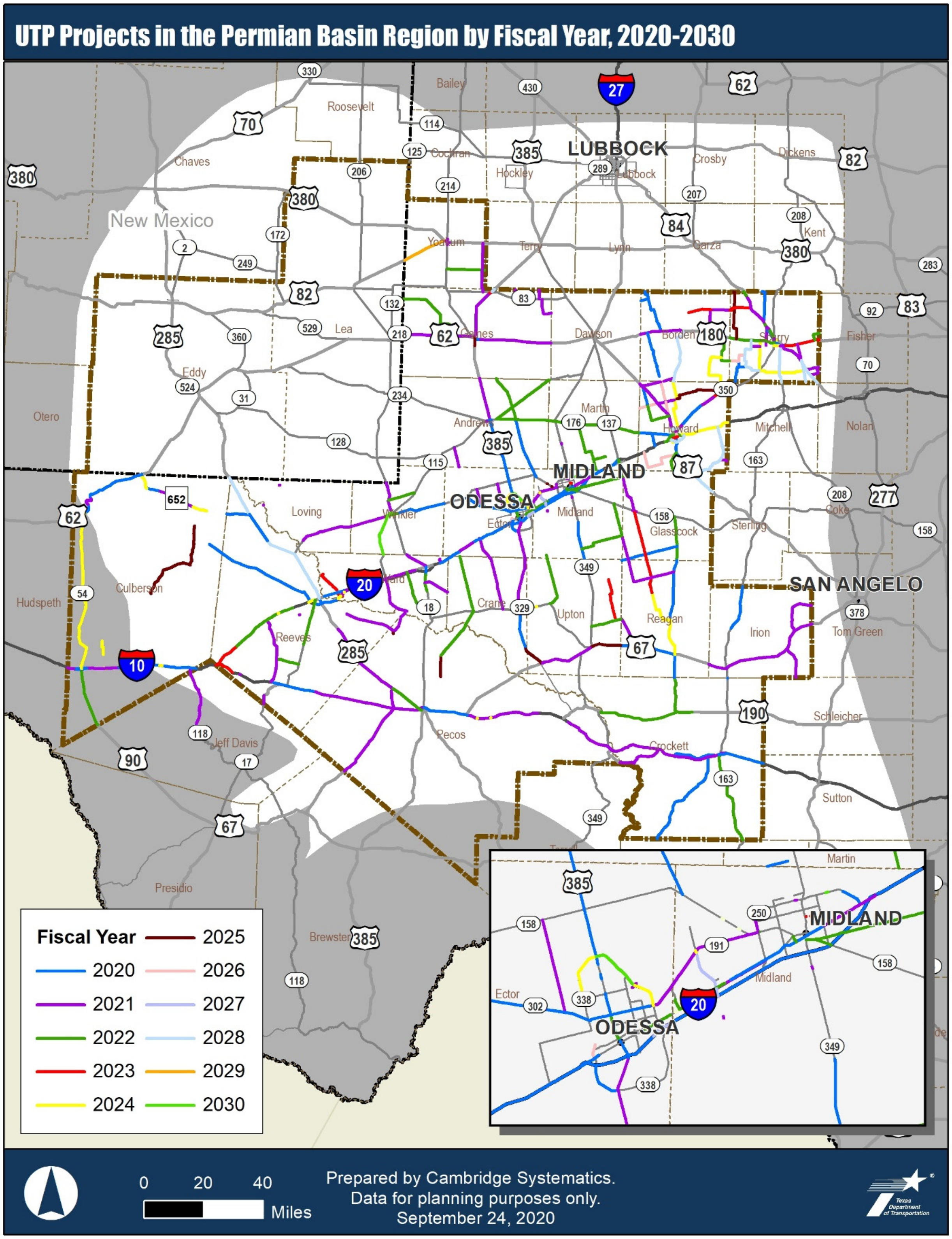
Exhibit 125 and Exhibit 126 display the implementation schedule for the Permian Basin Freight Investment Plan projects from the UTP by year. As illustrated, nearly 52% of the UTP projects are scheduled for implementation in the first two years (2020-2021); nearly 80% are scheduled in the first five years of the ten-year UTP.

Exhibit 125. Implementation Schedule for the Permian Basin Freight Investment Plan Projects from the UTP

Fiscal Year	No. of Projects	Total Cost (Millions$)
2020	166	$962.9
2021	206	$1,499.5
2022	88	$656.6
2023	36	$242.6
2024	77	$688.8
2025	46	$937.0
2026	23	$511.7
2027	12	$913.3
2028	23	$728.1
2029	4	$681.1
2030	37	$725.4
Total	**718**	**$8,547.0**

Source: 2021 TxDOT Unified Transportation Program.

Exhibit 126. UTP Projects in the Permian Basin by Year, 2020-2030

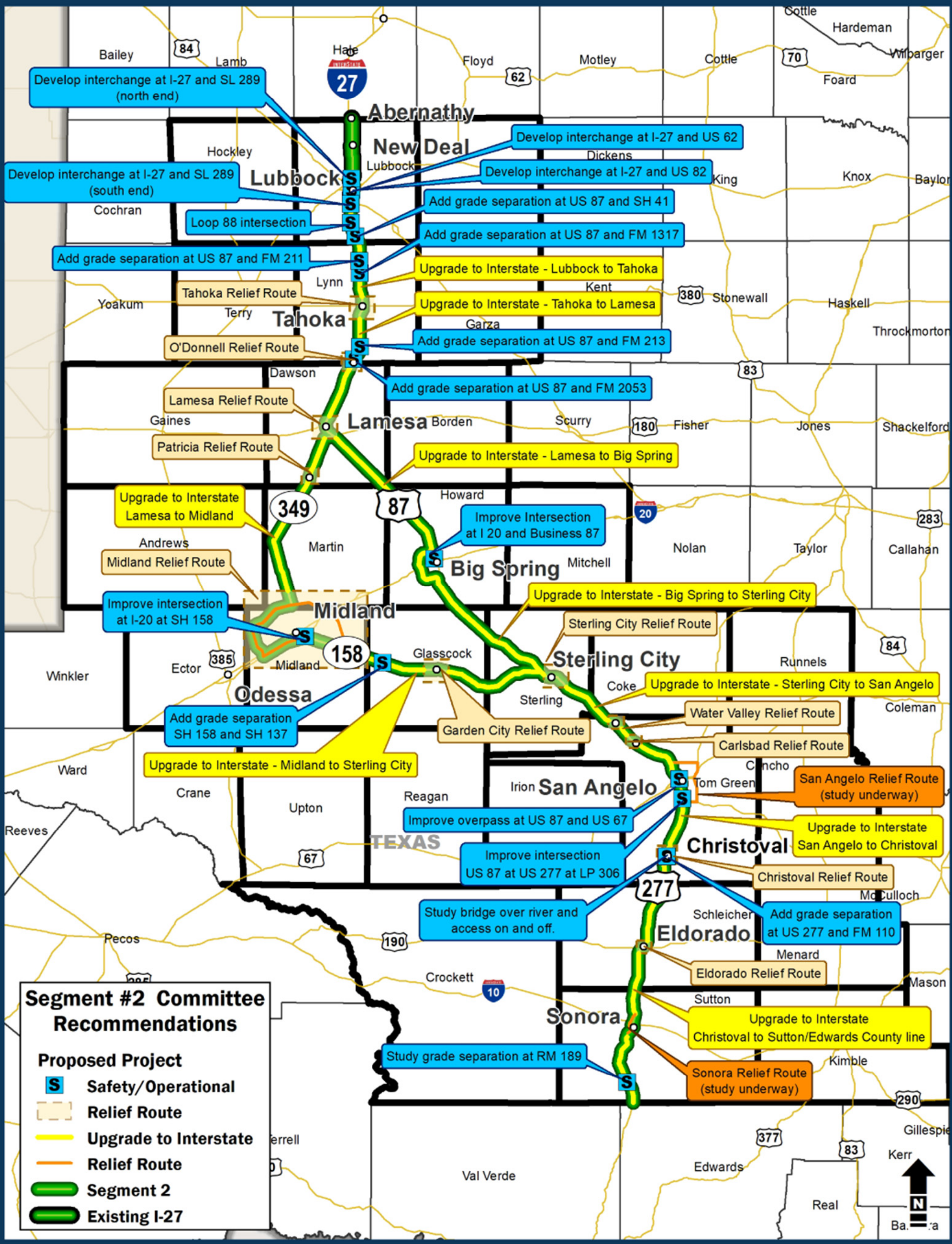


Source: TxDOT 2021 Unified Transportation Plan.

Ports-to-Plains (P2P) Corridor Interstate Feasibility Study

The Ports-to-Plains Corridor is an international, national and state significant transportation corridor that connects and integrates Texas' key economic engines, international trade, energy production, and agriculture. The corridor also plays a vital role in supporting the growing demographic and economic centers of South and West Texas. The corridor functions as the only north-south corridor facilitating the movement of people and goods in south and west Texas and beyond.

Segment 2 of the Ports-to-Plains Corridor passes through the Permian Basin and will have significant impacts on the future economic competitiveness of the region. The Segment Committee recommended a $12 billion program of improvements along with the following policy recommendations:



Source: TxDOT, Ports-to-Plains Corridor Feasibility Study, June 2020.

- Complete planned and programmed projects
- Continue detailed project-level planning development process
- Require environmental review and public input for any relief route
- Solicit community support
- Continue role of P2P Advisory Committee

9.4 SUMMARY AND NEXT STEPS

The development of the Permian Basin Freight Plan builds on the strong foundation of the 2018 Texas Freight Mobility Plan by enhancing and updating the data, tools, processes, and approaches. This lays the groundwork for the challenging job ahead: implementation. The Plan had a significant level of stakeholder engagement and was guided by the Steering Committee. It reaffirms the Permian Basin's freight transportation challenges and outlines strategies to address them.

Implementation of the Permian Basin Freight Plan should focus on:

1. **Continued collaboration**: Implementation will only be successful with the participation and collaboration of all public and private sector users and owners of the transportation system. TxDOT has an important role to play in maintaining and expanding the state's freight transportation infrastructure. However, TxDOT cannot be solely responsible for implementing all of the policy, program, and project recommendations. These recommendations can only become actionable with strong coordination and cooperation with energy sector companies, railroads, marine ports, airports, and other freight industry stakeholders, as well as with other agencies, such as federal and state agencies, the Permian Basin MPO, cities and counties, and other entities. TxDOT will continue to engage regional stakeholders in the implementation of the Permian Basin Freight Plan.
2. **Policy and Program Recommendations**:
   - Take short- and medium-term actions to fully implement freight policy and program recommendations outlined in Chapters 6 through 9.
   - Ensure that regional project development and prioritization incorporates freight considerations such as design, truck parking, economic competitiveness, supply chains, market access, and goods movement criteria.
3. **Permian Basin Freight Investment Plan**:
   - Move high freight priority partially funded projects to implementation by refocusing existing funding tied to low or medium freight priority projects.
   - Address the estimated $4.0 billion funding shortfall for freight projects.
   - Outline how to advance the partially funded freight projects in the Freight Investment Plan through project development and implementation by assessing how these projects can be given higher priorities based on freight needs.
   - Identify potential investments or strategies to address freight transportation needs which do not have a currently planned project.
   - Focus efforts at the district and MPO levels on developing freight-centric projects.
   - Monitor progress of strategic projects and support efforts to advance the highest priorities for those efforts.

These steps are crucial to the region's commitment to support economic development, environmental sustainability, and quality of life by addressing freight and energy sector transportation needs. Implementing the recommended policies, programs, and projects outlined in this freight transportation plan is critical to the continued economic prosperity in the region and in the state of Texas given the significant role the Permian Basin plays in supporting and generating statewide jobs, income, and tax revenue.

Texas Department of Transportation