SETTS
Southeast Trade and Transportation Study

Institute for Trade and Transportation Studies

SOUTHEAST TRADE AND TRANSPORTATION STUDY

Phase 2: Final Report




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Phase 2: Final Report

Departments of Transportation

Arkansas Department of Transportation

Florida Department of Transportation

Georgia Department of Transportation

Kentucky Transportation Cabinet

Louisiana Department of Transportation and Development

Mississippi Department of Transportation

Missouri Department of Transportation

South Carolina Department of Transportation

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Steering Committee

Arkansas Department of Transportation

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Texas Department of Transportation

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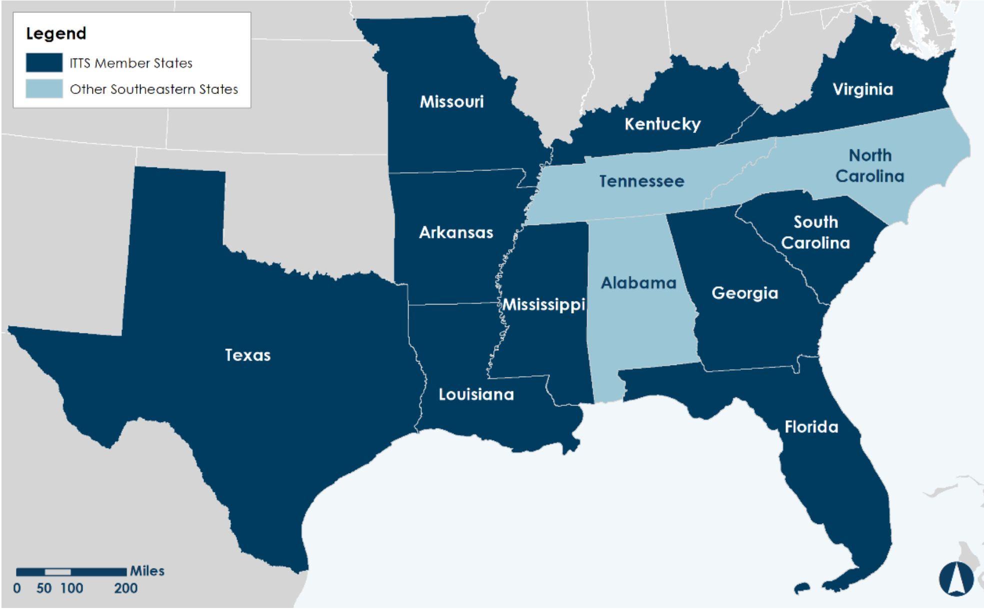
1 INTRODUCTION

In 2001, the Institute for Trade and Transportation Studies (ITTS) updated the 1996 Latin America Trade and Transportation Study (LATTS). The timing of the report came amid increased trade with Mexico seven years after the North American Free Trade Agreement (NAFTA) went into effect in 1994. By 2000, ships were being built that could not pass through the Panama Canal and discussion about its expansion had begun. The purpose of 2001 LATTS was to "evaluate opportunities for trade with Latin America, and to determine transportation infrastructure investment needs for the Alliance to capitalize on such trade."

FIGURE 1 ITTS MEMBER STATES AND OTHER SOUTHEASTERN STATES



The ITTS region once again faces a period of change and opportunity. Among other developments, the NAFTA has been replaced by the United States-Mexico-Canada Agreement (USMCA), advances in motor vehicle and communications technologies have opened new opportunities for addressing transportation challenges, changes in manufacturing and logistics practices have impacted land use and freight traffic patterns, and a global pandemic has transformed the way the supply chains are structured and managed. Phase I of the Southeast Trade and Transportation Study (SETTS) advanced the profile of the region in updating current economic, industry, modal, and network data to set the stage for research on future regional opportunities in prioritization, funding, and planning. SETTS Phase II examines current and future freight and trade conditions for the ITTS and revisits a central question of ITTS's 2001 Latin America Trade and Transportation Study (LATTS): how can the region position itself to take advantage of emerging economic opportunities and protect its existing freight and trade advantages?

1.1 Goals and Objectives

Defining goals and objectives is a critical first step for determining the strategic direction of the SETTS Phase II and generally for taking a transportation performance management-based approach to long range planning.[1] Goals and objectives establish the means to measure and manage performance. Goals are broad statements articulating a desired end state that provide strategic direction for an agency. Objectives are specific, measurable statements that support achievement of a goal.[2]

The Fixing America's Surface Transportation (FAST) Act established a national multimodal freight policy and required that U.S. DOT develop a National Freight Strategic Plan (NFSP) to implement the goals of the national policy. The NFSP serves to guide national freight policy, programs, initiatives, and investments; inform State freight plans; identify freight data and research needs; and provide a framework for increased cross-sector, multijurisdictional, and multimodal coordination and partnerships. To this end, the NFSP defined U.S. DOT's vision and goals for the national multimodal freight system, assessed the conditions and performance of the freight system and barriers to freight system performance, and defined strategies to achieve its vision and goals.

The goals and objectives of the NFSP are the foundation for the SETTS Phase II goals. The goals and objectives presented in Table 1 follow the same three major goal areas established in the NFSP: Safety, Infrastructure, and Innovation.

TABLE 1 SETTS PHASE II GOALS AND OBJECTIVES

Goal	Strategic objectives
Safety—Improve the safety, security, and resilience of the ITTS Multimodal Freight Network (MFN).	• Support the development and adoption of automation, connectivity, and other freight safety technologies. • Reduce the rate and severity of crashes involving freight vehicles. • Support the development of safe and secure truck parking facilities. • Protect the ITTS MFN from natural and human-caused disasters and improve system resilience and recovery speed.
Infrastructure—Modernize infrastructure and enhance operations on the ITTS MFN to support supply chains, grow domestic and global trade, increase competitiveness, and improve the quality of life for the ITTS region.	• Maintain and improve bridges on the ITTS MFN. • Maintain and improve pavements on the ITTS MFN. • Modernize the ITTS MFN to ensure it operates efficiently and will meet the needs of future freight movements. • Reduce congestion and delay on the ITTS MFN. • Increase travel time reliability on the ITTS MFN. • Support projects and initiatives that increase intermodal connectivity on the ITTS MFN and that enhances freight flows across supply chains. • Support freight-related job growth and economic competitiveness in the ITTS region.

[1] https://www.tpmtools.org/guidebook/chapter-01/.

[2] https://www.fhwa.dot.gov/planning/performance_based_planning/pbpp_guidebook/.

Goal	Strategic objectives
	• Minimize, mitigate, or eliminate adverse freight-related impacts on historically disadvantaged communities. • Reduce the environmental impacts (including emissions, flooding, stormwater runoff, and wildlife habitat loss) of building, maintaining, and operating the ITTS MFN.
Innovation—Prepare for the future by supporting the development of data, technologies, and tools that improve freight system performance and aid member states' planning and funding efforts.	• Support the development and deployment of advanced transportation technologies (including intelligent transportation systems, vehicle automation, and vehicle and infrastructure connectivity) on the ITTS MFN. • Support the development and deployment of innovative operational strategies that improve the safety and efficiency of freight movement on the ITTS MFN. • Improve the quality and breadth of freight data, modeling, and analytical tools and resources available to member states.

Source: Cambridge Systematics, Inc.

1.2 Organization of the Report

The SETTS Phase II Final Report is organized as follows:

- **Freight Industry Concentration and Growth—**The freight industry concentration and growth analysis identifies clusters of industries where employment data indicates that the competitive position of the ITTS region is either improving, declining, or remaining constant relative to national performance.

- **Key Industry Supply Chains—**The results of the freight industry concentration and growth analysis indicated that there are multiple industries on which the ITTS region may choose to focus when considering strategies for strengthening its trade position. This section of the report provides a more detailed analysis of those industries and their supply chains.

- **Needs Assessment—**The needs assessment describes the physical, operational, and policy/regulatory issues that are most significantly affecting the performance and efficiency of the multimodal freight system. It incorporates multi-state condition and performance data available from member states to develop a comprehensive understanding of needs.

- **Conclusions and Final Thoughts—**The report concludes with recommendations for the ITTS region to move forward with enhancing its trade position and capitalizing on opportunities to grow its role in global supply chains.

2 FREIGHT INDUSTRY CONCENTRATION AND GROWTH

The purpose of the freight industry concentration and growth analysis is to identify clusters of industries where employment data indicates that the competitive position of the ITTS region is either improving, declining, or remaining constant relative to national performance. For industries where the region's competitive position is improving, member states may wish to increase the freight-focused economic development efforts that have led to their success. For industries in which the region's competitive position is not growing, member states may choose to revise current strategies or to increase their focus on industries where they have experienced success. Furthermore, identifying these industry clusters provides a basis for understanding the freight transportation needs associated with these sectors and the types of investments needed to support growth. It also informs which industries should be the focus of the supply chain analysis presented in Section 3.0 of this report.

2.1 Analysis

The analysis presented in this section of the report relies on two analytical techniques: location quotient (LQ) analysis and shift-share (SS). Both techniques rely on employment data to estimate the concentration of freight-intensive industry clusters in the ITTS region, how those concentrations have changed over time, and how they compare to national performance. Freight-intensive industries are those that are major producers and/or consumers of goods in the ITTS region, or industries that provide either storage or carry services for freight production and freight attractions in the region. The information derived from these analytical techniques indicates how the region's competitive position for each freight-intensive industry cluster has changed over time.

2.1.1 Location Quotient (LQ) Analysis

An LQ analysis identifies strong and weakening industry clusters in the region by calculating the ratio of the region to U.S. employment concentrations in the selected historical years 2012 and 2022. The LQ can quickly indicate whether the employment share of a given industry is greater in the ITTS region compared to its national share. The employment LQs for the freight-intensive industries in ITTS member states region compared to the U.S. in 2012 and 2022 are shown in Table 2. The LQ can readily indicate whether the employment share of a given industry is greater in the ITTS region compared to its national share. If the ratio is greater than 1.0, then it is considered a cluster where such industry concentration and specialization at the regional level is strong in comparison to the same industry at the national level. If the ratio is less than 1.0, then it is considered a relative weaker cluster, where the industry is less concentrated regionally than what it is nationally. If the ratio equals 1.0, then the industry concentration at the regional level is equal to that at the national level.

TABLE 2 FREIGHT-INTENSIVE INDUSTRY CONCENTRATION IN THE ITTS REGION COMPATED TO THE U.S., 2012 AND 2022

Industry Sector	Freight-Intensive Industry	Employment LQ, 2012	Employment LQ, 2022
Agriculture	Crop Production	0.75	0.66
	Animal Production and Aquaculture	0.79	0.75
	Forestry and Logging	1.25	1.34
Energy and Petrochemicals	Oil and Gas Extraction	2.15	2.10
	Support Activities for Mining	2.05	2.10
Construction	Construction	1.13	1.09
Manufacturing	Food Manufacturing	0.94	0.88
	Beverage and Tobacco Product Manufacturing	0.92	0.86
	Textile Mills	1.36	1.38
	Textile Product Mills	1.61	1.57
	Apparel Manufacturing	0.54	0.68
	Leather and Allied Product Manufacturing	1.04	1.13
	Wood Product Manufacturing	1.11	1.10
	Paper Manufacturing	0.99	1.01
	Printing and Related Support Activities	0.83	0.81
	Petroleum and Coal Products Manufacturing	1.53	1.46
	Chemical Manufacturing (except Pharmaceutical and Medicine)	1.27	1.28
	Pharmaceutical and Medicine Manufacturing	0.41	0.50
	Plastics and Rubber Products Manufacturing	0.86	0.87
	Nonmetallic Mineral Product Manufacturing	1.03	1.06
	Primary Metal Manufacturing	0.73	0.78
	Fabricated Metal Product Manufacturing	0.84	0.85
	Machinery Manufacturing	0.90	0.88
	Computer and Electronic Product Manufacturing	0.64	0.64
	Electrical Equipment, Appliance, and Component Manufacturing	0.92	0.95
	Motor Vehicle Manufacturing	0.60	1.01
	Motor Vehicle Body and Trailer Manufacturing	0.78	0.77
	Motor Vehicle Parts Manufacturing	0.74	0.79
	Aerospace Product and Parts Manufacturing	0.90	0.94
	Railroad Rolling Stock Manufacturing	0.67	0.65

Industry Sector	Freight-Intensive Industry	Employment LQ, 2012	Employment LQ, 2022
	Ship and Boat Building	1.89	1.68
	Other Transportation Equipment Manufacturing	0.90	0.98
	Furniture and Related Product Manufacturing	0.90	0.90
	Miscellaneous Manufacturing (except Medical Equipment and Supplies)	0.73	0.79
	Medical Equipment and Supplies Manufacturing	0.60	0.64

Source: Cambridge Systematics, based on the Quarterly Census of Employment and Wages, U.S. Bureau of Labor Statistics.

Trends in freight-intensive industry concentration and employment in the ITTS region compared to the U.S. are shown in Table 3. The results indicate the following:

- **Strong Concentration and Growing**

  These industries had an LQ greater than 1.0 in 2022 and experienced an increase in LQ between 2012 and 2022. For the ITTS region, 21 out of the 35 analyzed industries increased their LQ between 2012 and 2022. Consolidated industries that continued to expand their specialization level include Forestry and Logging, Motor Vehicle Manufacturing, and Chemical Manufacturing (except Pharmaceutical and Medicine), among others.

- **Lower Concentration and Growing**

  These industries had an LQ less than 1.0 in 2022 but experienced an increase between 2012 and 2022. In addition to the eight consolidated industries that continued to expand their specialization level, 13 additional industries improved their relative concentration as compared to the U.S., although they remain overall less concentrated regionally when compared to the Nation. This group includes several industries in the manufacturing sector such as Apparel Manufacturing, Pharmaceutical and Medicine Manufacturing, and Primary Metal Manufacturing, among others.

- **Lower Concentration and Declining**

  These industries had an LQ less than 1.0 in 2022, which represented a decline between 2012 and 2022. For the ITTS region, eight industries were determined to fall in this category including Crop Production, Food Manufacturing, and Animal Production and Aquaculture, among others.

- **Strong Concentration and Declining**

  These industries had an LQ greater than 1.0 in 2022, which represented a decline between 2012 and 2022. These industries might be considered at risk and could deserve more research to understand why it has a strong yet declining concentration. The decline of strong concentrated industries presents a potential risk to the regional economy. Six industries were determined to fall in this category: Ship and Boat Building, Petroleum and Coal Products Manufacturing, Construction, Textile Product Mills, Oil and Gas Extraction, and Wood Product Manufacturing.

TABLE 3 FREIGHT-INTENSIVE INDUSTRY CONCENTRATION AND GROWING/ DECLINING TREND IN THE ITTS REGION COMPARED TO THE U.S., 2012–2022

Lower Concentration and Growing	Strong Concentration and Growing
• Apparel Manufacturing • Pharmaceutical and Medicine Manufacturing • Miscellaneous Manufacturing (except Medical Equipment and Supplies) • Other Transportation Equipment Manufacturing • Primary Metal Manufacturing • Motor Vehicle Parts Manufacturing • Medical Equipment and Supplies Manufacturing • Aerospace Product and Parts Manufacturing • Electrical Equipment, Appliance, and Component Manufacturing • Plastics and Rubber Products Manufacturing • Computer and Electronic Product Manufacturing • Fabricated Metal Product Manufacturing • Furniture and Related Product Manufacturing	• Motor Vehicle Manufacturing • Leather and Allied Product Manufacturing • Forestry and Logging • Support Activities for Mining • Nonmetallic Mineral Product Manufacturing • Paper Manufacturing • Textile Mills • Chemical Manufacturing (except Pharmaceutical and Medicine)
Lower Concentration and Declining	**Strong Concentration and Declining**
• Crop Production • Beverage and Tobacco Product Manufacturing • Food Manufacturing • Animal Production and Aquaculture • Railroad Rolling Stock Manufacturing • Machinery Manufacturing • Printing and Related Support Activities • Motor Vehicle Body and Trailer Manufacturing	• Ship and Boat Building • Petroleum and Coal Products Manufacturing • Construction • Textile Product Mills • Oil and Gas Extraction • Wood Product Manufacturing

Source: Cambridge Systematics, based on the Quarterly Census of Employment and Wages, U.S. Bureau of Labor Statistics.

2.1.2 *Shift-Share (SS) Analysis*

An SS analysis is another method for analyzing changes in a regional economy by taking a retrospective look at how the regional economy has changed in relation to the national economy. The SS analysis recognizes that some industries in a region are likely to be growing at a faster rate when compared to the nation, while others are not. The analysis also sheds light on what is behind the net change in employment, and which industries in the regional economy are competitive in comparison to the national economy in selected historical years. The SS analysis examines several of the factors that contribute to the growth or decline in the regional economy, breaking the actual change into three parts:

1. The **National Growth Component** is the expected change in industrial employment if the regional industry grew at the same pace as the whole national economy. Comparing this result to the actual change in industrial employment in the ITTS region gives insight whether the industry grew at a faster or slower pace than the national average.

2. The **Industrial Mix Component** depicts the change in national industry growth beyond the national average. It represents the portion of the ITTS industrial growth that is due to the national industry growth after accounting for the overall national growth. For example, between 2012 and 2022, the national employment growth was 12.9 percent, but the Construction industry grew faster, at 36.8 percent in the United States. This faster growth (by almost 24 percentage points) attributes an employment growth of 422,138 workers in the ITTS region in the Construction industry. If the Industrial Mix Component is greater than zero, then the regional industry outperformed the nationwide economy, while an Industrial Mix Component less than zero suggests the opposite.

3. The **Competitive Share** describes the ITTS industrial employment change compared to the national industry average. Here, this component considers a particular industry's nationwide change in employment to the change in employment for the same industry in the ITTS region. If the Competitive Share is greater than zero, it suggests the ITTS industry outpaced the nationwide industry average, while a Competitive Share less than zero suggests the opposite.

The results of the SS analysis over the 2012–2022 time period are shown in Table 4. In terms of number of jobs, the top-3 freight-intensive industries by competitive effect are shown in Figure 2, while the bottom-3 freight-intensive industries by competitive effect are shown in Figure 3. In relative terms, the top-3 freight-intensive industries by competitive effect (percentage growth values) are shown in Figure 4, while the bottom-3 freight-intensive industries by competitive effect (also using percentage growth values) are shown in Figure 5.

TABLE 4 ITTS REGION FREIGHT-INTENSIVE INDUSTRIES COMPETITIVENESS BASED ON SHIFT-SHARE ANALYSIS RESULTS COMPARED TO THE U.S., 2022

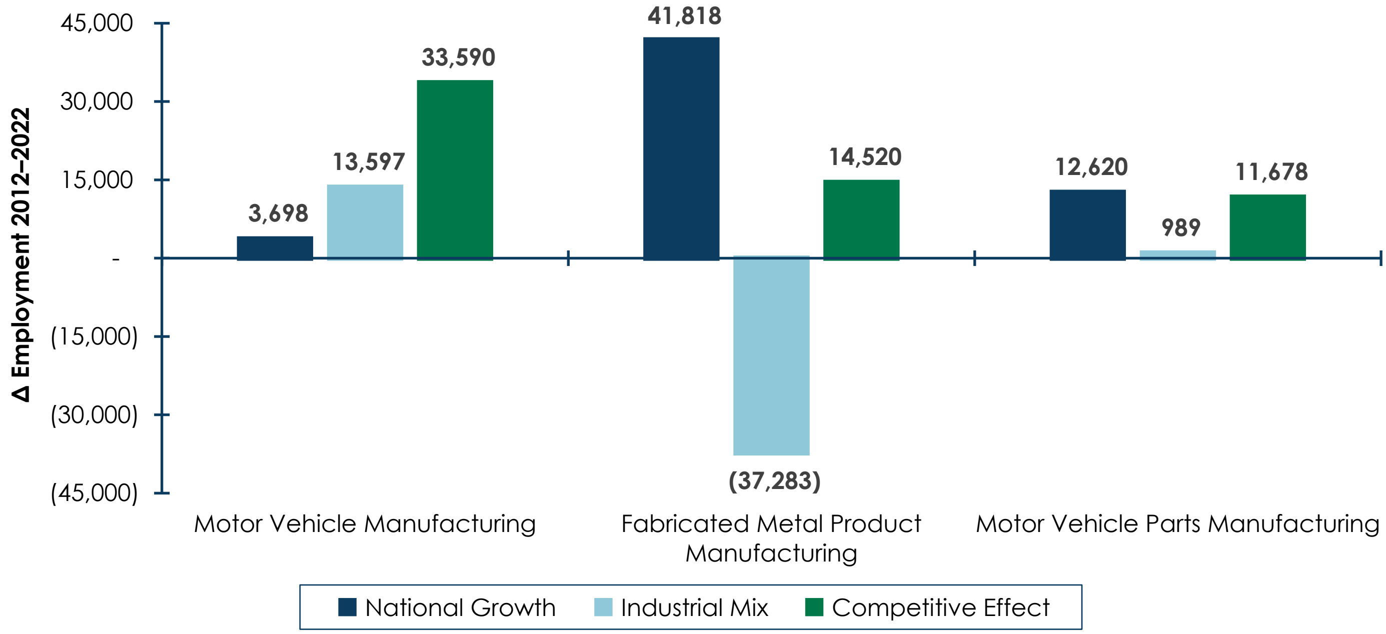
Freight-Intensive Industry	National Growth Share, %	National Growth Share, Jobs	Industrial Mix Share, %	Industrial Mix Share, Jobs	Competitive Share, %	Competitive Share, Jobs
Crop Production	12.9%	14,314	-12.1%	-13,411	-8.0%	-8,880
Animal Production and Aquaculture	12.9%	6,629	-1.4%	-706	-1.8%	-916
Forestry and Logging	12.9%	2,584	-20.8%	-4,151	10.5%	2,097
Oil and Gas Extraction	12.9%	14,304	-53.0%	-58,543	0.7%	793
Support Activities for Mining	12.9%	28,360	-46.2%	-101,124	4.2%	9,171
Construction	12.9%	229,245	23.8%	422,138	0.6%	10,563
Food Manufacturing	12.9%	48,428	2.8%	10,430	-2.6%	-9,692

Freight-Intensive Industry	National Growth Share, %	National Growth Share, Jobs	Industrial Mix Share, %	Industrial Mix Share, Jobs	Competitive Share, %	Competitive Share, Jobs
Beverage and Tobacco Product Manufacturing	12.9%	6,238	55.8%	26,876	-5.0%	-2,421
Textile Mills	12.9%	5,671	-31.3%	-13,687	4.0%	1,732
Textile Product Mills	12.9%	6,583	-22.3%	-11,324	1.0%	520
Apparel Manufacturing	12.9%	2,824	-50.5%	-11,018	18.8%	4,101
Leather and Allied Product Manufacturing	12.9%	1,081	-22.6%	-1,889	11.3%	942
Wood Product Manufacturing	12.9%	13,334	12.9%	13,266	2.8%	2,931
Paper Manufacturing	12.9%	13,313	-17.6%	-18,120	4.9%	5,030
Printing and Related Support Activities	12.9%	13,544	-30.8%	-32,211	1.6%	1,643
Petroleum and Coal Products Manufacturing	12.9%	6,015	-19.2%	-8,924	-0.8%	-364
Chemical Manufacturing (except Pharmaceutical and Medicine)	12.9%	23,132	-6.3%	-11,234	5.0%	8,899
Pharmaceutical and Medicine Manufacturing	12.9%	3,912	14.7%	4,448	32.9%	9,927
Plastics and Rubber Products Manufacturing	12.9%	19,563	2.8%	4,298	6.0%	9,103
Nonmetallic Mineral Product Manufacturing	12.9%	13,345	0.3%	318	7.0%	7,184
Primary Metal Manufacturing	12.9%	10,269	-21.7%	-17,233	10.9%	8,639
Fabricated Metal Product Manufacturing	12.9%	41,818	-11.5%	-37,283	4.5%	14,520
Machinery Manufacturing	12.9%	34,986	-12.4%	-33,435	1.6%	4,251

Freight-Intensive Industry	National Growth Share, %	National Growth Share, Jobs	Industrial Mix Share, %	Industrial Mix Share, Jobs	Competitive Share, %	Competitive Share, Jobs
Computer and Electronic Product Manufacturing	12.9%	24,489	-13.4%	-25,327	4.7%	8,842
Electrical Equipment, Appliance, and Component Manufacturing	12.9%	12,060	-4.3%	-4,025	7.9%	7,374
Motor Vehicle Manufacturing	12.9%	3,698	47.6%	13,597	117.6%	33,590
Motor Vehicle Body and Trailer Manufacturing	12.9%	3,496	20.9%	5,634	3.6%	983
Motor Vehicle Parts Manufacturing	12.9%	12,620	1.0%	989	12.0%	11,678
Aerospace Product and Parts Manufacturing	12.9%	15,952	-12.4%	-15,279	8.3%	10,280
Railroad Rolling Stock Manufacturing	12.9%	572	-29.4%	-1,298	0.1%	4
Ship and Boat Building	12.9%	10,626	5.6%	4,628	-9.8%	-8,040
Other Transportation Equipment Manufacturing	12.9%	1,037	11.2%	896	16.2%	1,297
Furniture and Related Product Manufacturing	12.9%	11,096	-5.5%	-4,730	4.4%	3,807
Miscellaneous Manufacturing (except Medical Equipment and Supplies)	12.9%	6,959	-4.8%	-2,577	14.2%	7,612
Medical Equipment and Supplies Manufacturing	12.9%	6,565	-4.3%	-2,202	11.2%	5,684

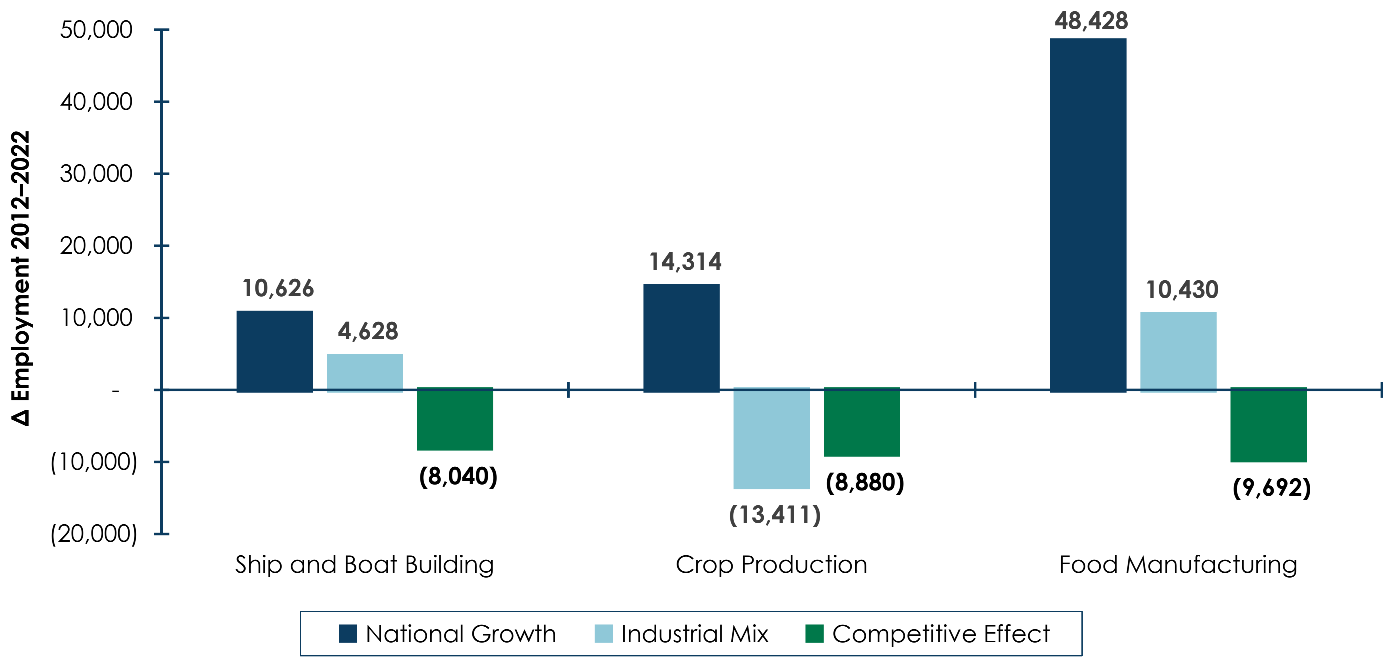
Source: U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages; Cambridge Systematics.

FIGURE 2 TOP-3 FREIGHT-INTENSIVE INDUSTRIES IN THE ITTS REGION BY SHIFT-SHARE COMPETITIVE EFFECT (NUMBER OF JOBS), 2012–2022



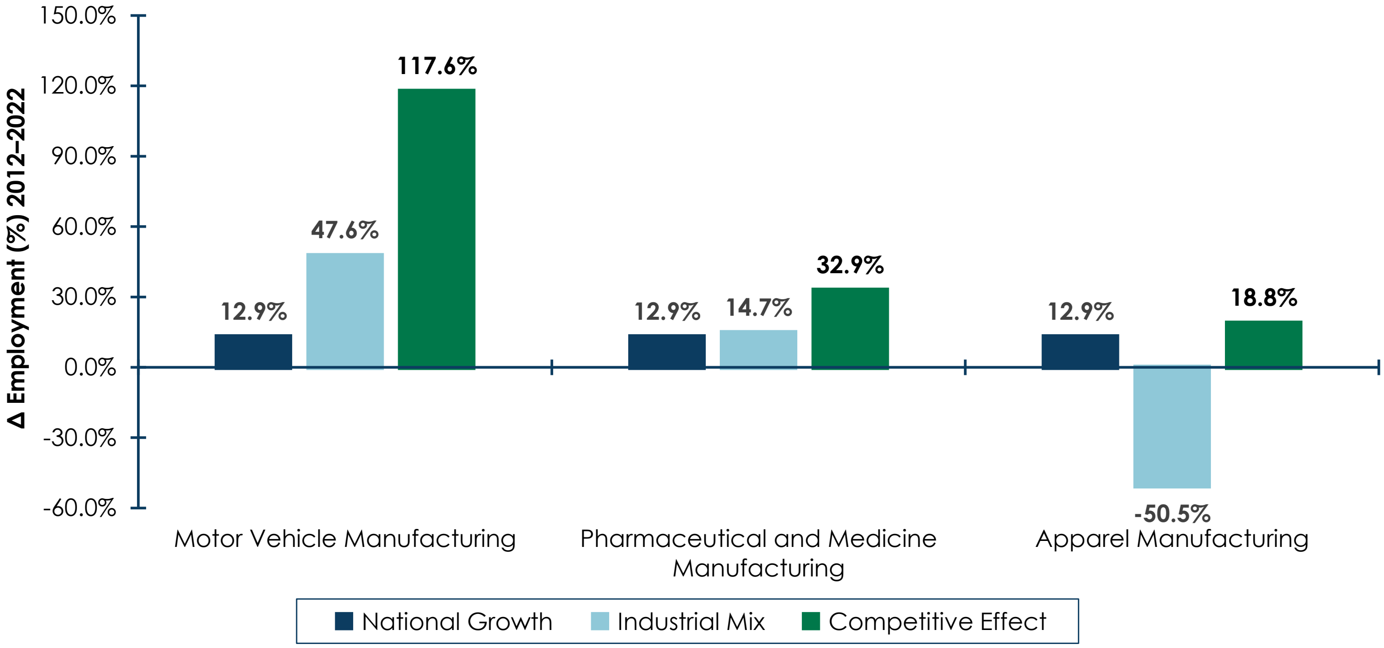
Source: U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages; Cambridge Systematics.

FIGURE 3 BOTTOM-3 FREIGHT-INTENSIVE INDUSTRIES IN THE ITTS REGION BY SHIFT-SHARE COMPETITIVE EFFECT (NUMBER OF JOBS), 2012–2022



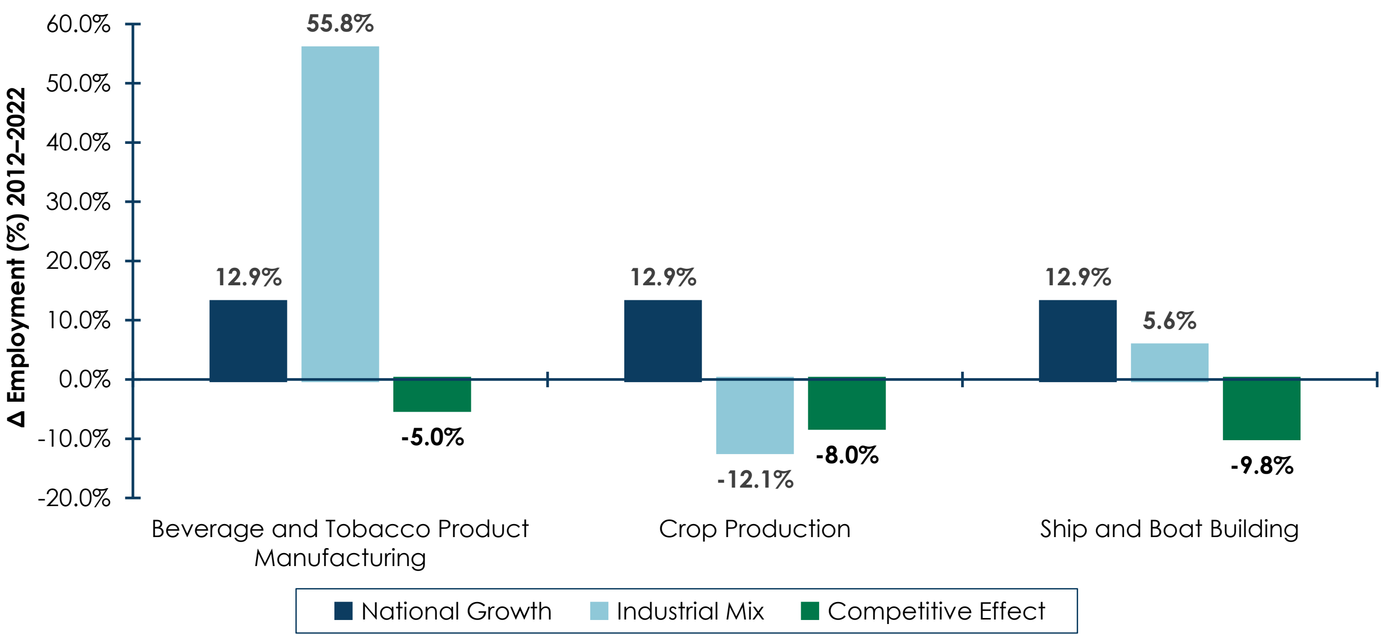
Source: U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages; Cambridge Systematics.

FIGURE 4 TOP-3 FREIGHT-INTENSIVE INDUSTRIES IN THE ITTS REGION BY SHIFT-SHARE COMPETITIVE EFFECT (PERCENTAGE GROWTH), 2012–2022



Source: U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages; Cambridge Systematics.

FIGURE 5 BOTTOM-3 FREIGHT-INTENSIVE INDUSTRIES IN THE ITTS REGION BY SHIFT-SHARE COMPETITIVE EFFECT (PERCENTAGE GROWTH), 2012–2022



Source: U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages; Cambridge Systematics.

2.2 Results

The results of the LQ and SS analyses were combined through industry classifications to offer a quick synopsis of individual industries, which is categorized in a matrix. Table 5 presents the ITTS region freight-intensive industry classification based on the combined results from the LQ and SS analyses. The industry classification is based on the LQ from 2022 shown in Table 2, and the results of the SS analysis that compares the ITTS economy relative to the U.S. economy over the 2012–2022 period shown in Table 4. The results indicate the following:

- **Opportunity Industries (17 out of 35)**

  Opportunity industries are those that are relatively less concentrated regionally as compared to the U.S. but have grown at a faster rate. They have an LQ less than 1.0, and a competitive share greater than zero. As a result, they may have greater potential for economic development efforts. Examples include Pharmaceutical and Medicine Manufacturing, Other Transportation Equipment Manufacturing, Motor Vehicle Parts Manufacturing, and Medical Equipment and Supplies Manufacturing, among others.

- **Strong Industries (12 out of 35)**

  Strong industries are those that are more concentrated in the ITTS region than in the U.S., yet still managed to grow faster at the regional level than the national level. They have an LQ greater than 1.0, and a competitive share greater than zero. These represent existing clusters with potential to grow and further strengthen the region's competitive position. Examples include Motor Vehicle Manufacturing and Chemical Manufacturing (except Pharmaceutical and Medicine).

- **Weaker Industries (4 out of 35)**

  Weaker industries are less concentrated within the ITTS region relative to the national level and have experienced less growth according to national-level indicators when conducting as implied by the SS analysis. They have an LQ less than 1.0, and a competitive share less than zero. As a result, the region's competitive position for these industries is not as strong as other locations in the U.S. Examples include Crop Production, Animal Production and Aquaculture, Food Manufacturing, and Beverage and Tobacco Product Manufacturing, among others.

- **Threatened Industries (2 out of 35)**

  Threatened industries define activities that are more concentrated regionally than at the national level but have grown less than expected by national-level factors as indicated by the SS results. They have an LQ greater than 1.0 and a competitive share less than zero. This industry might be considered at risk with potentially damaging impacts to the regional economy. Examples of threatened industries for the ITTS region include Ship and Boat Building and Petroleum and Coal Products Manufacturing.

TABLE 5 ITTS REGION FREIGHT-INTENSIVE INDUSTRY CLASSIFICATION BASED ON THE RESULTS FROM THE LQ AND SS ANALYSES COMPARED TO THE U.S., 2012–2022

Opportunity industries	Strong industries
• Pharmaceutical and Medicine Manufacturing • Apparel Manufacturing • Other Transportation Equipment Manufacturing • Miscellaneous Manufacturing (except Medical Equipment and Supplies) • Motor Vehicle Parts Manufacturing • Medical Equipment and Supplies Manufacturing • Primary Metal Manufacturing • Aerospace Product and Parts Manufacturing • Electrical Equipment, Appliance, and Component Manufacturing • Plastics and Rubber Products Manufacturing • Computer and Electronic Product Manufacturing • Fabricated Metal Product Manufacturing • Furniture and Related Product Manufacturing • Motor Vehicle Body and Trailer Manufacturing • Machinery Manufacturing • Printing and Related Support Activities • Railroad Rolling Stock Manufacturing	• Motor Vehicle Manufacturing • Leather and Allied Product Manufacturing • Forestry and Logging • Nonmetallic Mineral Product Manufacturing • Chemical Manufacturing (except Pharmaceutical and Medicine) • Paper Manufacturing • Support Activities for Mining • Textile Mills • Wood Product Manufacturing • Textile Product Mills • Oil and Gas Extraction • Construction
Weaker industries	**Threatened industries**
• Animal Production and Aquaculture • Food Manufacturing • Beverage and Tobacco Product Manufacturing • Crop Production	• Petroleum and Coal Products Manufacturing • Ship and Boat Building

Source: U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages; Cambridge Systematics.

3 ANALYSIS OF KEY INDUSTRY SUPPLY CHAINS

The results of the freight industry concentration and growth analysis performed in Section 2.0 indicate that there are multiple industries on which the ITTS region may choose to focus when considering strategies for strengthening its trade position. The "opportunity" industries are natural candidates for increased focus as they represent industries where the ITTS region already has a relatively strong competitive position that could be made stronger. On the other hand, "threatened" industries are also potential candidates as they represent industries where the region is currently competitive but has been trending towards a weaker position.

In addition to the freight industry concentration and growth analysis results, findings from SETTS Phase I and a review of ITTS state freight plans (SFP) also suggests industries on which to focus trade growth opportunities. Of the 10-member state SFPs, seven different states included supply chain analyses for the manufacturing, transportation and warehousing, and construction industry sectors. Half of the member states also include agriculture as a focus industry of their supply chain analyses.

The following industries were selected for an analysis of their supply chains with an eye towards opportunities for increasing the region's trade in goods related to those supply chains:

- Food Manufacturing;
- Plastics and Rubber Manufacturing;
- Motor Vehicle Manufacturing;
- Pharmaceutical and Medicine Manufacturing;
- Aerospace Product and Parts Manufacturing; and
- Computer and Electronic Product Manufacturing.

In support of the goal of strengthening domestic and international trade associated with the focus industries, the remainder of this section of the report develops an analysis of the supply chains for the selected industries. An important element of the supply chain analysis is *freight fluidity*. "Freight fluidity" is a broad term referring to the characteristics of a multimodal freight network in a geographic area of interest, where any number of specific modal data elements and performance measures are used to describe the network performance (including costs and resiliency) and quantity of freight moved (including commodity value) to inform decisionmaking."[3] Corridors that are able to transport relatively high volumes of freight and exhibit good network performance are more "fluid" than those that transport comparatively lower volumes of freight and exhibit poor network performance.

3.1 Food Manufacturing

3.1.1 Industry Overview

Businesses in the food manufacturing industries subsector transform livestock and agricultural products into products for intermediate or final consumption.[4] The industry groups are distinguished by the raw materials (generally of animal or vegetable origin) processed into food products. Goods produced by food manufacturers are typically sold to wholesalers or retailers for distribution to consumers. This also includes establishments primarily engaged in retailing bakery and candy products that are not for immediate consumption.

The food manufacturing sector is important for economic development across the ITTS region. For example, Arkansas and Georgia are among the largest poultry producers in the nation.[5] Because much of the ITTS region lines the Gulf and Atlantic Coasts, it generates a substantial share of the Nation's seafood production and value.[6] As a result, establishments engaged in preparing seafood products are prevalent throughout ITTS coastal states such as Texas, Mississippi, and Florida. Data from the Bureau of Labor Statistics indicates that there were over 423,000 jobs in the food manufacturing sector in the ITTS region in 2022. In addition, the gross domestic product (GDP) contributed by the food manufacturing industry to ITTS states has generally increased since 2017.[7] Notably, Arkansas and Texas have experienced GDP growth from this industry of 25 and 32 percent, respectively.

As shown in Figure 6, nearly 372 million tons of commodities related to the food manufacturing industry—meat/seafood, milled grain products, other prepared foodstuffs, and alcoholic beverages—were transported into, out of, or within the ITTS region in 2022. Illinois and Iowa contributed the highest tonnage of inbound flows to the region—14.9 and 9.3 percent, respectively. Illinois and California received the highest tonnage of food manufacturing goods from the region—15.3 and 9 percent, respectively.

[3] https://cattworks.org/projects/freight-fluidity/.

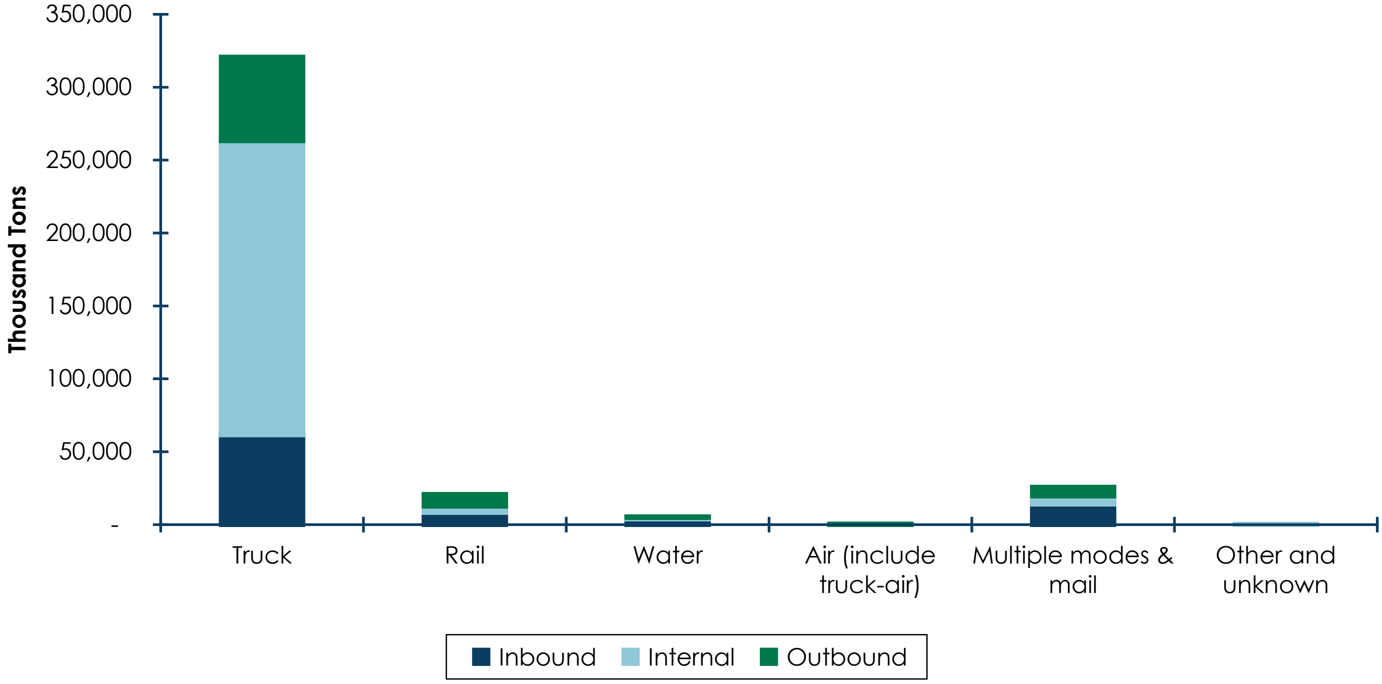
[4] https://www.bls.gov/iag/tgs/iag311.htm.

[5] https://www.nass.usda.gov/Charts_and_Maps/Poultry/brlmap.php.

[6] https://www.fisheries.noaa.gov/national/sustainable-fisheries/fisheries-united-states.

[7] U.S. Bureau of Economic Analysis, "SAGDP9N Real GDP by state 1" (accessed Thursday, September 12, 2024).

FIGURE 6 FOOD MANUFACTURING COMMODITIES BY DIRECTION, 2022

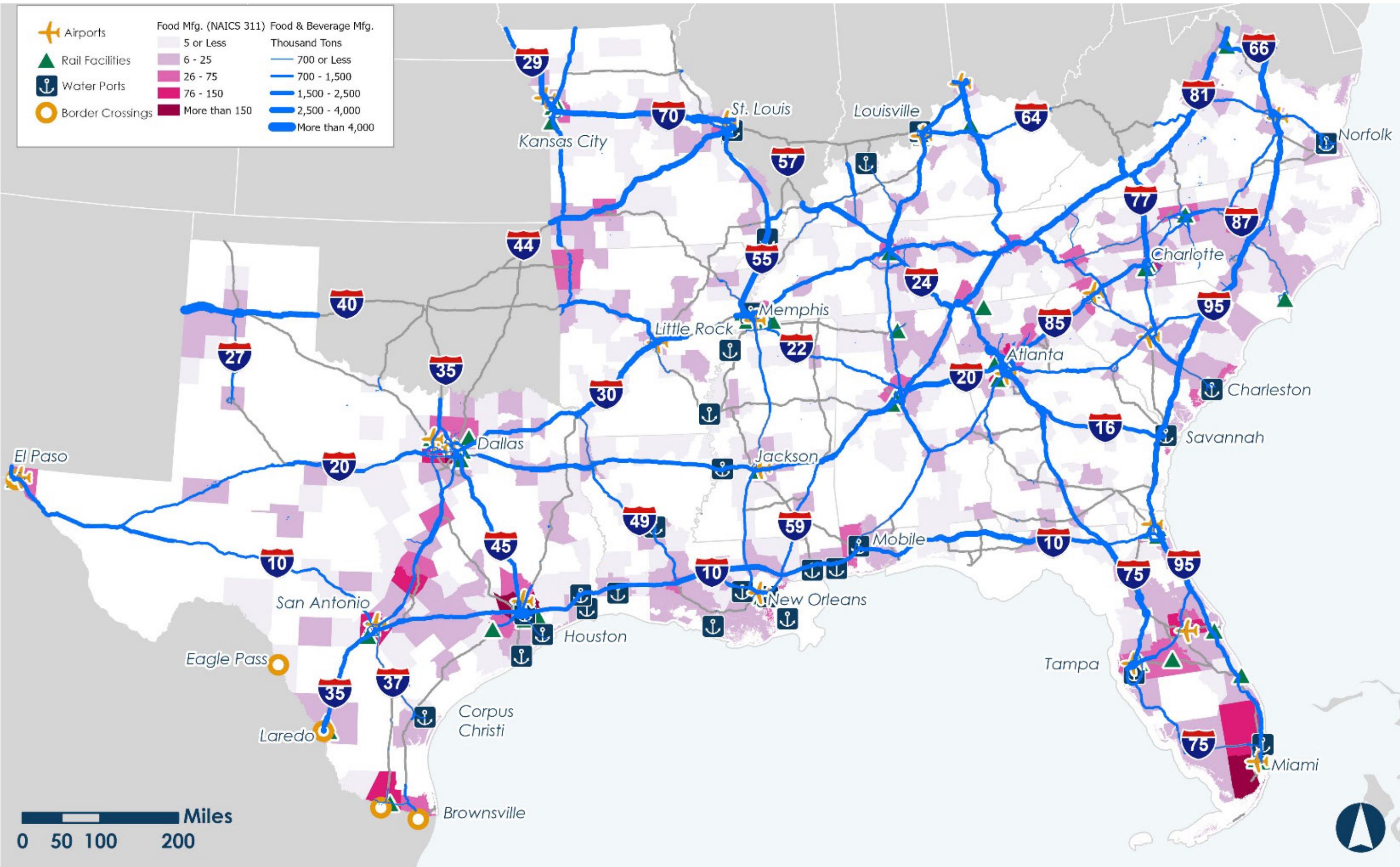


Source: Federal Highway Administration, Freight Analysis Framework version 5.5.1; Cambridge Systematics.

Figure 7 shows the network level flows of food and beverage commodities across the ITTS region's highways.[8] It also shows the locations of businesses in the food manufacturing sector (NAICS 311) using the U.S. Census Bureau's County Business Patterns database. The results in Figure 7 indicate that food manufacturers are generally clustered in the region's metropolitan areas and along major interstate corridors such as I-95, I-40, and I-65, among others.

[8] Note that the commodity flows shown are limited to the predefined commodity groupings available at the network level from the FAF5. In this case, food and beverage commodities include SCTG 06, 07, 08, and 09 commodity codes.

FIGURE 7 FOOD MANUFACTURING BUSINESSES AND FOOD AND BEVERAGE COMMODITY FLOWS, 2022



Source: Federal Highway Administration, Freight Analysis Framework version 5.5.1; U.S. Census Bureau, County Business Patterns; Cambridge Systematics.

3.1.2 Supply Chain Overview and Block Diagrams

The food and agriculture supply chain includes a wide range of natural and processed materials. Each manufacturer, distributor, grower, commodity, and good within the food and agriculture industry could have its own supply chain diagram. The below description and diagram are intended to provide a general overview and starting point of the supply chain for food and agriculture in the subject states.

Most goods within food and agriculture begin with a naturally grown product, such as tobacco, grain, or livestock. The paths these products take to their destinations vary greatly, with some products only processed minimally before consumption and others heavily processed as inputs into clothing, furniture, or more advanced food and beverages.

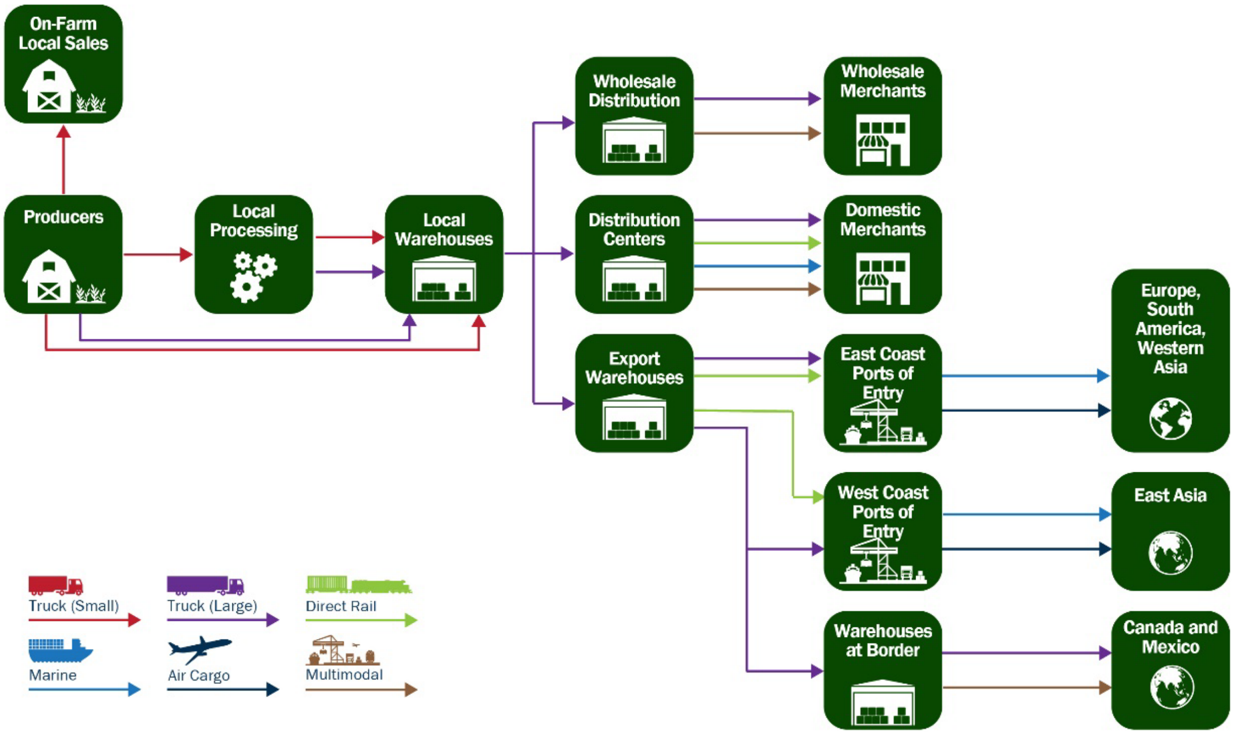
The most basic element of the supply chain is raw materials. These raw materials begin with Producers (see Figure 8). Some raw foods and beverages are sold on-site or at farmers markets as On-Farm Local Sales. More often, these raw materials are transported by small truck for Local Processing or directly to Local Warehouses for storage. The same raw material can be used for various products requiring a great range of processing and other inputs. For example, milk can be sold locally or sold as inputs into a variety of other products that require additional inputs from around the world. Depending on the commodity, Local Processing can include several intermediate steps, requiring transport by small and large truck between sites. Transport from Producers to Local Warehouses and from Local Processing to Local Warehouses can be completed by either small or large truck. Large producers are more likely to use large trucks.

From Local Warehouses, goods can be brought by large truck to regional Wholesale Distribution, Distribution Centers, or Export Warehouses. From Wholesale Distribution, goods are transported domestically by either Large Truck or Multimodal to Wholesale Merchants. From Distribution Centers, goods are brought domestically by large truck, multimodal, marine, or direct rail to Domestic Merchants. Domestic marine transports vary from state to state, with some states having little or no domestic marine goods movement. Raw and processed food products can have short expiration periods, requiring a quick turnaround for local usage. Other goods with longer or no expiry date can more easily be transported internationally.

Specific goods within the food and agriculture group display varying trends and relationships with nations around the world. Some goods stay mainly within the United States, while Mexico, Canada, China, and Japan are prime destinations for other commodities grown in the southeastern United States. Within the southeastern United States, demand for goods movement with Mexico varies by good and state. According to 2023 Freight Analysis Framework (FAF) data, a significant amount of Other Agricultural Products, Milled Grain Products, Other Foodstuffs, and Alcoholic Beverages are exported from Texas to Mexico, while other states and goods have little or no tonnage moved to Mexico.

From Export Warehouses, goods are brought by direct rail or large truck to East Coast Ports of Entry, direct rail or large truck to West Coast Ports of Entry, or by large truck to Warehouses at the national border. East Coast and West Coast ports of entry include both seaports and international airports. Some of the country's largest airports and seaports for goods movement are in the southeastern United States, including Atlanta-Hartsfield International Airport and the Port of Savannah. From East Coast Ports of Entry, goods are shipped via air or marine to Europe, South America, and Western Asia (i.e., India, Pakistan, etc.). From West Coast Ports of Entry, goods are shipped via air or marine to East Asia (i.e., China, Japan, etc.). From Warehouses at the Border, goods are shipped via large truck or multimodal to Canada and Mexico.

FIGURE 8 FOOD MANUFACTURING BLOCK DIAGRAM



Source: WSP Global.

3.1.3 Fluidity, Critical Infrastructure, and Supply Chain Issues and Challenges

Figure 9 and Figure 10 depict the travel time reliability and delay performance of a selection of key highways along with food manufacturing commodity flows for the ITTS region. Visualizing the commodity flows in conjunction with travel time performance on these key corridors provides an indication of supply chain fluidity. Food manufacturing commodity flows are heaviest on I-10 as well as portions of I-75 (through north Georgia and Tennessee) and I-95. These flows coincide with some of the region's most pronounced reliability and travel time delay challenges. More specifically:

- **I-75 between Atlanta and Knoxville.** Up to 5.9 million tons of food and beverage related commodities are transported annually along the I-75 corridor. It links food manufacturing hubs in Metro Atlanta, Chattanooga, and Knoxville as indicated by the industry location data. The critical multimodal connections along this corridor are primarily located in Metro Atlanta (i.e., Hartsfield-Jackson Atlanta International Airport and multiple rail intermodal terminals) but also include the Georgia Port Authority's Appalachian Regional Port. Furthermore, it connects with the I-81 corridor which also has substantial volumes of food manufacturing related goods. Both travel time reliability and delay are elevated on this corridor indicating less supply chain fluidity.

- **I-95 between Jacksonville and Washington, D.C.** Portions of this corridor carry over 4 million tons of food and beverage related commodities annually. It links food manufacturing hubs throughout the Southeast with population centers in the Mid-Atlantic and Northeast. Critical multimodal connections along this corridor include the Port of Jacksonville, Port of Savannah, and Port of Charleston as well as multiple international airports and rail intermodal terminals. In particular, the Port of Savannah is one of the largest U.S. ports for agricultural trade. As such, it is a critical multimodal link in the food manufacturing supply chain.

- **I-10 between San Antonio and New Orleans.** Much of I-10 through Texas has relatively high buffer time index and delay values, indicating worse performance. This corridor carries 1.2 to 3.6 million tons of food manufacturing-related goods on an annual basis. Notably, there are also multiple ports within this corridor that are integral for agricultural and food manufacturing trade—namely the Ports of Houston and New Orleans.

- **I-44 in Missouri.** Over 5.5 million tons of food and beverage related commodities are transported annually along the I-44 corridor. It links food manufacturing hubs in Missouri (i.e., St. Louis and Joplin areas) to those in Arkansas (e.g., Bentonville and Fayetteville), as indicated by the industry location data. Also, the I-44 corridor encompasses key multimodal connections in St. Louis, namely the St. Louis International Airport, intermodal rail terminals (BNSF, CSX, and NS), and Mississippi River port facilities.

- **I-81 between Knoxville and Virginia State Line.** The I-81 corridor is one of the busiest corridors for food manufacturing related goods. Over 7.5 million tons of food manufacturing-related goods are transported annually on this corridor. Though the industry location does not indicate the presence of significant food manufacturing hubs directly along the I-81 corridor, it does connect hubs in western ITTS states (i.e., Mississippi, Arkansas, Louisiana, and Texas) with large consumer markets in the Mid-Atlantic and Northeast.

FIGURE 9 FOOD MANUFACTURING SUPPLY CHAIN FLUIDITY—RELIABILITY

Source: National Performance Management Research Data Set; Texas A&M Transportation Institute; WSP Global; Cambridge Systematics.

FIGURE 10 FOOD MANUFACTURING SUPPLY CHAIN FLUIDITY—DELAY

Source: National Performance Management Research Data Set; Texas A&M Transportation Institute; WSP Global; Cambridge Systematics.

3.1.4 Positioning the Region to Grow

Food manufacturing and related industries, namely agriculture, are some of the largest industries across the ITTS region. As a result, the transport of food and farm goods over the multimodal freight network is essential to the economies of multiple ITTS member states. However, the freight industry concentration and growth analysis found that these are "weaker" industries for the region. Weaker industries are less concentrated at the regional level than at the national level and have grown less than expected when compared to national-level trends.

One consideration for increasing the region's competitiveness is to improve the network level performance for export gateways and the multimodal links (i.e., highway, rail) that provide access to them. The perishability of farm and food manufacturing products makes them particularly sensitive to travel time delays and unreliability. Anecdotally, an hour of delay is equivalent to the loss of a day in freshness for produce. Globally, about 14 percent of the world's food (valued at more than $14 billion) is lost between harvest and the retail market.[9] The fluidity analysis revealed that highway links providing access to critical food and agricultural trade

[9] Food loss and waste | Nutrition | Food and Agriculture Organization of the United Nations (fao.org).

gateways—such as the Ports of Houston, New Orleans, Savannah, and Virginia—experience relatively high levels of delay and unreliability. Strategies that are focused on reducing the risks associated with the harvest-to-gateway link in the supply chain could help to improve the region's competitive position. While reducing highway travel time delays would be a key component of such a strategy, improving access to alternative modes would also be an important factor. For example, railroads carry more than 60,000 carloads of food and agriculture products per week.[10] This includes fresh fruits and vegetables, meat, and poultry transported via refrigerated rail cars. Rail could serve as an alternative mode for the ITTS region's food manufacturing industry with improved access.

3.2 Plastics and Rubber Manufacturing

3.2.1 Industry Overview

The plastics and rubber products manufacturing industry make goods by processing plastics materials and raw rubber.[11] The industry consists of two subsectors: plastics manufacturing and rubber manufacturing. These industries have largely different production processes, but the two are grouped together because plastics increasingly are used as a substitute for rubber due to advances in materials technology.[12] Natural rubber is derived from rubber trees, primarily grown in tropical regions of the world. The U.S. relies entirely on imports for natural rubber. Natural rubber is often blended with synthetic rubber materials, which are also known as synthetic polymers or elastomers. Synthetic rubbers can in some cases completely replace natural rubber. The plastics industry produces a variety of intermediated and finished goods including plastic films, sheets, bags, pipes and pipe fittings, laminates, foam products and bottles as well as plumbing fixtures. The rubber products industry includes the processing of rubber into intermediate or final products such as tires, inner tubes, and rubber hoses and belting.

In the ITTS region, the plastics and rubber products manufacturing industry was responsible for over 184,000 jobs in 2022. This is an increase of about 22 percent compared to 2012 employment. However, the GDP contributed by the plastics and rubber products manufacturing industry to ITTS states has generally decreased since 2017. Notably, Florida and Louisiana have experienced GDP growth from this industry of 9 and 12 percent, respectively.[13]

As shown in Figure 11, over 161.3 million tons of commodities related to the plastics and rubber manufacturing industry (i.e., SCTG 24—plastics and rubber) were transported into, out of, or within the ITTS region in 2022. Rail intermodal (i.e., multiple modes and mail) plays a significant role in this supply chain as it accounted for nearly 25 percent of total tonnage. Illinois and California contributed the highest tonnage of inbound flows to the region at approximately 10.2 percent each of total inbound flows. Tennessee received the highest tonnage of plastics and rubber manufacturing goods from the region at about 9.3 percent of all outbound flows.

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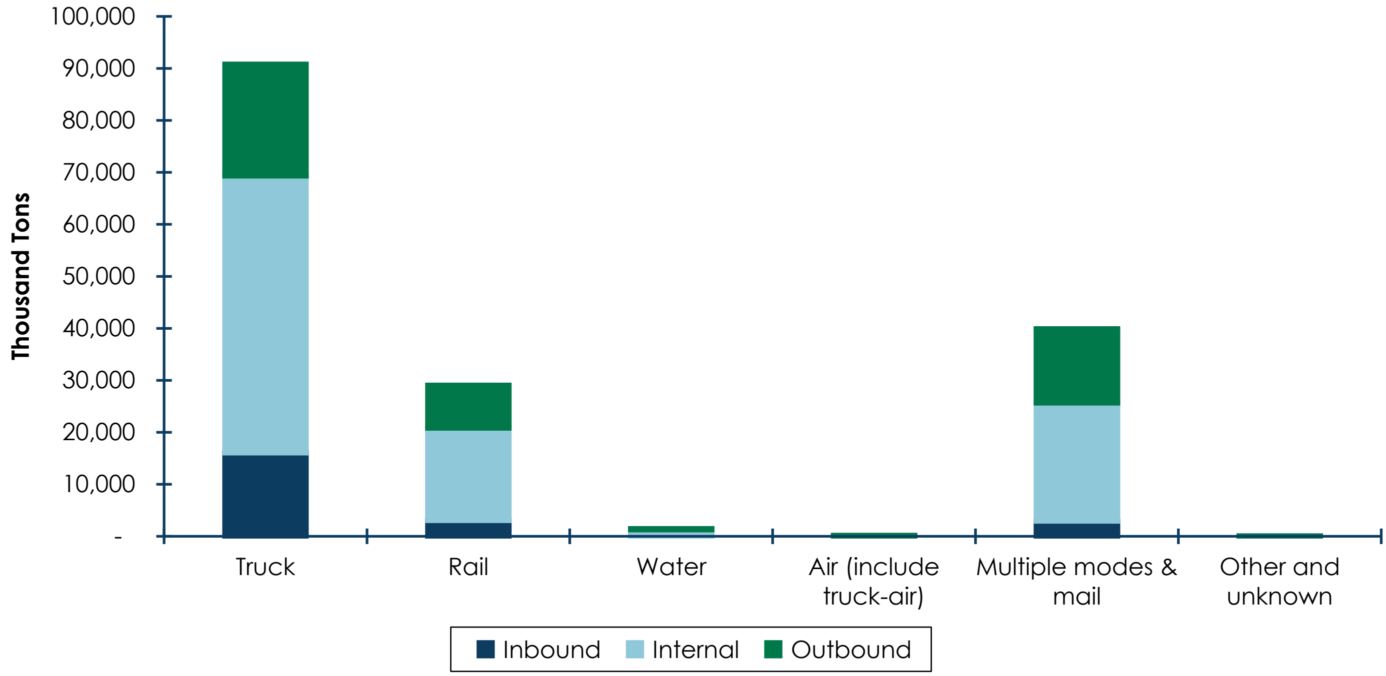
[10] American Association of Railroads, "Food and Agriculture Fact Sheet," https://www.aar.org/wp-content/uploads/2020/07/AAR-Food-Farm-Fact-Sheet.pdf, Accessed 9/12/2024.

[11] https://www.bls.gov/iag/tgs/iag326.htm.

[12] https://comptroller.texas.gov/economy/economic-data/manufacturing/2016/naics326-overview.php.

[13] U.S. Bureau of Economic Analysis, "SAGDP9N Real GDP by state 1" (accessed Thursday, September 12, 2024).

FIGURE 11 PLASTICS AND RUBBER COMMODITIES BY DIRECTION, 2022

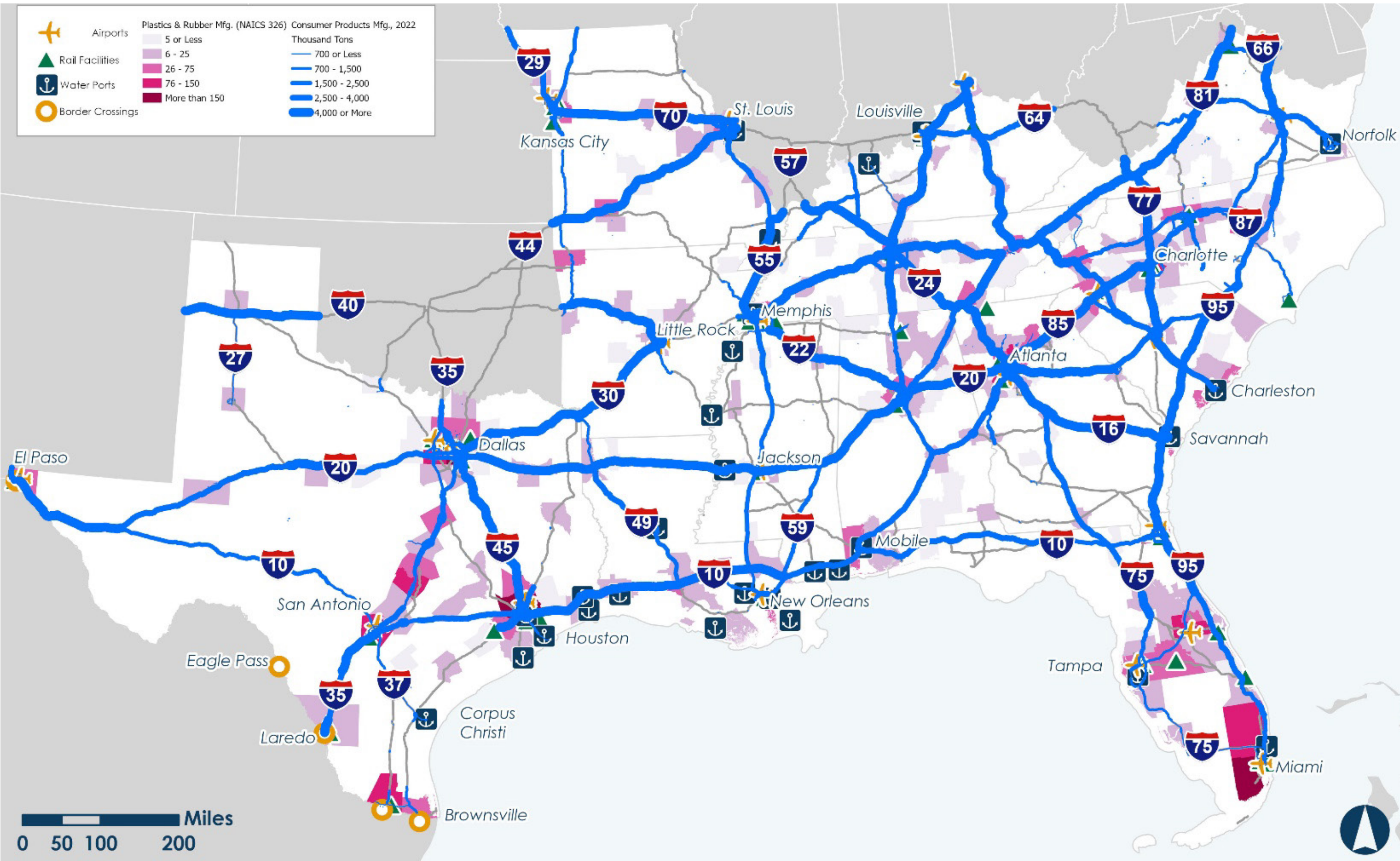


Source: Federal Highway Administration, Freight Analysis Framework version 5.5.1; Cambridge Systematics.

Figure 12 shows the network level flows of consumer manufacturing commodities across the ITTS region's highways.[14] It also shows the locations of businesses in the plastics and rubber manufacturing sector (NAICS 326) using the U.S. Census Bureau's County Business Patterns database. The results in Figure 12 indicate that plastics and rubber manufacturers are generally clustered in a handful of metropolitan region across the ITTS—namely the Texas Triangle (i.e., Austin, Houston, Dallas-Ft. Worth, San Antonio), Central Florida (i.e., Tampa and Orlando), Miami-Ft. Lauderdale, Metro Atlanta, Greenville-Spartanburg, and Metro Charlotte.

[14] Note that the commodity flows shown are limited to the predefined commodity groupings available at the network level from the FAF5. In this case, consumer and manufacturing commodities include chemical products (SCTG23), plastics/rubber (SCTG24), wood products (SCTG26), newsprint/paper (SCTG27), paper articles (SCTG28), printed products (SCTG29), and textiles/leather (SCTG30).

FIGURE 12 PLASTICS AND RUBBER MANUFACTURING BUSINESSES AND CONSUMER MANUFACTURING COMMODITY FLOWS, 2022



Source: Federal Highway Administration, Freight Analysis Framework version 5.5.1; U.S. Census Bureau, County Business Patterns; Cambridge Systematics.

3.2.2 Supply Chain Overview and Block Diagrams

The plastics supply chain is integrated deeply with the oil and gas industries, as byproducts of oil and gas refining serve as the base inputs of plastic and synthetic rubber products. Given that the ITTS states lead the Nation in oil and gas extraction, refinement, and distribution, they necessarily also lead in plastics manufacturing. The below description and diagram are intended to provide a general overview and starting point of the supply chain for plastics and rubber manufacturing in the ITTS states.

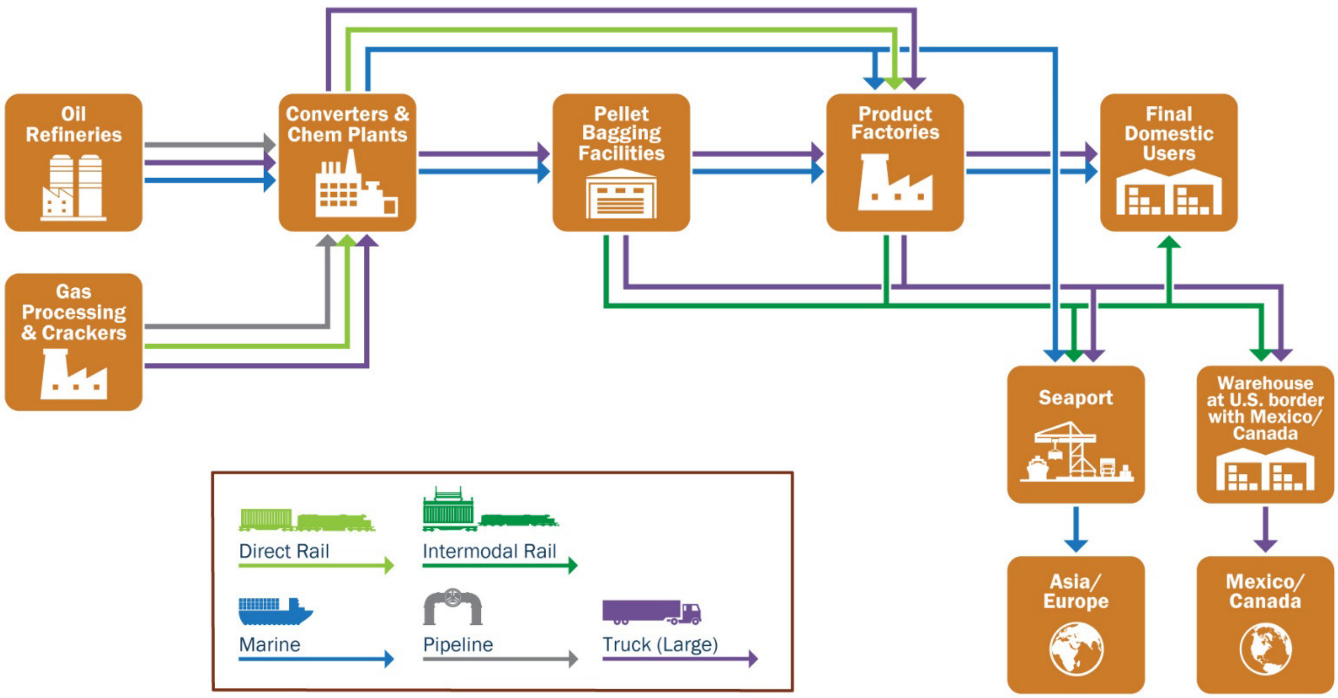
Plastic manufacturing is a multi-step process that begins with the extraction and refinement of raw materials, typically derived from fossil fuels like crude oil or natural gas. This activity takes place at gas cracker plants. A gas cracker plant, also known as an ethylene cracker or steam cracker, is a facility used in the petrochemical industry to break down larger hydrocarbon molecules, typically obtained from natural gas or crude oil, into smaller molecules such as ethylene, propylene, and other basic building blocks of the chemical industry. The monomers serve as the foundation for various types of plastics. Through polymerization, monomers are chemically bonded together to form long chains known as polymers. The specific arrangement of these polymers, as well as the addition of additives such as plasticizers, fillers, and colorants, determines the properties and characteristics of the final plastic product. Cracker facilities are often strategically located near sources of natural gas or crude oil feedstocks and integrated with other downstream chemical processing units to optimize production efficiency and logistics.

Once polymers are synthesized, they undergo further processing in manufacturing facilities. This often involves melting the polymer resin and shaping it into the desired form using techniques like injection molding, extrusion, blow molding, or compression molding. After shaping, the plastic components may undergo additional finishing processes such as machining, assembly, or surface treatment before being packaged and distributed for use in various industries.

In terms of transportation of the components of the plastics and rubber manufacturing supply chain, mode of transport can vary depending on the weight and volume of the materials as well as the stage of the chain. As shown in the supply chain diagram below, the transport modes are as follows:

- **Pipeline—**In earlier stages of the supply chain, pipelines are used to transport liquid plastic inputs such as ethylene or propylene from petrochemical refineries or gas processing plants directly to manufacturing facilities. This method is highly efficient for continuous transportation over long distances and minimizes the need for intermediate handling and packaging.
- **Trucking—**Many plastic inputs are transported via truck, especially for shorter distances or when the volume of materials is smaller than what would otherwise more economically be moved by rail. Trucks provide flexibility in delivery schedules and can access a wide range of locations, including factories located in urban or remote areas.
- **Rail—**Both direct rail and intermodal rail transport is often used for transporting large volumes of plastic inputs over longer distances. Rail transport is particularly efficient for bulk shipments and can offer cost-effective transportation solutions, especially for factories located near rail lines or terminals.
- **Maritime—**For factories located near coastal regions or ports, maritime transport is a common method for importing and exporting plastic inputs from and to overseas suppliers and receivers. Large cargo ships can transport massive quantities of materials in containers or bulk shipments to ports, where they are unloaded and further transported by truck or rail to the factory.

FIGURE 13 PLASTICS AND RUBBER BLOCK DIAGRAM



Source: WSP Global.

3.2.3 Fluidity, Critical Infrastructure, and Supply Chain Issues and Challenges

As indicated by the commodity flow data for consumer products and chemicals, some of the highest levels of activity associated with the plastics and rubber manufacturing supply chain occurs on the following corridors.

- **I-10 between Houston and New Orleans.** The I-10 corridor along the Gulf Coast is essential to chemical manufacturing that supports the plastics and rubber supply chain. This segment handles approximately 10 million tons of chemical products annually, and the corridor connects the ports of Texas City, Houston, Galveston, Freeport, Beaumont, Port Arthur, Lake Charles, South Louisiana, Baton Rouge, New Orleans, and more. The surrounding area is home to most of the Nation's refining capacity, and private terminals handle additional input materials outside of reported marine port data. This segment of I-10 is the least reliable of the I-10 corridor, with a buffer time index between 12–14 percent.

- **I-40 between Knoxville and Arkansas-Oklahoma State Line.** Over 10 million tons of consumer products—the outputs of the plastics and rubber supply chain—are transported on I-40 in Arkansas and Tennessee. In addition to serving population and distribution clusters in Little Rock, Memphis, Nashville, and Knoxville, it is a central east-west connection for the region that provides connectivity to Dallas-Fort Worth via I-30, St. Louis via I-55, Louisville via I-65, Atlanta via I-75, and the northeast via I-81. The plastics, rubber, and consumer products moving on I-40 are destined for industry and population centers throughout the ITTS region.

- **I-81 between Knoxville and Virginia-Maryland State Line.** Nearly 13 million tons of consumer products are transported on I-81 in Virginia annually. This corridor connects to I-40 and I-75 in Knoxville, extending connectivity between major consumer markets and ports in the northeast and the rest of the ITTS region. Specifically, the corridor is a significant connection to distribution hubs in Nashville, Memphis, and Dallas-Fort Worth where airports and rail intermodal facilities are located. The Port of Virginia (Norfolk) is less than 200 miles from I-81 via I-64.

- **I-65 in Tennessee and Kentucky.** Nearly 12 million tons of consumer products are transported by I-65 in Kentucky, and more than 7.5 million tons are transported by I-65 in Tennessee. These two states are critical distribution points for the southeast and the Nation due to the location of the UPS Worldport in Louisville, access to rail intermodal facilities along the corridor between Louisville and Birmingham, Alabama. The corridor parallels the I-55 corridor and the Mississippi River where additional highway, rail, marine, and air facilities are located.

FIGURE 14 PLASTICS AND RUBBER MANUFACTURING SUPPLY CHAIN FLUIDITY—RELIABILITY

Source: National Performance Management Research Data Set; Texas A&M Transportation Institute; WSP Global; Cambridge Systematics.

FIGURE 15 PLASTICS AND RUBBER MANUFACTURING SUPPLY CHAIN FLUIDITY—DELAY

Source: National Performance Management Research Data Set; Texas A&M Transportation Institute; WSP Global; Cambridge Systematics.

3.2.4 Positioning the Region to Grow

Plastics and rubber manufacturing was identified as an opportunity industry as part of the freight industry concentration and growth analysis. Opportunity industries are those that are relatively less concentrated regionally as compared to the U.S. but have grown at a faster rate. This implies that as an opportunity industry, plastics and rubber manufacturing has potential for growth and may be amenable to strategic investments in the links and nodes that support this industry's supply chain.

As observed in Section 3.2.2, the plastics and rubber supply chain is integrated deeply with the oil and gas industries as byproducts of oil and gas refining serve as the base inputs of plastic and synthetic rubber products. This implies that addressing transportation challenges on the components of the region's multimodal freight network that connect to its oil and gas producing states and the metropolitan regions in which plastics/rubber manufacturing is concentrated—the Texas Triangle (i.e., Austin, Houston, Dallas-Ft. Worth, San Antonio), Central Florida (i.e., Tampa and Orlando), Miami-Ft. Lauderdale, Metro Atlanta, Greenville-Spartanburg, and Metro Charlotte as shown in Figure 12—are critical for positioning the region for growth.

A 2016 study from the Texas A&M Transportation Institute (TTI) identified some of the transportation issues impacting plastic resins export supply chains which are relevant for the broader plastics/rubber industry and the ITTS region.[15] These included:

- **Captive Rail.** Rail is a key component of the plastics/rubber supply chain, particularly for exports. Plastics/ rubber rely on rail for a significant portion of its supply chain due to the bulk nature of the product. This is reflected in the FAF5 data as some of the region's highest rail intermodal flows are attributed to plastics/ rubber commodities.[16] As a result, any increases in rail rates increase the cost of exporting plastic resin.

- **Rail Capacity.** Related to the challenge of plastics/rubber reliance on rail, these commodities are also sensitive to rail capacity shortages. Strategic investments in sidings and yard capacity can mitigate this challenge.

- **Trucking Challenges—Labor, Overweight/Oversize Regulations, and Last-Mile Congestion.** Despite its dependence on rail, a significant share of plastics/rubber commodities are moved by truck. The trucking industry is challenged by high driver turnover and low retention which translates to less service availability for customers (including the plastics/rubber industry) at higher rates. Furthermore, due to their bulk nature plastics/rubber commodities tend to "weight out" as opposed to "cube out" when transported by truck, meaning that these shipments reach the gross vehicle weight limit for trucks (i.e., 80,000 lbs. per Federal regulations) though the truck still has space available for more goods. As a result, plastics/rubber commodities that are being exported must be transloaded to oceangoing containers with higher weight capacities as opposed to being loaded directly onto the vessel. This increases the cost of the supply chain and decreases its fluidity.

  Additionally, plastics/rubber commodities are exposed to the same types of last-mile challenges as other goods—including at-grade rail crossings, commuter congestion, and others. The identification and development of multi-state heavy-haul corridors where trucks may exceed Federal gross vehicle weight limits is one option for improving the fluidity of this supply chain and positioning the region for growth. Also, member states can further position the region for growth by improving operations at at-grade rail crossings (and where possible separating highway-rail crossings) along corridors that provide access to ports.

- **Port Capacity.** Several of the member states' ports that handle plastics/rubber exports have experienced significant growth in recent years—including Houston, Freeport, and Savannah, among others. Enhancing capacity at the region's ports is essential to improving the fluidity of the plastics/rubber supply chain and positioning the region for growth.[17,18] For exports, ITTS ports operate at a disadvantage to West Coast ports as those ports have more frequent service to China and other Asian nations which are large consumers of plastics/rubber commodities. Improving capacity at ITTS ports helps to mitigate this disadvantage.

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[15] Prozzi, J. and M. Kenney. *Moving Texas Exports: Examining the role of transportation in the plastic resin export supply chain*. March 2016. https://static.tti.tamu.edu/tti.tamu.edu/documents/TTI-2016-5.pdf.

[16] Note that the FAF5 includes rail intermodal the "Multiple Modes and Mail" mode.

[17] Ibid.

[18] https://gaports.com/blog/port-of-savannah-doubles-plastic-resin-exports/.

Beyond the types of infrastructure investments just discussed, policies and actions that encourage the growth and development of emerging industries that are consumers of plastics and rubber would overall bolster the industry. For example, SETTS Phase I identified additive and distributive manufacturing as a trend that could potentially impact supply and demand throughout the ITTS region. 3D printing is a rapidly advancing type of additive manufacturing (AM) by which products are formed by layering materials, as opposed to subtractive (cutting away) or formative (molding) techniques. 3D processes will enable and facilitate systems of “distributed manufacturing,” which refer to the production of components and goods near the points of demand via multiple small factories situated in and serving many local markets.

Plastics will be a key input to additive and distributive manufacturing processes. As a result, this represents an emerging industry for the domestic trade of plastics/rubber commodities produced in the ITTS region.

3.3 Motor Vehicle Manufacturing

3.3.1 Industry Overview

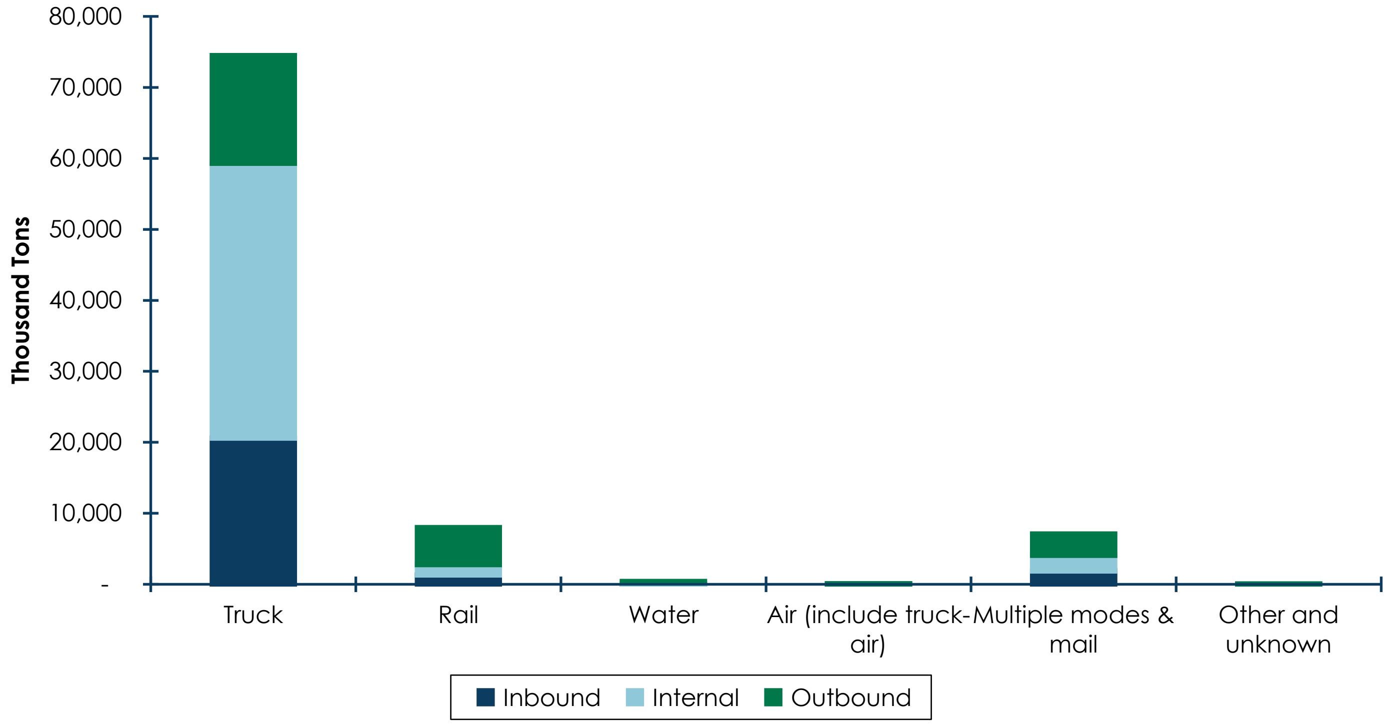
The motor vehicle manufacturing industry produces vehicles for the transport of people and goods and is a subset of the broader transportation equipment manufacturing sector. Because the automotive industry is generally associated with large numbers of high-wage jobs, the motor vehicle manufacturing industry is often a targeted industry for many states’ economic development agencies. Multiple ITTS and southeastern states are home to motor vehicle assembly plants and networks of parts suppliers for those plants. For example, BMW and Mercedes Benz currently operate in South Carolina with planned facilities for Volvo and Volkswagen; Kia and the Blue Bird Corporation have existing plants in Georgia with new assembly plants being developed for Hyundai and Rivian; General Motors and Toyota operate assembly plants in Texas.

In the ITTS region, the motor vehicle manufacturing industry was responsible for over 239,000 jobs in 2022. This is an increase of about 56 percent compared to 2012 employment. Georgia, South Carolina, Florida, and Virginia have all experienced significant GDP growth in this sector relative to 2017 values.[19] For Georgia and South Carolina, GDP contributions from the motor vehicle manufacturing industry have grown by 44 and 52 percent since 2017, respectively. In Florida and Virginia, growth has been more substantial—about 71 percent.

Over 161.3 million tons of commodities related to the motor vehicle manufacturing industry (i.e., SCTG 36—motorized vehicles) were transported into, out of, or within the ITTS region in 2022 as shown in Figure 16. Indiana and Michigan contributed the highest tonnage of inbound flows to the region at approximately 20.9 and 19.2 percent of total inbound flows. Michigan was also the recipient of the largest share of motorized vehicle commodities from the region at approximately 26.8 percent of all outbound flows.

[19] U.S. Bureau of Economic Analysis, "SAGDP9N Real GDP by state 1" (accessed Thursday, September 12, 2024).

FIGURE 16 MOTOR VEHICLE COMMODITIES BY DIRECTION, 2022

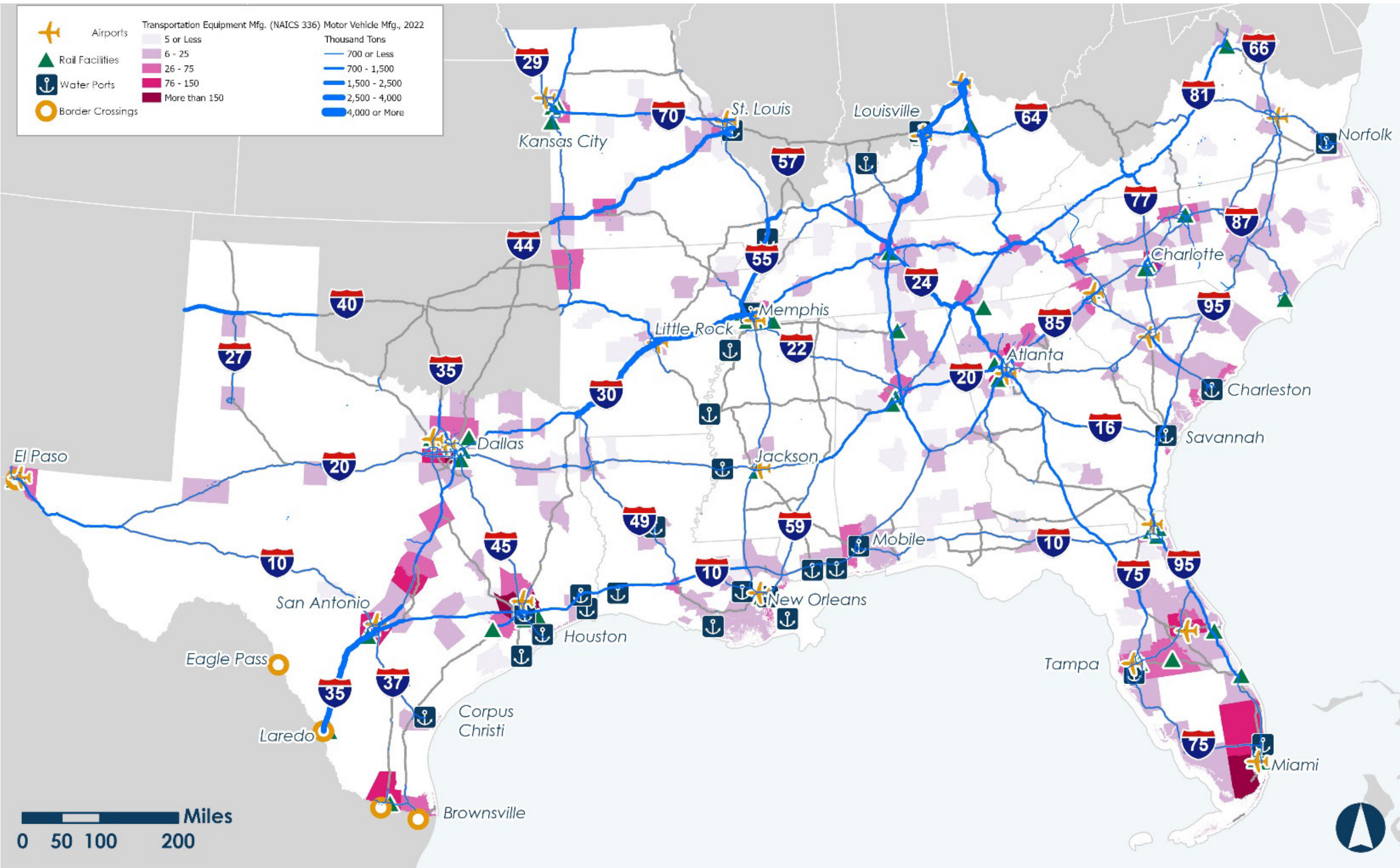


Source: Federal Highway Administration, Freight Analysis Framework version 5.5.1; Cambridge Systematics.

Figure 17 shows the network level flows of motor and other vehicles commodities across the ITTS region's highways.[20] It also shows the locations of businesses in the transportation equipment manufacturing sector (NAICS 336)—which includes motor vehicle manufacturing as well as other types of transportation equipment manufacturing—using the U.S. Census Bureau's County Business Patterns database. The results in Figure 17 indicate that this sector is generally clustered in metropolitan regions across the ITTS states.

[20] Note that the commodity flows shown are limited to the predefined commodity groupings available at the network level from the FAF5. In this case, it is comprised of motorized and other vehicles (including parts) (SCTG36).

FIGURE 17 MOTOR VEHICLE MANUFACTURING BUSINESSES AND MOTOR AND OTHER VEHICLES COMMODITY FLOWS, 2022



Source: Federal Highway Administration, Freight Analysis Framework version 5.5.1; U.S. Census Bureau, County Business Patterns; Cambridge Systematics.

3.3.2 Supply Chain Overview and Block Diagrams

The motor vehicle manufacturing supply chain is divided into three discussions due to its complexity and importance to current economic development efforts in the ITTS region: vehicle parts, vehicle assembly, and vehicle electrification.

Vehicle Parts Supply Chain

Vehicle parts are not only produced for new vehicles, but also to serve after-market maintenance needs for tires, batteries, windshield wipers, lamps, engine components, and other parts with a finite life and to serve demand for vehicle modification and customization.

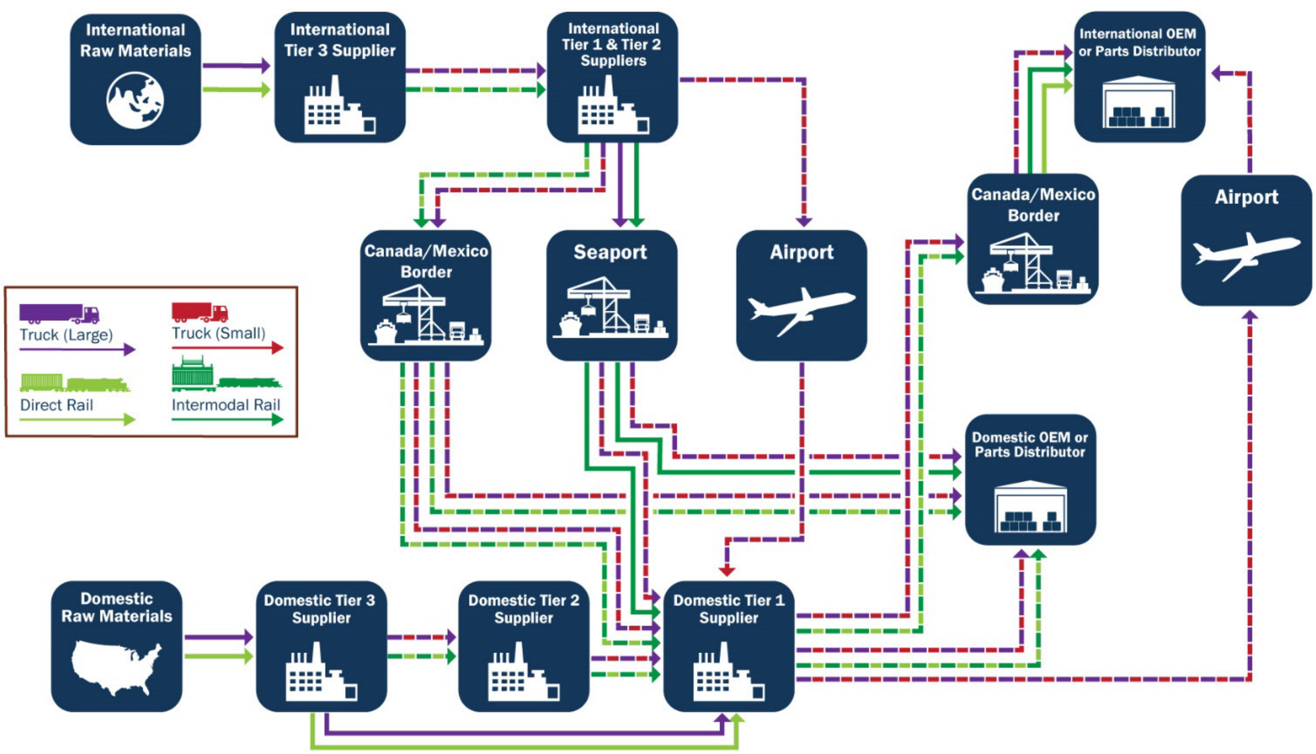
Figure 18 illustrates a generalized supply chain flow for vehicle parts. With 30,000 or more parts provided by three separate tiers of suppliers addressing (1) raw materials; (2) intermediate parts and systems; and

(3) finished parts and systems ready for assembly, any single graphic depicting the vehicle parts supply chain necessarily involves simplification.

The modes chosen to move vehicle parts between suppliers are determined by logistics managers at a range of organization levels seeking to optimize transportation expense and service reliability. Disruptions with first-, second-, and third-tier suppliers and their supply chain network risk disrupting downstream operations for entire original equipment manufacturer (OEM) manufacturing plants. For example, the global chip shortage resulting from the COVID-19 pandemic subsequently caused some auto manufacturers to reduce or temporarily suspend vehicle assembly.

Rail and truck are used extensively throughout the vehicle parts supply chain. Where the marine mode is used, rail and truck servicing ports deliver and receive international containers that are placed on ships for transport across bodies of water. The high cost of aviation limits its application in vehicle parts to expedited shipping whereby time is of the essence and risks of plant shutdowns are high. When aviation is used, the first/last mile segment is handled by the appropriately sized truck.

FIGURE 18 VEHICLE PARTS BLOCK DIAGRAM



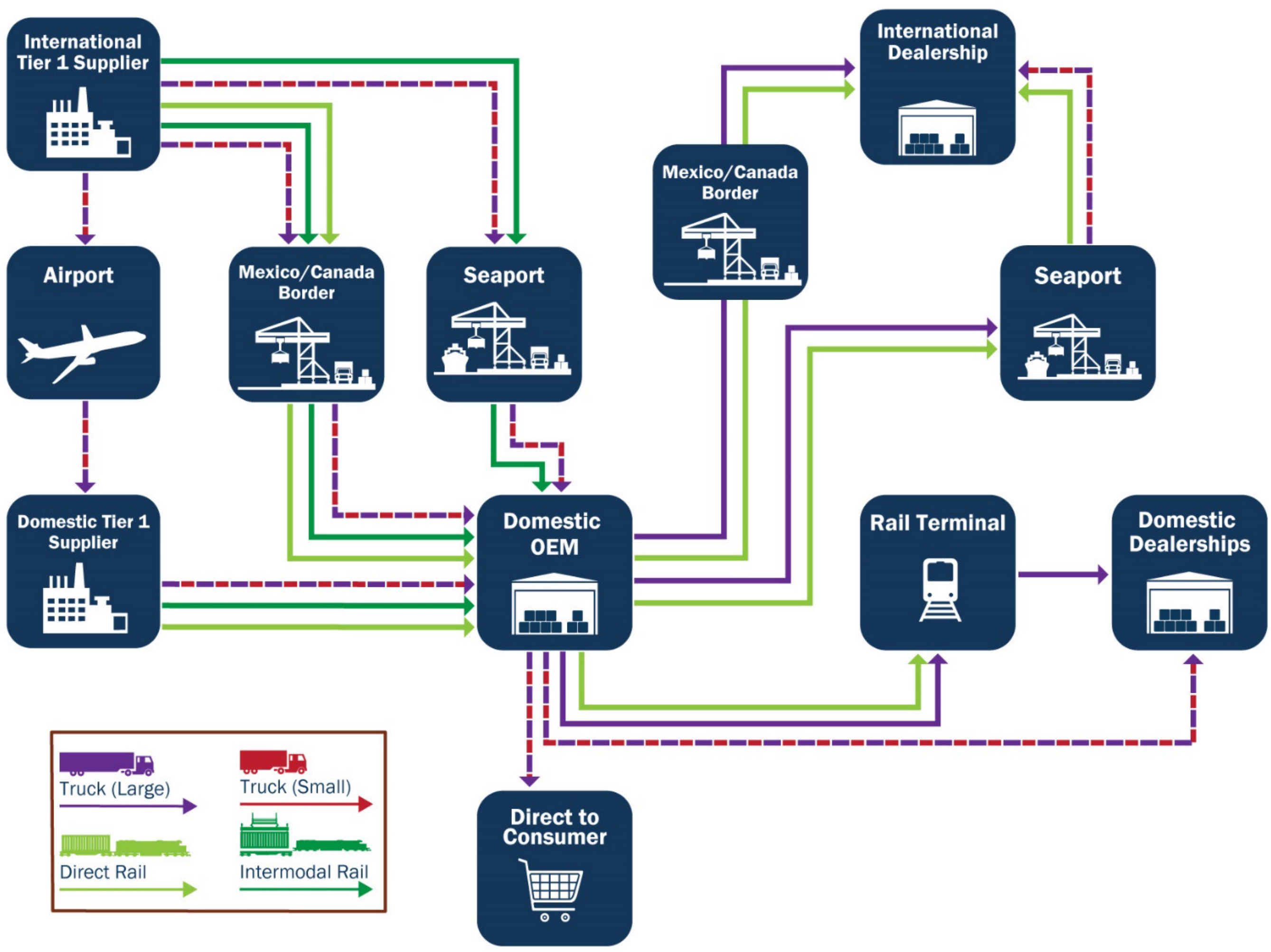
Source: WSP Global.

Vehicle Assembly Supply Chain

Figure 19 similarly captures a generalized model of how tier 1 and tier 3 suppliers interact with OEMs and how the final assembled product from the OEM is distributed. Similarly, rail and truck are the dominant modes used across the supply chain, with aviation finding application only in special cases or critical emergencies where time is of the essence. Finished vehicles do not ship via rail in intermodal lanes using containers, as railroads provide dedicated equipment to hauling vehicles of all sizes, including tri-level, bi-level and single-level auto racks. Trucks also used specialized vehicles designed specifically for carrying automobiles. Because different vehicle models are often manufactured at plants in different locations, OEMs will ship finished vehicles to rail terminal or other intermediate "mixing centers," where different models from different plants are off-loaded and then resorted and reloaded to supply specific destinations with multiple model types.

Likewise, OEMs will ship finished vehicles for export on ocean-capable ferries, or vessels specifically designed for hauling vehicles. Port terminals will similarly serve the purpose of mixing different models and brands from different plants so as to supply destination regions with a range of different makes and models.

FIGURE 19 VEHICLE MANUFACTURING BLOCK DIAGRAM



Source: WSP Global.

Vehicle Electrification

The move to electric vehicles is redefining automotive and vehicle supply chains. While the relationship between tier 1, tier 2 and tier 3 suppliers remains largely the same, electric vehicles require considerably fewer components in final vehicle assembly. For example, General Motors estimates that the electric Bolt, a five-passenger electric vehicle with a 259-mile range, uses 80 percent fewer parts than a comparable internal combustion engine vehicle.[21] Standard components required in any internal combustion vehicle such as spark plugs, radiators, fuel pumps and transmissions simply are not needed in electric models.

Similarly, while the schematic relationship of tier 3 raw material producers remains largely the same for vehicle electrification, the mix of required raw materials for automobile manufacturing is changing, in particular the rare-earth metals, like lithium and cobalt, required for battery manufacturing. Bloomberg estimates that the cumulative lithium-ion battery demand for electric vehicles and storage will increase from 555 Giga-watt hours in 2020 to 9,300 gigawatt hours (GWh) in 2030.[22]

Electric vehicle manufacturers are further redefining auto supplier tier-lever relationships through vertical integration, bringing some functions such as battery manufacturing directly in-house and under the control of the OEM. Tesla's construction of battery manufacturing facilities such as Gigafactory Nevada, which has a capacity 37 GWh and will expand to 100 GWh following an additional $3.6 billion investment announced in 2023, is the leading example of power-supply integration by an electric vehicle OEM.[23]

Figure 19 also illustrates how EV manufacturers are redefining the lines among OEM, dealer, and consumer. Traditional OEMs sell their vehicles to privately-owned franchise-dealerships. In contrast, Tesla sells direct to consumers through its website or app. In states where that allow direct to consumer sales, Tesla operates showrooms where customers purchase vehicles directly from the OEM.

3.3.3 Fluidity, Critical Infrastructure, and Supply Chain Issues and Challenges

As indicated by the commodity flow data for consumer products and chemicals, some of the highest levels of activity associated with the motor vehicle manufacturing supply chain occurs on the following corridors.

- **I-35, I-35W, and I-35E in Texas and Missouri.** Nearly 4 million tons of motor vehicle related commodities are transported annually along this corridor. It includes key multimodal connections at the Mexican border in Loredo, TX, and then in Dallas, TX, (Dallas Fort Worth International Airport, Southern Dallas Inland Port, and multiple intermodal rail terminals), and Kansas City, MO (Kansas City International Airport and multiple intermodal rail terminals, including BNSF, CSX, NS, and UP). There are motor vehicle assembly plants near these routes in Austin, Arlington, and San Antonio TX, Kansas City, KS.

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[21] "Shift to electric vehicles will radically change auto factories," The Detroit News, 1/5/19.

[22] Bloomberg via Statista. https://www.statista.com/chart/23808/lithium-ion-battery-demand/.

[23] Forbes. Tesla Pouring $3.6 Billion Into Nevada Plant For EV Battery, Semi Production. https://www.forbes.com/sites/alanohnsman/2023/01/24/tesla-pouring-36-billion-into-nevada-plant-for-ev-battery-semi-production/?sh=3b3352f211ef.

- **I-30 in Texas and Arkansas.** Nearly 3.4 million tons of motor vehicle related commodities are transported annually along the I-30 corridor. It links intermodal connections in Dallas to those in Arkansas towards Little Rock and on towards Memphis, TN via I-40.

- **I-65 from Alabama to Kentucky.** This route carries 3.7 million tons of motor vehicle related commodities, from Mobile to Birmingham, AL and on to Nashville, TN and Louisville, KY, and eventually Illinois. The Port of Mobile recently completed a new roll-on/roll-off terminal, including the Auto Mobile International terminal with a 40,000 square foot vehicle processing center.[24] I-65 serves a significant number of automobile manufacturing plants, including those in Madison, Lincoln, Vance, and Montgomery, AL, in Spring Hill, TN, and in Bowling Green and Louisville, KY.

- **I-75 between central Florida and Chattanooga, TN, and on to Knoxville, TN.** Over 4 million tons of motor vehicle related commodities are transported annually along the I-75 corridor. It links motor vehicle manufacturing hubs in Metro Atlanta, and Chattanooga, Knoxville, and Georgetown TN, as indicated by the industry location data. The critical multimodal connections along this corridor are located primarily in Metro Atlanta (i.e., Hartsfield-Jackson Atlanta International Airport and multiple rail intermodal terminals) but also include the Georgia Port Authority's Appalachian Regional Port. Furthermore, it connects with the I-24 corridor which also has substantial volumes of motor vehicle manufacturing related goods. I-75 has significant delay in Tennessee, with more than 15 minutes of delay per 100 miles of travels, and it is one of the least reliable segments in the region.

[24] https://www.alports.com/cargo/automobiles/.

FIGURE 20 MOTOR VEHICLE MANUFACTURING SUPPLY CHAIN FLUIDITY—RELIABILITY

Source: National Performance Management Research Data Set; Texas A&M Transportation Institute; WSP Global; Cambridge Systematics.

FIGURE 21 MOTOR VEHICLE MANUFACTURING SUPPLY CHAIN FLUIDITY—DELAY

Source: National Performance Management Research Data Set; Texas A&M Transportation Institute; WSP Global; Cambridge Systematics.

3.3.4 Positioning the Region to Grow

As part of the freight industry concentration and growth analysis, motor vehicle manufacturing was identified as one of the most compelling “strong” industries given its robust growth throughout the ITTS region. In addition, related industries such as Motor Vehicle Parts Manufacturing and Motor Vehicle Body and Trailer Manufacturing were classified as “opportunity” industries. These results indicate that there is strong potential to grow trade related to this supply chain throughout the region.

One consideration for increasing the region’s competitiveness is generally improving the network level performance across the region’s multimodal freight network. As discussed in Section 3.3.2, the motor vehicle supply chain is very complex and encompasses multiple modes as well as domestic and international suppliers. Because of this, general corridor-level investments that decrease travel times, increase reliability, and improve access to truck parking will improve the fluidity of this supply chain and the economic competitiveness of the region. Particularly, Michigan and Indiana are significant contributors to both inbound and outbound flows of motor vehicles and parts into the ITTS region. This suggests that corridors such as I-65 and I-69 through Kentucky are critical for this trade for the entire ITTS region.

More specific to the motor vehicle manufacturing industry, a unique element of its supply chain is a high-level of integration between manufacturing facilities in Texas and Mexico. Often, partially assembled components cross the Texas-Mexico border multiple times in the binational shared production of motor vehicle parts. As a result, for the ITTS region capacity and operational investments that reduce delays at border crossings would improve the fluidity of this supply chain and regional economic competitiveness.

3.4 Pharmaceutical and Medicine Manufacturing

3.4.1 Industry Overview

The pharmaceutical and medicine manufacturing industry is a subset of the chemical manufacturing industry. The chemical manufacturing industry is based on the transformation of organic and inorganic raw materials by a chemical process and the formulation of products.[25] Certain subgroups within this industry, including pharmaceutical and medicine manufacturing, further process basic chemicals to produce intermediate and end products. More specifically, pharmaceutical and medicine manufacturing consists of establishments primarily engaged in one or more of the following:

- Manufacturing biological and medical products.
- Processing botanical drugs and herbs.
- Isolating active medical principles from botanical drugs and herbs.
- Manufacturing pharmaceutical products intended for internal and external consumption in forms such as tablets, capsules, ointments, powders, and solutions.[26]

In the ITTS region, the pharmaceutical and medicine manufacturing industry provided over 48,500 jobs in 2022—a 60 percent increase over 2012 employment. Data on GDP growth by state is only available for the broader chemical manufacturing industry. It shows that nearly every ITTS state experienced substantial growth relative to 2017 values.[27] In particular, Florida, Arkansas, and Kentucky experienced significant growth in this sector—38 percent, 41 percent, and 45 percent, respectively.

As shown in Figure 22, nearly 19 million tons of commodities related to the pharmaceuticals and medicine manufacturing industry (i.e., SCTG 21- pharmaceutical products) were transported into, out of, or within the ITTS region in 2022. Rail intermodal (i.e., multiple modes and mail) plays a significant role in this supply chain as it accounted for about 10 percent of total tonnage. By far, North Carolina contributed the highest tonnage of inbound flows to the region at about 31.2 percent of total inbound flows. New Jersey and Indiana were also responsible for significant shares of inbound flows to the region at approximately 12.9 and 12.8 percent, respectively, of total inbound flows. Tennessee received the highest tonnage of pharmaceutical and medicine manufacturing goods from the region at about 23.1 percent of all outbound flows. In addition to being a top

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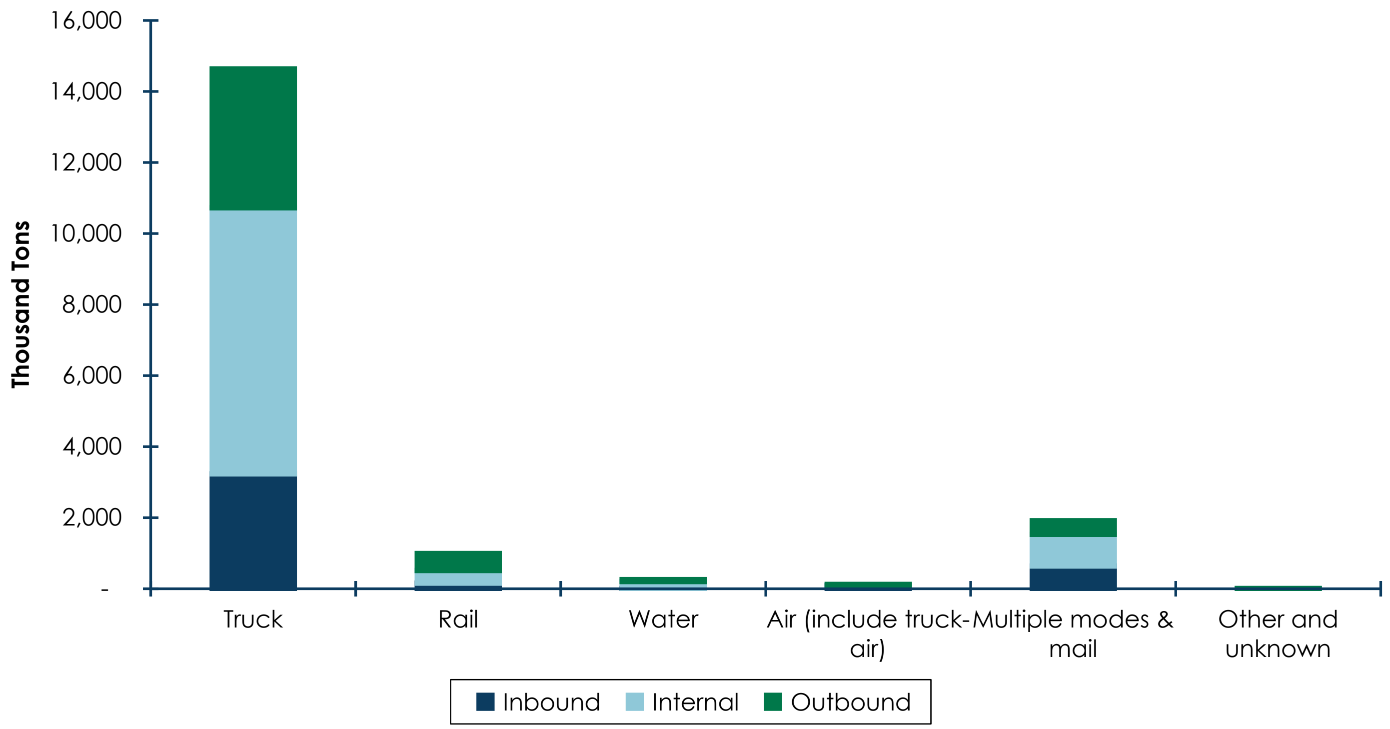
[25] https://www.bls.gov/iag/tgs/iag325.htm.

[26] https://www.epa.gov/regulatory-information-sector/pharmaceutical-and-medicine-manufacturing-sector-naics-3254.

[27] U.S. Bureau of Economic Analysis, "SAGDP9N Real GDP by state 1" (accessed Thursday, September 12, 2024).

shipper of pharmaceutical and medicine manufacturing goods into the region, North Carolina also received a large share of these goods from the region at about 12.1 percent of total outbound flows.

FIGURE 22 PHARMACEUTICALS AND MEDICINE MANUFACTURING COMMODITIES BY DIRECTION, 2022

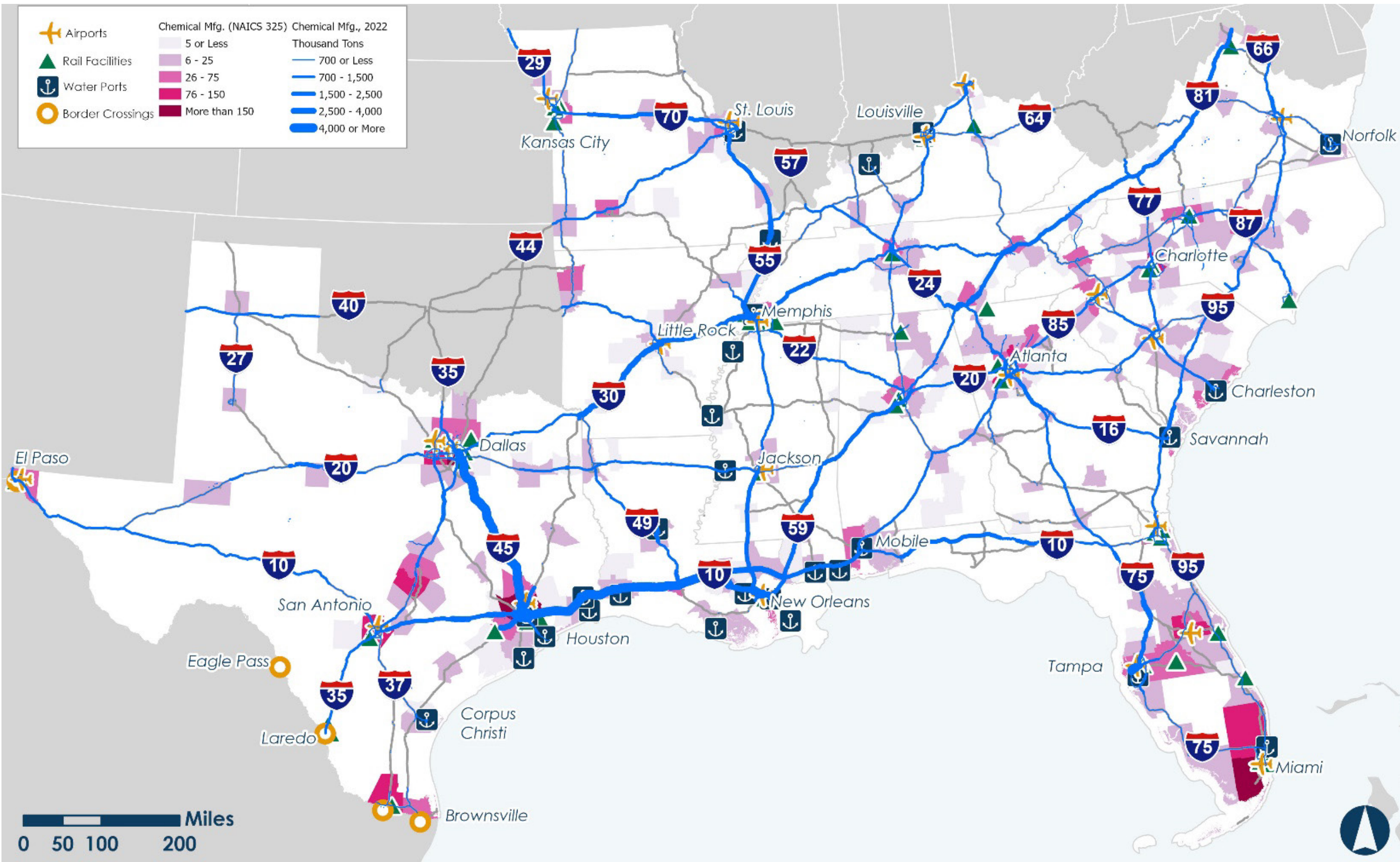


Source: Federal Highway Administration, Freight Analysis Framework version 5.5.1; Cambridge Systematics.

Figure 23 shows the network level flows of chemicals, pharmaceuticals, and fertilizers commodities across the ITTS region's highways.[28] It also shows the locations of businesses in the chemicals manufacturing sector (NAICS 325), which includes pharmaceutical and medicine manufacturing, using the U.S. Census Bureau's County Business Patterns database. The results shows that these businesses are generally clustered in metropolitan regions across the ITTS, but a few metropolitan areas have particularly high concentrations—namely Houston and Dallas-Ft. Worth. This is likely due to the inclusion of petrochemical manufacturers in this grouping in addition to the prevalence of pharmaceutical and medicine manufacturing.

[28] Note that the commodity flows shown are limited to the predefined commodity groupings available at the network level from the FAF5. In this case, consumer and manufacturing commodities include chemical products (SCTG23), plastics/rubber (SCTG24), wood products (SCTG26), newsprint/paper (SCTG27), paper articles (SCTG28), printed products (SCTG29), and textiles/leather (SCTG30).

FIGURE 23 PHARMACEUTICAL AND MEDICINE MANUFACTURING BUSINESSES AND CHEMICALS, PHARMACEUTICALS, AND FERTILIZERS COMMODITY FLOWS, 2022



Source: Federal Highway Administration, Freight Analysis Framework version 5.5.1; U.S. Census Bureau, County Business Patterns; Cambridge Systematics.

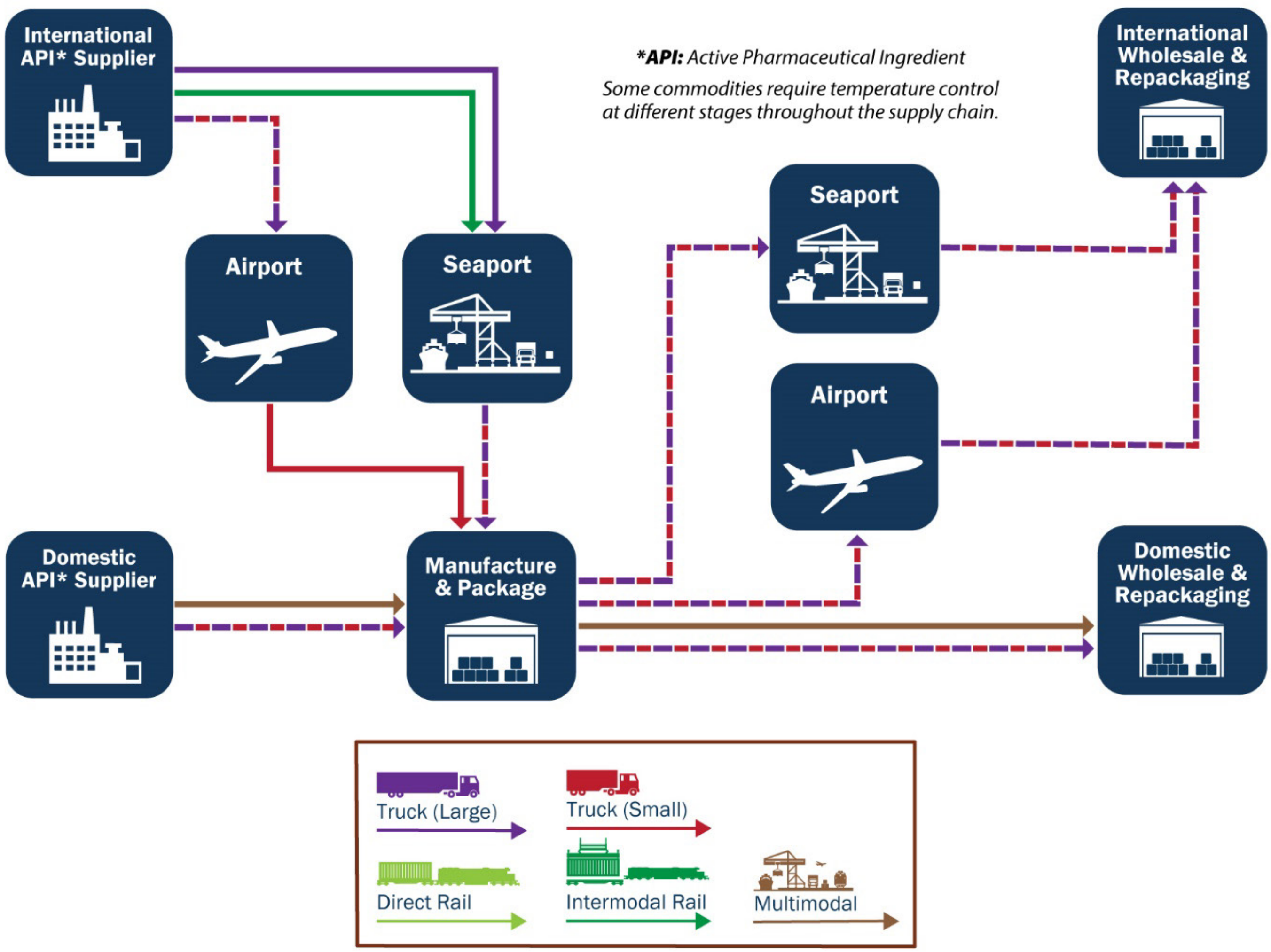
3.4.2 Supply Chain Overview and Block Diagrams

The pharmaceutical supply chain is complex, with several major organizations, including pharmacy benefit management companies, involved in negotiating prices. These companies, such as online and retail pharmacies, are not detailed in the flow diagram, which focuses on the production and storage portion of the pharmaceutical supply chain. However, these steps do influence the capacity and ability of the supply chain to respond to demand.

Active Pharmaceutical Ingredients (APIs) are the key inputs to pharmaceuticals. At this time, most APIs are produced outside of the United States, although there is a push to increase domestic suppliers, partly as a result of the supply chain issues that occurred during COVID. As shown starting on the top right side of the flow diagram in Figure 13, the international API supplies are delivered by large and small trucks to international airports or seaports. When they arrive at airports or seaports in the United States, the APIs are trucked to manufacturing plants in the ITTS region. On the bottom left, the flow also shows the domestic API suppliers who deliver APIs by large or small truck or multimodally to the manufacturing plant.

Once a pharmaceutical is manufactured, it is packaged for shipment and sent to a wholesaler who then repackages it for retail sale. If the wholesaler is located internationally, the pharmaceutical goes from the point of manufacture by either a large or small truck to an airport or seaport and is either flown or shipped by water to an international seaport or airport. Then it is delivered by either large or small truck to the international wholesale and repackaging warehouse. If it is traveling domestically from the point of manufacture, the pharmaceutical is carried by large or small truck or multimodally to the domestic wholesale and repackaging warehouse.

FIGURE 24 PHARMACEUTICAL AND MEDICINE BLOCK DIAGRAM



Source: WSP Global.

3.4.3 Fluidity, Critical Infrastructure, and Supply Chain Issues and Challenges

- **I-10 between Texas and Louisiana.** Due to the prevalence of the petrochemical industry in the Gulf states, the I-10 corridor unsurprisingly moves significant volumes, nearly 9.7 million tons, of chemical and pharmaceutical commodities. This stretch of I-10 between San Antonio, TX and New Orleans, LA is also highly congested, with an average delay of nearly nine minutes per 100 miles. The high volumes coupled with the significant delay highlight the fluidity challenges on this corridor.

- **I-45 in Texas.** Between Houston and Dallas, I-45 moves nearly 7.8 million tons of chemical and pharmaceutical commodities, placing it in the top three corridors by volume for this commodity type. Many chemical and pharmaceutical manufacturing facilities are located along this corridor, comprising everything from companies producing cancer drugs and platelet testing, to companies producing materials and equipment to manufacture and package medicines.

- **I-81 in Tennessee and Virginia.** I-81 is not in the top 10 corridors that move pharmaceuticals, as it only transports 2.4 million tons of these commodities. However, in the town of Bristol, TN, which is in eastern Tennessee at the border with Virigina, is the only amoxicillin manufacturer in the United States. The company USAntibiotics has a nearly 400,000 sq. ft. production facility and makes 30 percent of antibiotics prescribed in the U.S. annually. Maintaining access and fluidity on this corridor is highly important for maintaining the public health.

- **I-610 in Texas.** There are two I-610 corridors in the ITTS region, one that rings the city of Houston, TX, and the other that bypasses the central business district of New Orleans, LA. It is the I-610 corridor in Houston that carries the majority of tonnage, over 16 million tons, for chemical and pharmaceutical manufacturing commodities in the region. As noted above, this is likely due to the inclusion of petrochemical manufacturers in this grouping in addition to the prevalence of pharmaceutical and medicine manufacturing.

FIGURE 25 PHARMACEUTICAL AND MEDICINE SUPPLY CHAIN FLUIDITY—RELIABILITY

Source: National Performance Management Research Data Set; Texas A&M Transportation Institute; WSP Global; Cambridge Systematics.

FIGURE 26 PHARMACEUTICAL AND MEDICINE SUPPLY CHAIN FLUIDITY—DELAY

Source: National Performance Management Research Data Set; Texas A&M Transportation Institute; WSP Global; Cambridge Systematics.

3.4.4 Positioning the Region to Grow

Pharmaceuticals and medicine was identified as an opportunity industry as part of the freight industry concentration and growth analysis, meaning that though it is relatively less concentrated regionally as compared to the U.S. it has grown at a faster rate. Notably, this industry exhibited the strongest growth among all opportunity industries. The vast majority of pharmaceuticals and medicines are transported via truck. Furthermore, they are high-value, time-sensitive goods that in some cases require refrigeration as they are perishable. As such, pharmaceuticals and medicines are particularly sensitive to highway congestion and unreliability. Because of this, strategies to address travel time performance on the region's shared corridors—particularly 1-10, I-45, and I-30—would strengthen its competitiveness for trade in this industry.

3.5 Aerospace Product and Parts Manufacturing

3.5.1 Industry Overview

Businesses in the aerospace product and parts manufacturing industry manufacture aircraft, aircraft components (including engines), spacecraft, and missiles.[29] It is a subset of the broader transportation equipment manufacturing sector, which produces equipment for transporting people and goods.[30] Generally, aerospace product and parts manufacturing sector contributes heavily to research and development investment and exports at the national level.

Across the ITTS region, businesses in this industry sector were responsible for over 134,000 jobs in 2022. This is approximately a nine percent increase over 2012 values. Data on GDP growth by state is only available for the broader other transportation equipment manufacturing industry. It shows that nearly every ITTS state experienced substantial growth relative to 2017 values.[31] In particular, Missouri has experienced tremendous growth—approximately 244 percent. Multiple aerospace product and parts manufacturing businesses are located in Missouri, including Boeing, which recently expanded operations in the state.[32]

As shown in Figure 27, approximately 6.5 million tons of commodities related to the aerospace products and parts manufacturing industry (i.e., SCTG 36- transportation equipment) were transported into, out of, or within the ITTS region in 2022. Alabama and Illinois were responsible for the highest shares of inbound flows to the region at approximately 21.3 and 12.7 percent, respectively, of total inbound tonnage. Illinois was the largest recipient of these goods from the region at about 16.0 percent of all outbound flows. Michigan also received a large share of aerospace-related goods from the region at about 11.4 percent of total outbound tonnage.

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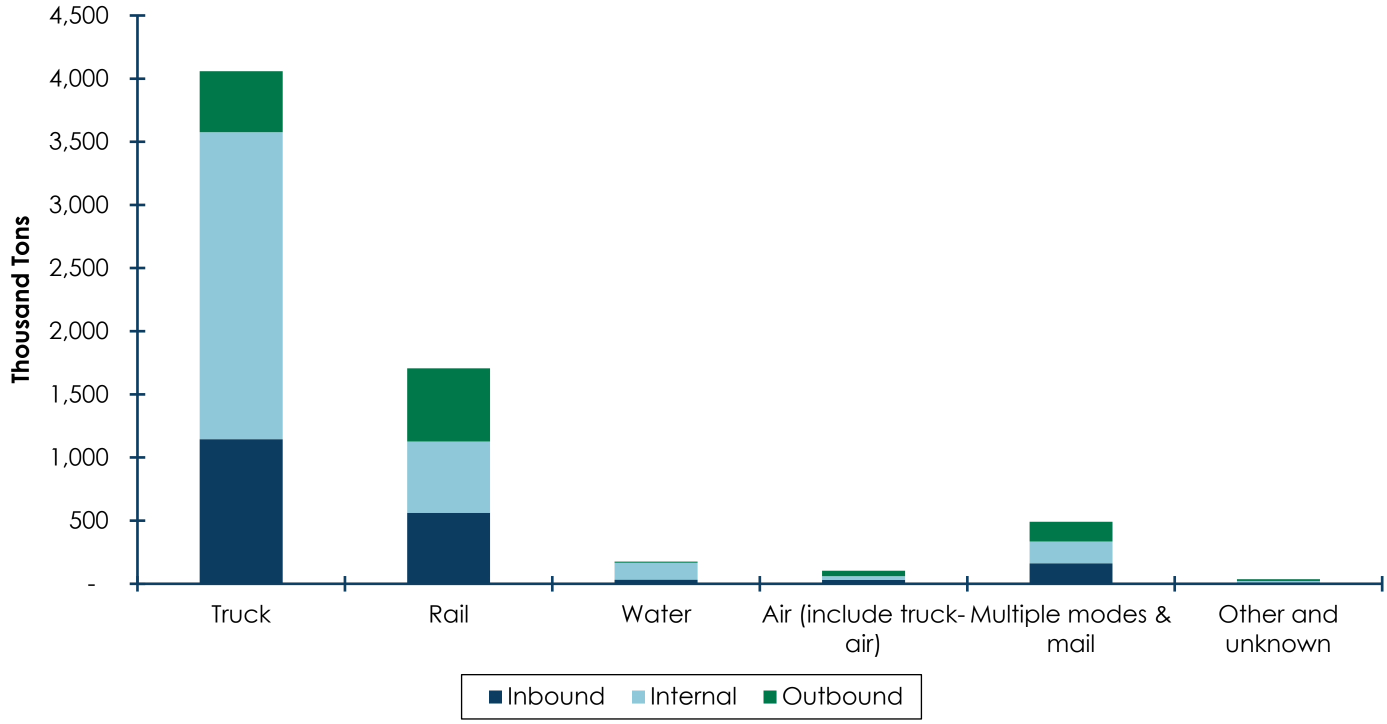
[29] https://comptroller.texas.gov/economy/economic-data/manufacturing/2016/naics3364-3369-aerospace.php.

[30] https://www.bls.gov/iag/tgs/iag336.htm.

[31] U.S. Bureau of Economic Analysis, "SAGDP9N Real GDP by state 1" (accessed Thursday, September 12, 2024).

[32] https://ded.mo.gov/press-room/missouri-prepared-support-boeing-st-louis-county-considered-location-18-billion.

FIGURE 27 AEROSPACE PRODUCTS AND PARTS MANUFACTURING COMMODITIES BY DIRECTION, 2022

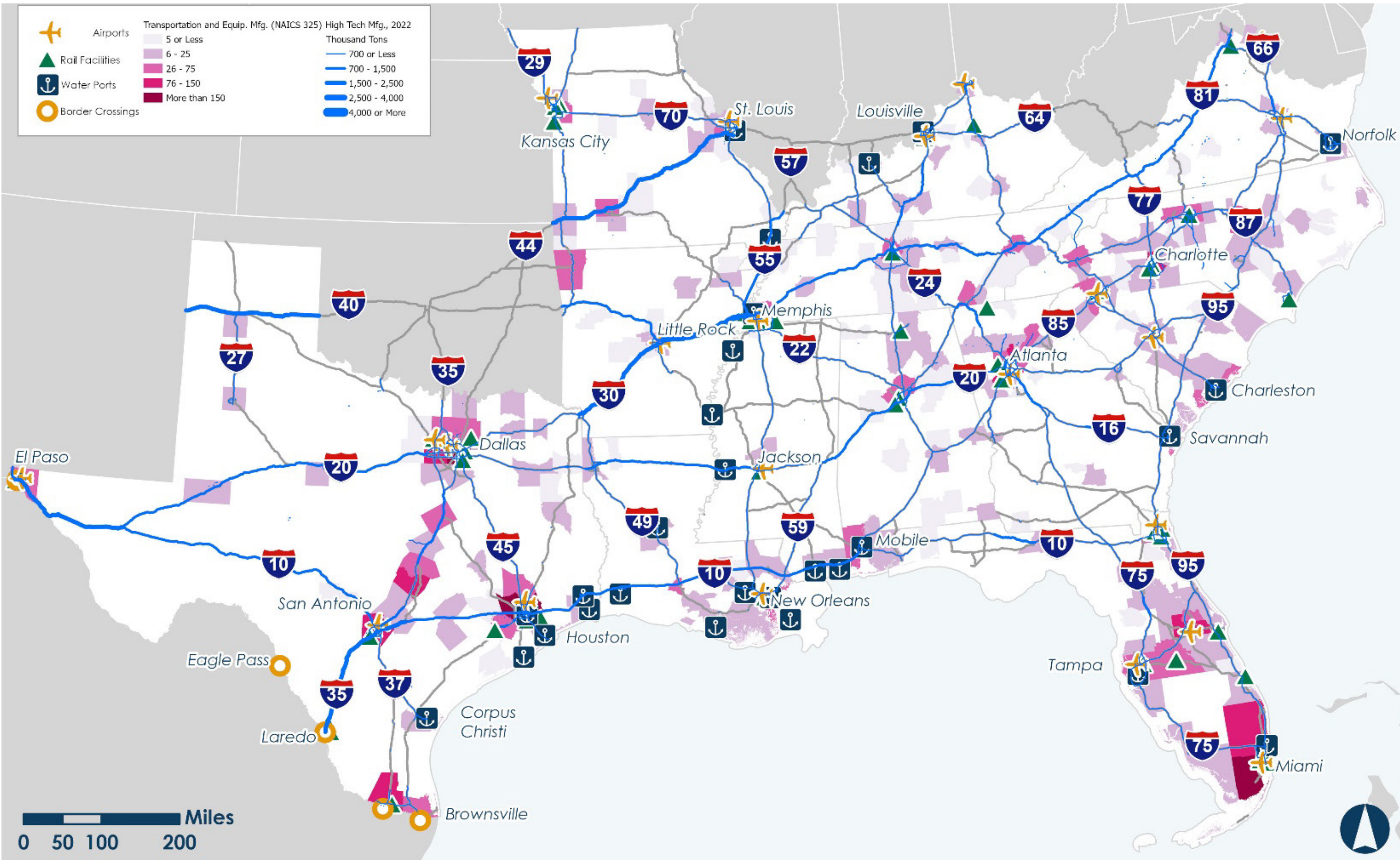


Source: Federal Highway Administration, Freight Analysis Framework version 5.5.1; Cambridge Systematics.

Figure 28 shows the network level flows of high-tech durables commodities across the ITTS region's highways.[33] It also shows the locations of businesses in the transportation equipment manufacturing sector (NAICS 336), which includes aerospace products and parts manufacturing, using the U.S. Census Bureau's County Business Patterns database. Businesses in these industries are broadly distributed across the ITTS region with some clustering in its major metropolitan areas.

[33] Note that the commodity flows shown are limited to the predefined commodity groupings available at the network level from the FAF5. In this case, high-tech durables commodities include electronics (SCTG35), transportation equipment (SCTG37), and precision instruments (SCTG38).

FIGURE 28 AEROSPACE PRODUCTS AND PARTS MANUFACTURING BUSINESSES AND HIGH-TECH DURABLES COMMODITY FLOWS, 2022



Source: Federal Highway Administration, Freight Analysis Framework version 5.5.1; U.S. Census Bureau, County Business Patterns; Cambridge Systematics.

3.5.2 Supply Chain Overview and Block Diagrams

The aerospace supply chain includes a wide range of raw materials, intermediate materials, and outputs. Each manufacturer, distributor, and good within the aerospace industry could have its own supply chain diagram. The description and diagram below are intended to provide a general overview and starting point for the aerospace supply chain in the subject states.

Aerospace parts are produced through a tiered system of domestic and international suppliers. Manufacturers assemble the parts into finished aircrafts or helicopters, or into engines and other components to be used by manufacturers elsewhere. Aerospace suppliers fall into one of three tiers:

- **Tier 1—**Supply parts or systems directly to original equipment manufacturers (businesses that make the final product for the customer). They typically manufacture components such as engine parts, steering and suspension systems, air conditioning systems, and electronic components.

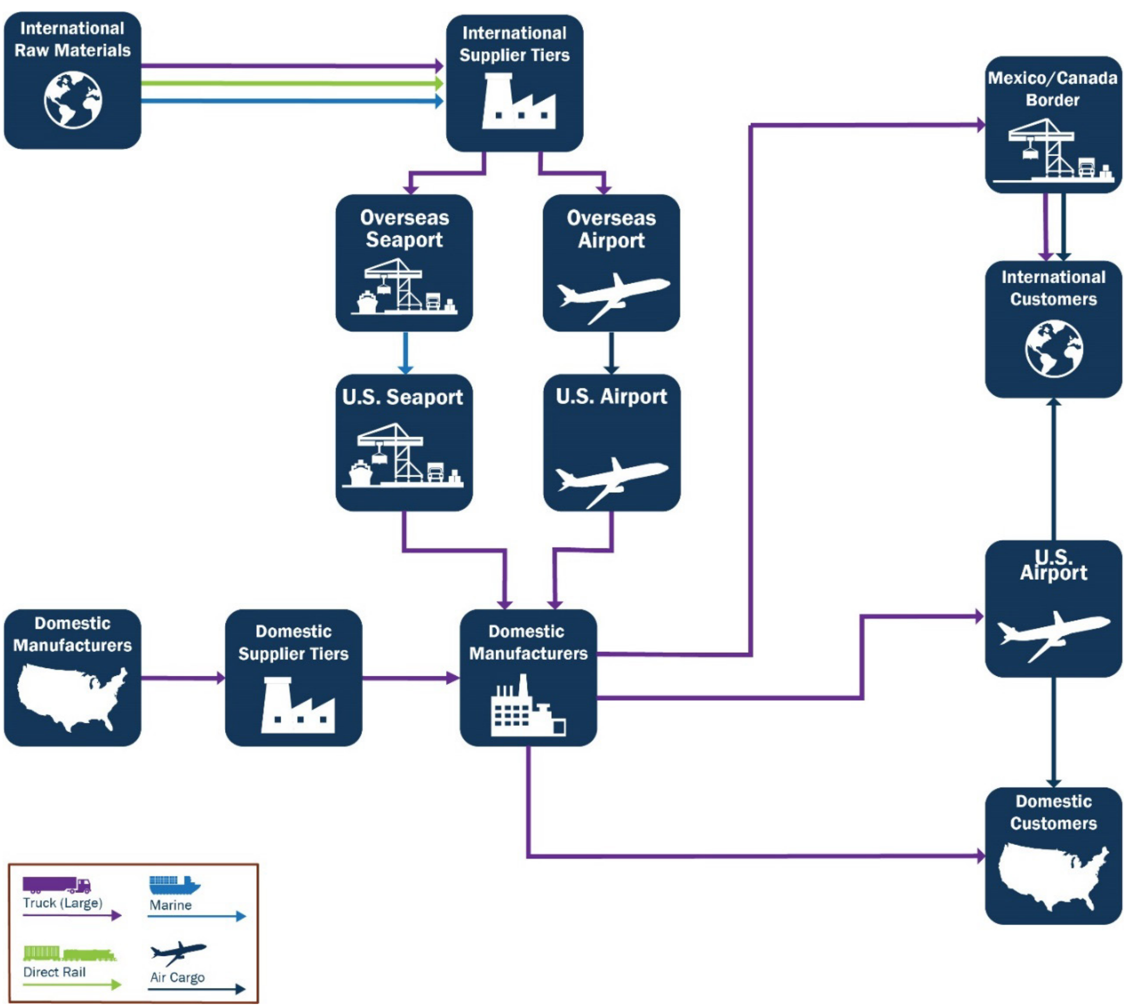
- **Tier 2—**Often experts in a specific subfield that can also support non-transportation customers. They manufacture the components needed by Tier 1 suppliers, including specialized forged parts, die casting, plastic parts, and machined parts.

- **Tier 3—**Suppliers or raw or near-raw materials like metal or plastic. They typically sell to Tier 2 suppliers.

These three tiers are illustrated in the diagram below as *Domestic Supplier Tiers* and *International Supplier Tiers*.

The most basic element of the supply chain is raw materials such as metals, plastic, rubber, and textiles. Raw materials in the aerospace industry tend to be sourced internationally. The materials are moved by large truck, direct rail, or water to international supplier tiers. Raw materials are then moved by large truck to overseas seaports or airports, and then moved by water or air cargo to U.S. seaports and airports, respectively. Once reaching the United States, goods are moved by large truck to domestic manufacturers. From domestic manufacturers, completed goods may be moved by large truck directly to domestic customers. They may also reach international customers via air cargo from a U.S. airport or by large truck or air cargo after crossing the Mexico or Canada borders.

FIGURE 29 AEROSPACE PRODUCT BLOCK DIAGRAM



Source: WSP Global.

3.5.3 Fluidity, Critical Infrastructure, and Supply Chain Issues and Challenges

As indicated by the commodity flow data, some of the highest levels of activity associated with the aerospace manufacturing supply chain occurs on the following corridors. This analysis is based on flows of high-tech durable goods, which includes commodities used in other supply chains in addition to aerospace manufacturing.

- **I-40 in Texas and Arkansas.** I-40 carries as much as 2.5 million tons of high-tech goods with the greatest concentration in Texas and Arkansas. The I-40 corridor spans the entire Nation, reaching from Southern California to North Carolina, and is a critical connection to the region from West Coast ports. Within the ITTS region, I-40 interchanges with other important routes for high-tech manufacturing, specifically I-44 and I-35. The corridor connects to airports in Little Rock and Memphis and to rail facilities in Arkansas, Tennessee, and North Carolina.
- **I-10 in Texas.** The I-10 corridor in Texas handles approximately 2.3 million tons of high-tech products annually. This corridor connects advanced manufacturing and research facilities in the San Antonio and Houston areas to the ports along the Gulf Coast and markets to both the east and west. This segment is the least reliable segment of I-10 and one of the least reliable segments analyzed (11 percent buffer time). Average delay per 100 miles on this segment is nearly nine minutes, slightly above average for the corridors analyzed.
- **I-44 in Missouri.** Over 2.1 million tons of high-tech goods travel on I-44 in Missouri annually. This corridor provides a connection between I-40, where parts from the West Coast enter the region, to St. Louis where Boeing and other aerospace manufacturing firms are clustered. The corridor also interchanges with I-70 providing connectivity to transportation and manufacturing in Louisville, Kansas City, and beyond Missouri.
- **I-35 between Laredo and San Antonio.** I-35 in Texas provides a critical linkage to the Texas-Mexico border where binational manufacturing and assembly occurs. Between Laredo and San Antonio, over two million tons of high-tech goods are transported annually on I-35. The San Antonio area includes Kelly Field, a Department of Defense joint-use airfield, and Port San Antonio, which is a hub for aerospace manufacturing, maintenance, and research tenants. The I-35 corridor connects to major airports and rail facilities in Dallas-Fort Worth and Kansas City, as well as the I-10, I-20, I-30, and I-40 corridors that traverse the ITTS region.

FIGURE 30 AEROSPACE PRODUCTS AND PARTS MANUFACTURING SUPPLY CHAIN FLUIDITY—RELIABILITY

Source: National Performance Management Research Data Set; Texas A&M Transportation Institute; WSP Global; Cambridge Systematics.

FIGURE 31 AEROSPACE PRODUCTS AND PARTS MANUFACTURING SUPPLY CHAIN FLUIDITY—DELAY

Source: National Performance Management Research Data Set; Texas A&M Transportation Institute; WSP Global; Cambridge Systematics.

3.5.4 Positioning the Region to Grow

The aerospace product and parts manufacturing industry already has a significant and growing presence in multiple ITTS states. For example, Boeing has operations in Missouri and recently expanded operations in the state;[34] in 2023, Gulfstream Aerospace Corporation expanded its operations in Georgia near the Port of Savannah;[35] Lockheed Martin has a production facility in South Carolina.[36] Highway and rail networks are essential to operating the supply chain on which the aerospace product and parts manufacturing industry relies and facilitating continued growth and investment. Because of this, improvement to multimodal network level performance, including trade gateways, is critical to increasing the region's economic competitiveness.

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[34] https://ded.mo.gov/press-room/missouri-prepared-support-boeing-st-louis-county-considered-location-18-billion.

[35] https://www.gulfstreamnews.com/en/news/?id=dc65881c-4255-497d-ace5-40872af39d1c.

[36] https://www.sccommerce.com/industries/aerospace-industry.

More specifically, the ITTS region will need to ensure sufficient capacity and reliability for the following elements of the multimodal freight network:

- Higher tonnage critical corridors such as I-40 in Texas and Arkansas, I-10 in Texas, I-44 in Missouri, I-30 in Arkansas, and I-81 in Virginia.
- Intermodal rail ramps and intermodal rail mainline corridors and service tracks connecting to manufacturing facilities.
- Seaports, particularly the Ports of Charleston, Savannah, Houston, Freeport, and Galveston as much of the region's export activity for transportation equipment is centered in the States of South Carolina, Georgia, and Texas based on FAF5 data.
- Last-mile truck routes in the metropolitan regions in which aerospace production is clustered—such as Houston, St. Louis, Greenville-Spartanburg, and Savannah.

3.6 Computer and Electronic Product Manufacturing

3.6.1 Industry Overview

Businesses in the computer and electronic product manufacturing industry sector manufacture computers, computer peripherals, communications equipment, and similar electronic products, and they produce components for such products.[37] The design and use of integrated circuits and the application of highly specialized miniaturization technologies are common elements in the production technologies of the computer and electronic subsector. As observed by the U.S. Bureau of Labor Statistics, the computer and electronic product manufacturing industry sector has attained a high level of economic significance, and its rapid growth suggests that it will become even more important to the national economy in the future.

In the ITTS region, businesses in the computer and electronic product manufacturing industry sector provided over 197,000 jobs in 2022. This is a modest increase relative to 2012 employment levels—about four percent. Growth in this sector as indicated by GDP has been uneven across the region as most states have experienced growth, but others have experienced contraction.[38] The most robust growth in the computer and electronic product manufacturing industry sector over the 2017–2022 timeframe occurred in Mississippi, which experienced approximately 190 percent growth. This was driven in part by the relatively small size of this sector (in terms of GDP) in 2017. Hence, *any* growth results in a large percentage growth.

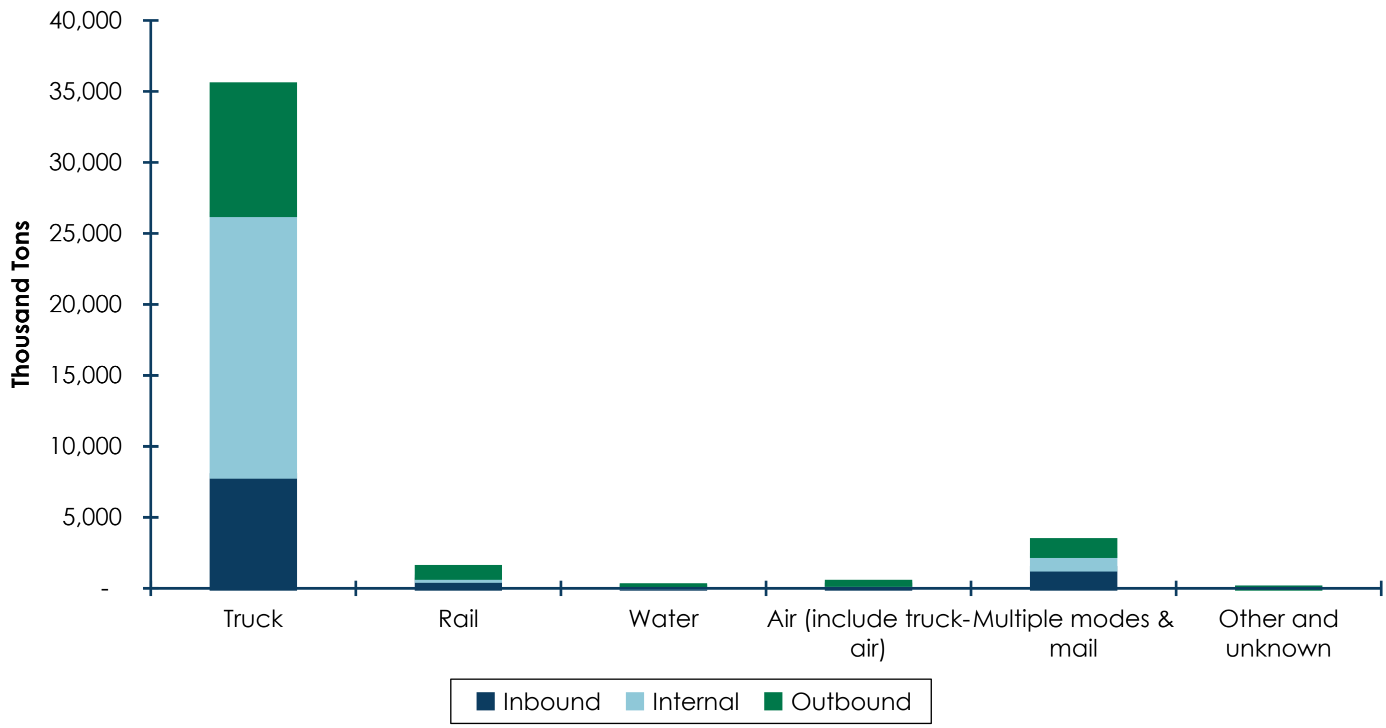
As shown in Figure 32, approximately 40.8 million tons of commodities related to the computer and electronic product manufacturing industry (i.e., SCTG 35- electronic and other electrical equipment and components) were transported into, out of, or within the ITTS region in 2022. By far, California accounted for the highest shares of inbound flows to the region at approximately 31.0 percent of total inbound tonnage. It was also the largest recipient of these goods from the region at approximately 12.8 percent of all outbound flows. North Carolina

[37] https://www.bls.gov/iag/tgs/iag334.htm.

[38] U.S. Bureau of Economic Analysis, "SAGDP9N Real GDP by state 1" (accessed Thursday, September 12, 2024).

also received a large share of computer and electronic product-related goods from the region at about 10.7 percent of total outbound tonnage.

FIGURE 32 COMPUTER AND ELECTRONIC PRODUCT MANUFACTURING COMMODITIES BY DIRECTION, 2022

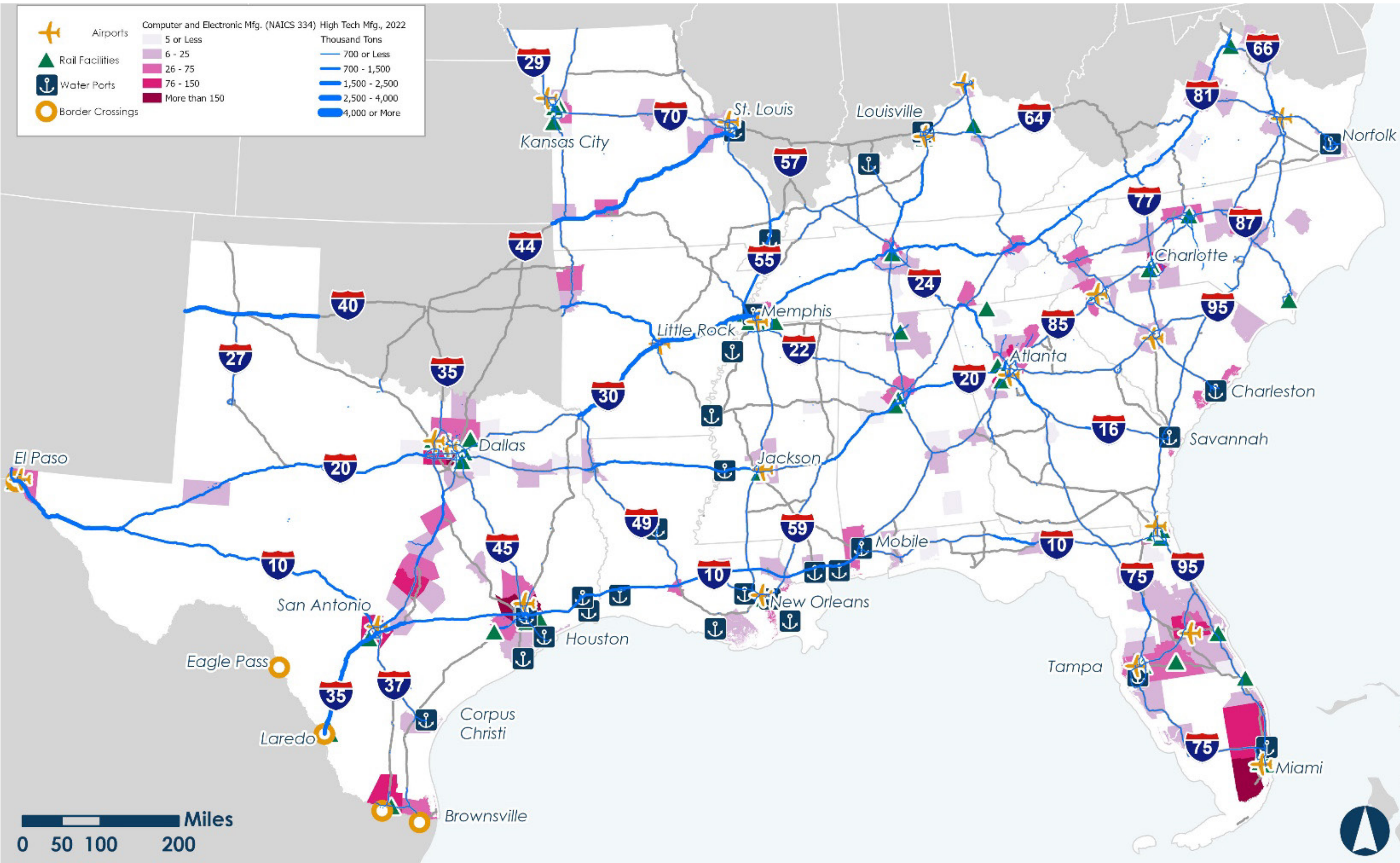


Source: Federal Highway Administration, Freight Analysis Framework version 5.5.1; Cambridge Systematics.

Figure 33 shows the network level flows of high-tech durables commodities across the ITTS region's highways.[39] It also shows the locations of businesses in the computer and electronics manufacturing sector (NAICS 334) using the U.S. Census Bureau's County Business Patterns database. Businesses in these industries are generally clustered in a few major metropolitan areas—Texas Triangle (i.e., Austin, Houston, Dallas-Ft. Worth, San Antonio), Central Florida (i.e., Tampa and Orlando), Miami-Ft. Lauderdale, and Metro Atlanta.

[39] Note that the commodity flows shown are limited to the predefined commodity groupings available at the network level from the FAF5. In this case, high-tech durables commodities include electronics (SCTG35), transportation equipment (SCTG37), and precision instruments (SCTG38).

FIGURE 33 COMPUTER AND ELECTRONIC PRODUCTS MANUFACTURING BUSINESSES AND HIGH-TECH DURABLES COMMODITY FLOWS, 2022



Source: Federal Highway Administration, Freight Analysis Framework version 5.5.1; U.S. Census Bureau, County Business Patterns; Cambridge Systematics.

3.6.2 Supply Chain Overview and Block Diagrams

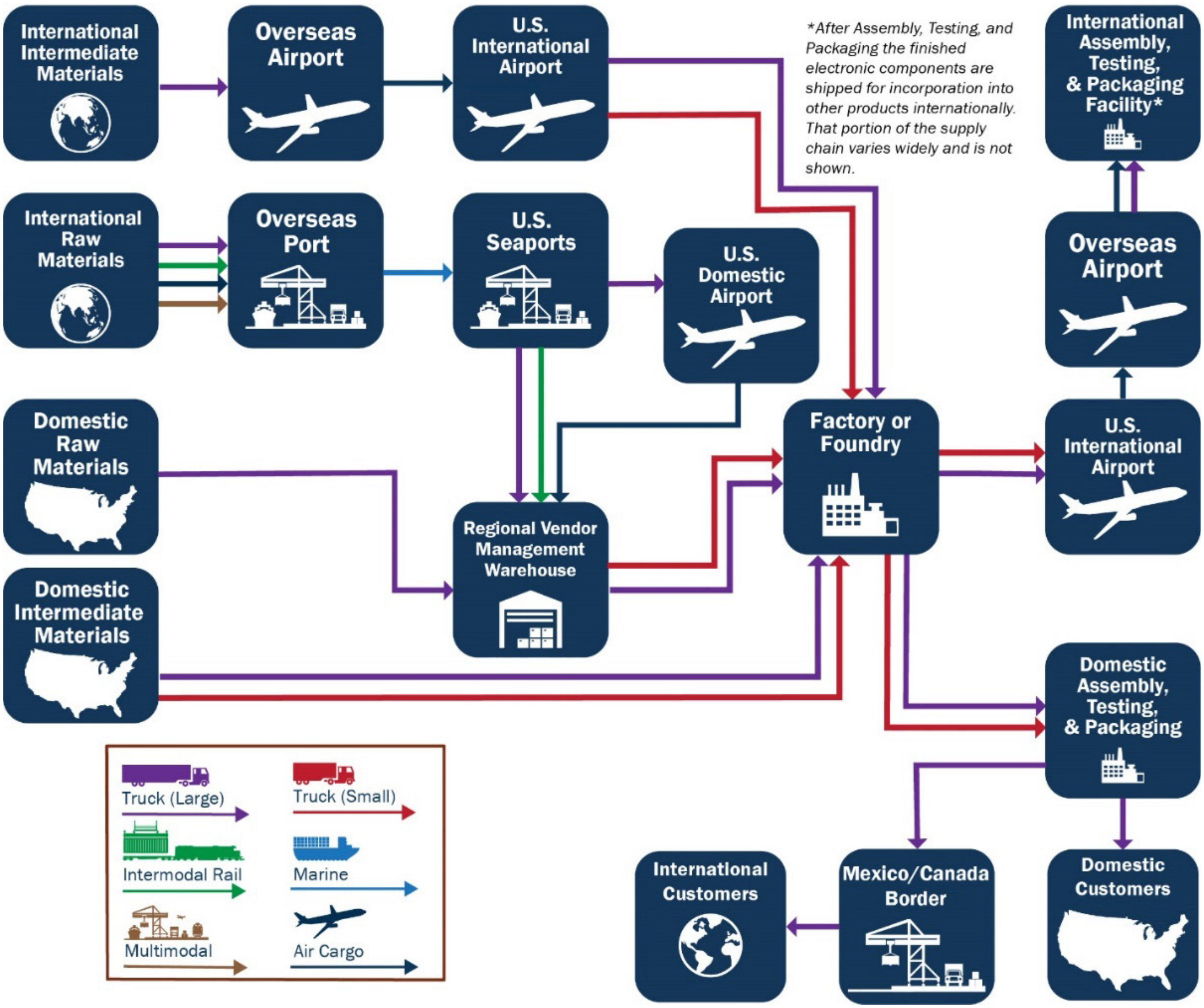
The electronics supply chain includes a wide range of raw materials, intermediate materials, and outputs. Each manufacturer, distributor, and good within the electronics industry could have its own supply chain diagram; However, the description and diagram below provide a general overview and starting point of the electronics supply chain.

The most basic element of the supply chain is raw materials. Domestic raw materials are transported by large truck to a regional vendor management warehouse. International raw materials are transported by various means (large truck, intermodal rail, air cargo, or multimodal) to overseas seaports, and then shipped by water to U.S. seaports. These raw materials are then transported by large truck or intermodal rail from U.S. seaports to the regional vendor management warehouse. Here, materials are stored until they are needed by the factory or foundry. Raw materials are often in bulk and hazardous in nature so must be shipped internationally by water rather than air cargo. Depending on the specific electronics subsector, raw materials may largely be transported from East Asia, including China. These materials are typically shipped by water to West Coast seaports. If shipped to East Coast seaports, they are transported directly by large truck or intermodal rail to the regional vendor management warehouse. If shipped to West Coast seaports, they may be flown to an airport closer to the regional vendor management warehouse.

From the regional vendor management warehouse, goods are moved by large and small truck to a nearby factory or foundry where the manufacturing process begins, and raw materials are combined or treated with intermediate materials. Domestic intermediate materials are shipped directly to the factory or foundry by large or small truck. International intermediate materials reach the factory or foundry by way of truck to an overseas airport, air cargo to a U.S. international airport, and large or small truck from the airport to the factory or foundry. From the factory or foundry, goods ultimately destined for North America will be sent by large or small truck for domestic assembly, testing, and packaging (ATP). From here, they are shipped by large truck to domestic customers, or by large truck to Mexico or Canada and North American customers.

Goods ultimately destined for overseas customers will be transported by large or small truck from the factory or foundry to a U.S. international airport, and then by air cargo to overseas airports. From here, they may be transported locally/regionally by truck for ATP or may be sent elsewhere internationally by air cargo for ATP before ultimately reaching the customer. Some electronics subsectors' ATPs facilities are heavily concentrated in China and East Asia. Due to the time sensitivity of some products, they must be exported by air.

FIGURE 34 ELECTRONICS BLOCK DIAGRAM



Source: WSP Global.

3.6.3 Fluidity, Critical Infrastructure, and Supply Chain Issues and Challenges

As indicated by the commodity flow data, some of the highest levels of activity associated with the computer and electronic products supply chain occurs on the following corridors. This analysis is based on flows of high-tech durable goods, which includes commodities used in other supply chains in addition to electronics manufacturing.

- **I-40 in Texas and Arkansas.** I-40 carries as much as 2.5 million tons of high-tech goods with the greatest concentration in Texas and Arkansas. The I-40 corridor spans the entire Nation, reaching from Southern

California to North Carolina, and is a critical connection to the region from West Coast ports. Within the ITTS region, I-40 interchanges with other important routes for high-tech manufacturing, specifically I-44 and I-35. The corridor connects to airports in Little Rock and Memphis and to rail facilities in Arkansas, Tennessee, and North Carolina.

- **I-10 in Texas.** The I-10 corridor in Texas handles approximately 2.3 million tons of high-tech products annually. This corridor connects advanced manufacturing and research facilities in the San Antonio and Houston areas to the ports along the Gulf Coast and markets to both the east and west. This segment is the least reliable segment of I-10 and one of the least reliable segments analyzed (11 percent buffer time). Average delay per 100 miles on this segment is nearly 9 minutes, slightly above average for the corridors analyzed.

- **I-44 in Missouri.** Over 2.1 million tons of high-tech goods travel on I-44 in Missouri annually. This corridor provides a connection between I-40, where parts from the West Coast enter the region, to St. Louis. Computer and electronics products in Missouri support the state and region's aerospace industry. The corridor also interchanges with I-70 providing connectivity to transportation and manufacturing in Louisville, Kansas City, and beyond Missouri.

- **I-35 in Texas.** I-35 in Texas connects several hubs of computer and electronics manufacturing. It provides a critical linkage to the Texas-Mexico border where binational manufacturing and assembly of a wide variety of electronic products occurs. The corridor also connects semiconductor and computer production and research facilities in Austin and Dallas-Fort Worth where Texas' electronics industry is most concentrated. The I-35 corridor connects to major airports and rail facilities in Dallas-Fort Worth and Kansas City, as well as the I-10, I-20, I-30, and I-40 corridors that traverse the ITTS region.

FIGURE 35 COMPUTER AND ELECTRONIC PRODUCTS MANUFACTURING SUPPLY CHAIN FLUIDITY—RELIABILITY

Source: National Performance Management Research Data Set; Texas A&M Transportation Institute; WSP Global; Cambridge Systematics.

FIGURE 36 COMPUTER AND ELECTRONIC PRODUCTS MANUFACTURING SUPPLY CHAIN FLUIDITY—DELAY

Source: National Performance Management Research Data Set; Texas A&M Transportation Institute; WSP Global; Cambridge Systematics.

3.6.4 Positioning the Region to Grow

The production of semiconductors, computer components, and other electronics is a significant and expanding sector of the region's economy. It is hastened by the region's growing motor vehicle manufacturing sector, as modern vehicles are increasingly relying on computers and electronics for core functions. The recent global shortage in semiconductors illustrates this as the shortage resulted in large-scale disruptions to automotive supply chains.[40]

One strategy to address computer and electronic supply chain challenges is Federal and state efforts to reshore the production of semiconductors and other critical components. The CHIPS and Science Act for Research, Development, and Workforce is an example as this initiative, among other goals, seeks to increase

[40] https://www.spglobal.com/mobility/en/research-analysis/the-semiconductor-shortage-is-mostly-over-for-the-auto-industry.html.

the amount of domestically produced semiconductors.[41] While this and similar strategies address production-side supply chain challenges, there is still potential to mitigate challenges on the multimodal freight network that links these production nodes. Specifically, corridors such as I-81 in Virginia, I-30 in Arkansas, and I-40 in Texas are among the busiest highways for transporting high-tech durable goods which include computer and electronics products. Improving network-level performance on these corridors through reducing and improving the reliability of travel times would strengthen the region's competitive position.

Rail intermodal plays a significant role in the computer and electronics supply chain for the ITTS region as a substantial share of these goods are transported via rail. Furthermore, California is among the region's top trading partners for computer and electronics goods. This suggests that in addition to highways, intermodal rail links are critical for this supply chain—especially those mainlines and intermodal terminals providing access to southern California.

[41] https://www.whitehouse.gov/briefing-room/statements-releases/2024/02/09/fact-sheet-biden-harris-administration-announces-over-5-billion-from-the-chips-and-science-act-for-research-development-and-workforce/.

4 NEEDS ASSESSMENT

The needs assessment describes the physical, operational, and policy/regulatory issues that are most significantly affecting the performance and efficiency of the multimodal freight system. It incorporates multi-state condition and performance data available from member states to develop a comprehensive understanding of needs, including current and future capacity constraints, including identifying bottlenecks; asset preservation deficiencies; truck involved crashes; truck parking deficiencies; and connectivity and accessibility gaps.

4.1 Performance-Based Assessment of Needs and Challenges

This section of the report focuses on the physical and operational issues impacting the performance and efficiency of the multimodal freight system. It relies on information gathered from a review of ITTS state freight plans, the ITTS Bottlenecks Study, as well as analyses of crash, travel time, pavement condition, and bridge condition data, among others.

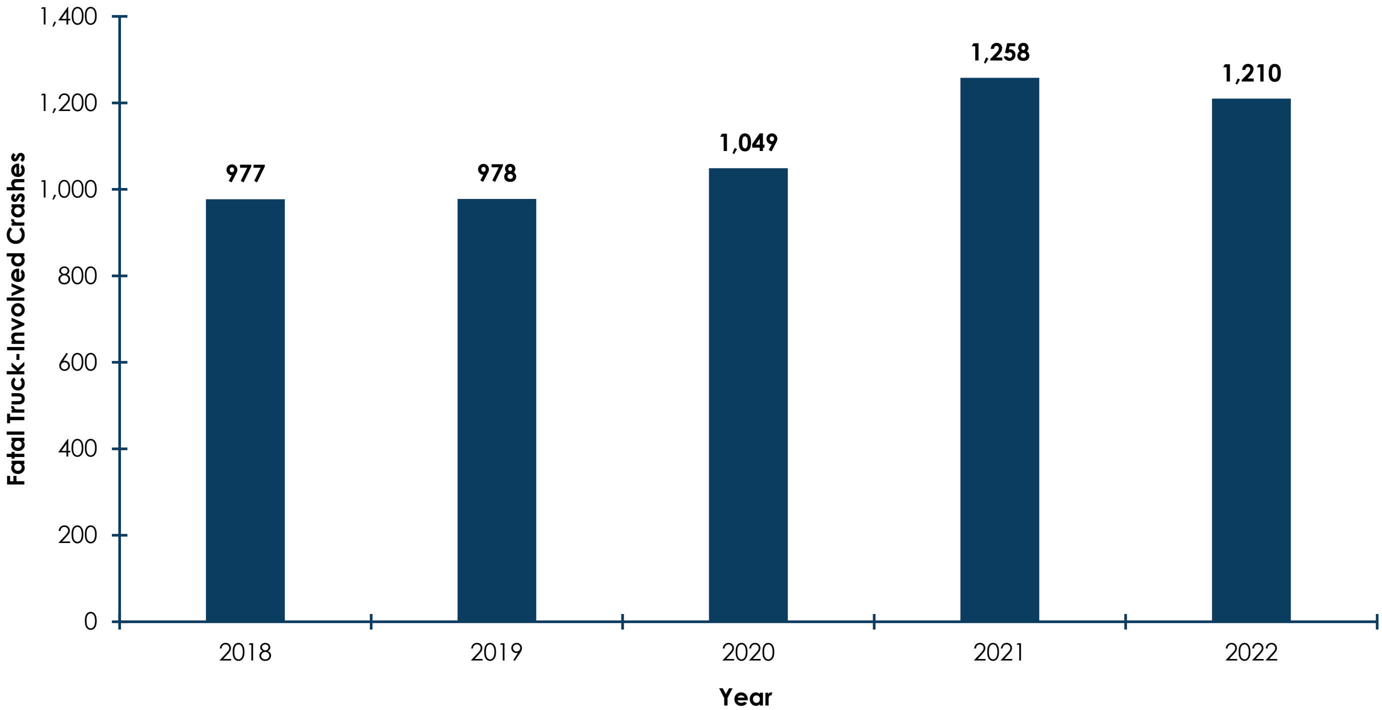
4.1.1 Safety

Fatal Truck Crashes

Transportation safety is extremely important and is one of the highest priorities at all levels of transportation planning and engineering—national, statewide, regional, and local. The safety analysis was conducted using 2018–2022 truck-involved fatal crash data from the Fatality Analysis Reporting System (FARS). FARS data was selected to ensure uniformity in truck crash data collecting and reporting across states. For purposes of this analysis, vehicle model types in FARS that correspond to medium/heavy truck vehicle types were considered as trucks. Additionally, the analysis was limited to the National Highway System (NHS). NHS corridors generally carry the majority of truck traffic and often traverse state lines, thereby being more representative of the entire ITTS region.

There were 5,472 fatal truck-involved crashes on NHS corridors across the ITTS region between 2018 and 2022. As shown in Figure 37, the number of fatal truck-involved crashes generally increased over the analysis period—rising from 977 crashes in 2018 to 1,210 in 2022. Year 2021 experienced the highest number of fatal truck-involved crashes across the region with 1,258 incidents. However, it should be noted that travel conditions during portions of 2020 and 2021 were atypical given the impacts of the COVID-19 pandemic on travel behavior as multiple states issued stay-at-home orders and schools shifted to remote learning. This change in travel behavior may have impacted the magnitude and frequency of fatal truck-involved crashes observed during that timeframe.

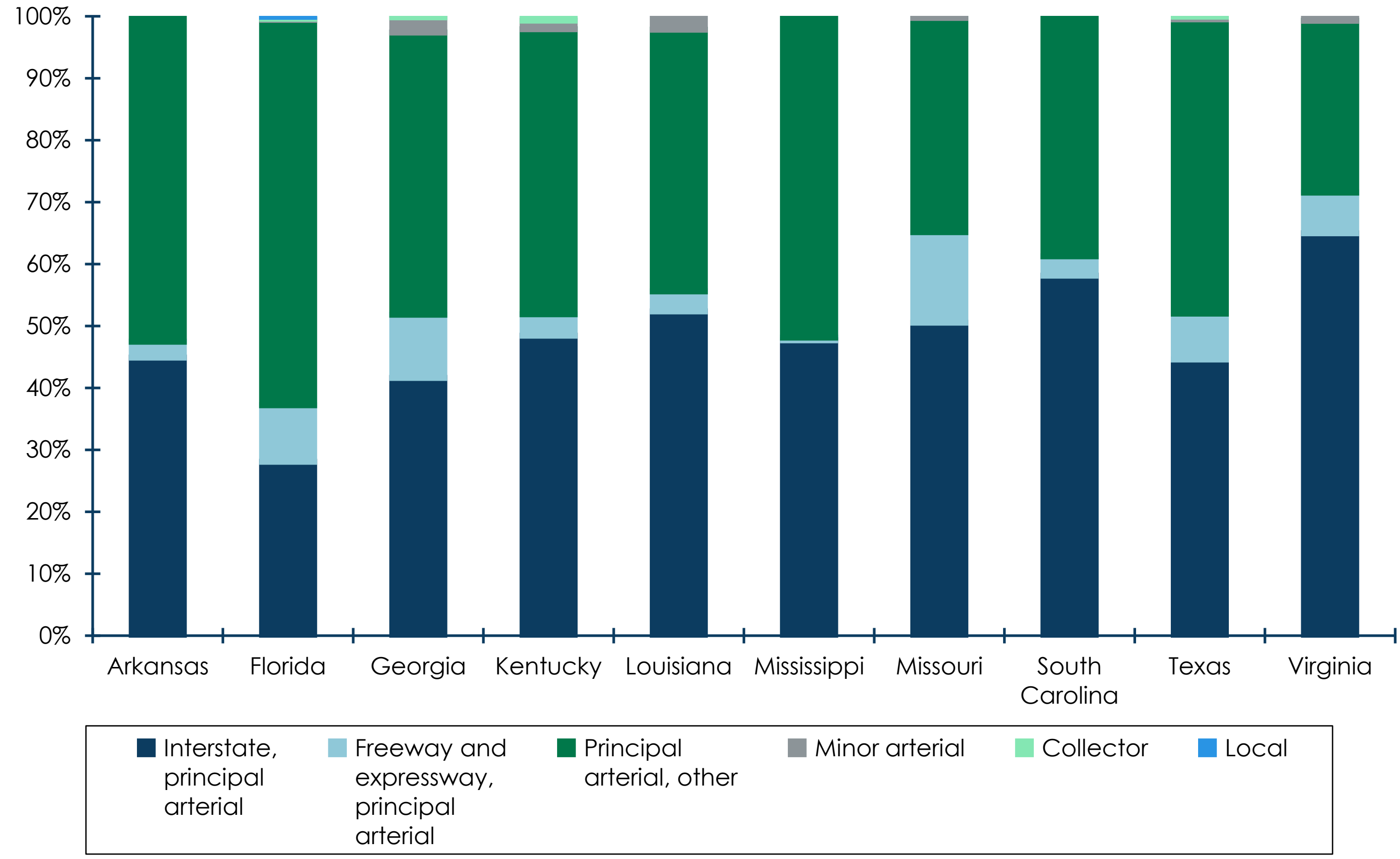
FIGURE 37 FATAL TRUCK-INVOLVED CRASHES, 2018–2022



Source: Fatality Analysis Reporting System; Texas A&M Transportation Institute; Cambridge Systematics.

Figure 38 shows the breakdown of fatal truck-involved crashes by functional class for each ITTS member state. In general, fatal truck-involved crashes occur along the highest functional class roadways as Interstates and principal arterials account for the highest shares. These roadways generally carry greater volumes of freight traffic, thereby increasing their exposure to crashes.

FIGURE 38 FATAL TRUCK-INVOLVED CRASHES BY FUNCTIONAL CLASS



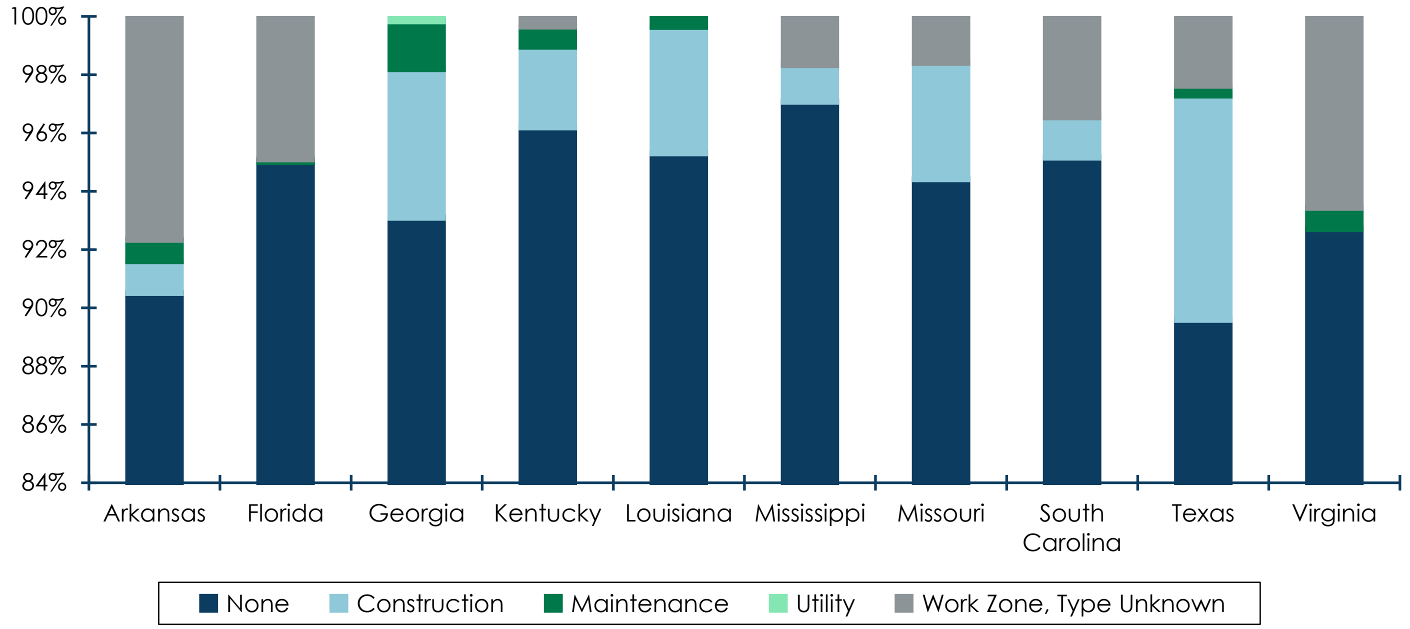
Source: Fatality Analysis Reporting System; Texas A&M Transportation Institute; Cambridge Systematics.

At the national scale, commercial motor vehicles are generally over-represented in fatal work zone crashes.[42] This may be due to several factors including physical constraints caused by the temporary degradation of roadway geometrics and operating conditions that make it more challenging for trucks to operate (e.g., lane closures, restricted lane widths and lateral clearances, shortened merge and diverge areas); the correlation between work zone activity times and the operating hours of large trucks; and the fact that work zones themselves generate multiple large truck trips to deliver materials and remove dirt and debris. These activities increase the relative exposure of large trucks to areas with work zones relative to areas without work zones. As a result, FHWA and several state DOTs have developed resources and practices to reduce the risk of large truck crashes in work zones.

Figure 39 shows the occurrence of fatal truck-involved crashes in work zones by ITTS state. Georgia, Louisiana, Missouri, and Texas appear to have among the highest shares of fatal truck-involved crashes in work zones across the region. However, it should be noted that several ITTS states have a significant number of fatal truck-involved crashes where the work zone status is not recorded.

[42] https://ops.fhwa.dot.gov/publications/fhwahop20027/fhwahop20027.pdf.

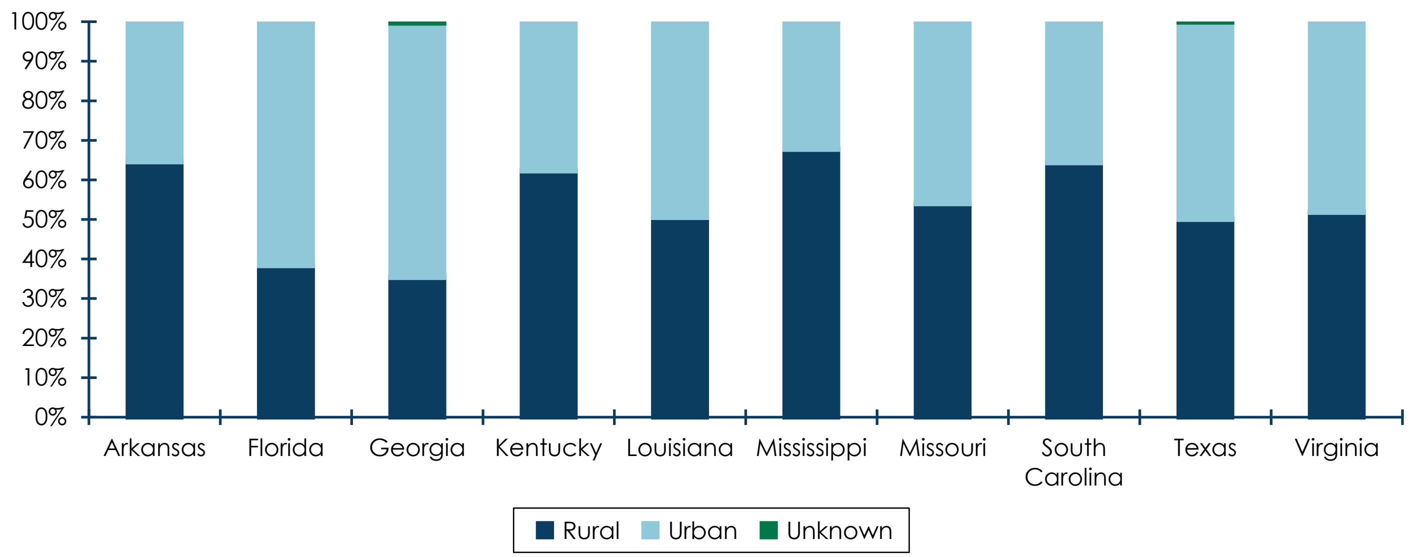
FIGURE 39 FATAL TRUCK-INVOLVED CRASHES IN WORK ZONES



Source: Fatality Analysis Reporting System; Texas A&M Transportation Institute; Cambridge Systematics.

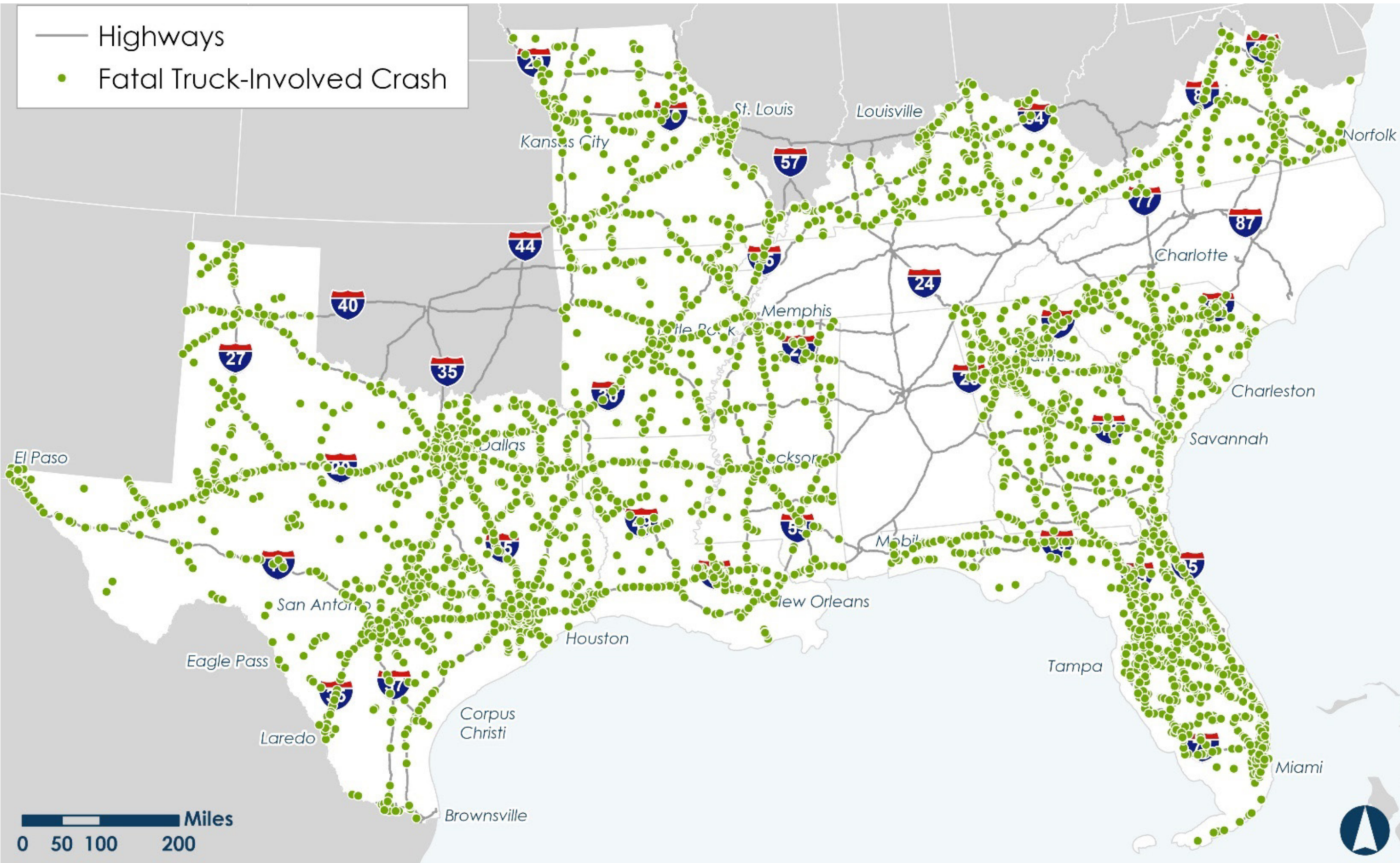
Fatal truck-involved crashes occurring in rural versus urban areas is shown in Figure 40. Figure 41 depicts fatal truck crashes in ITTS states along with the multimodal freight network. Overall, the data does indicate that these crashes are more prevalent in rural areas, but inconsistently so. For example, out of the 10 ITTS states, five have a higher share of fatal truck-involved crashes in rural areas; two states have a higher share of fatal truck crashes in urban areas; three states are nearly evenly split between urban and rural fatal truck crashes.

FIGURE 40 FATAL TRUCK-INVOLVED CRASHES ACROSS RURAL AND URBAN AREAS



Source: Fatality Analysis Reporting System; Texas A&M Transportation Institute; Cambridge Systematics.

FIGURE 41 MAP OF FATAL TRUCK-INVOLVED CRASHES IN THE ITTS REGION



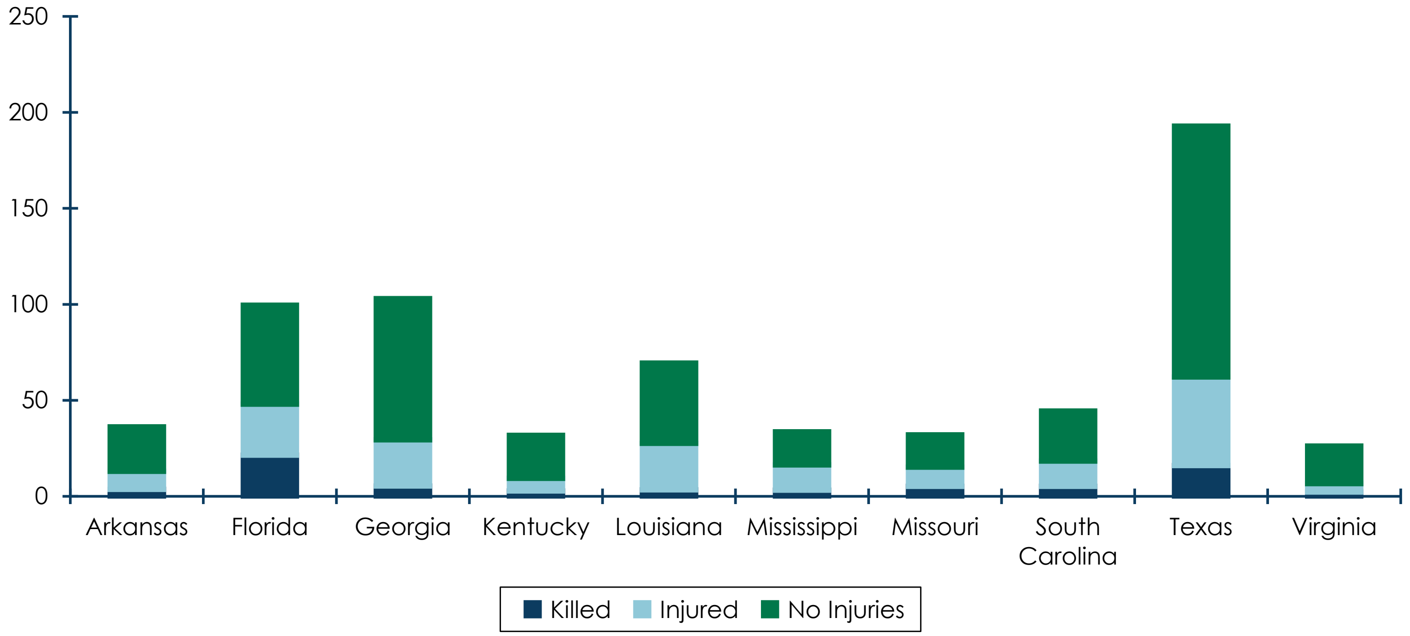
Source: Fatality Analysis Reporting System; Texas A&M Transportation Institute; Cambridge Systematics.

Highway-Rail Crashes

At-grade rail crossings represent points where the highway and rail systems interact and have the potential for conflict. Grade-level rail crossings can impose significant delays to trucks and other vehicles as they wait for trains to pass. In addition, trucks idling at crossings emit more pollutants especially as they must accelerate from a complete stop. Furthermore, at-grade crossings are a potential safety hazard as they present an opportunity for trains to collide with vehicles, pedestrians, or other roadway users.

Using data available from the Federal Railroad Administration's (FRA) Highway-Rail Crossing Inventory database, a safety analysis was performed for active at-grade public crossings for the region. Figure 42 shows the average annual crashes by severity at at-grade crossing between 2019 and 2023. The vast majority of these crashes resulted in property damage only. However, the risk of severe injuries or death for crashes at at-grade crossings is significantly higher than crashes at other locations.

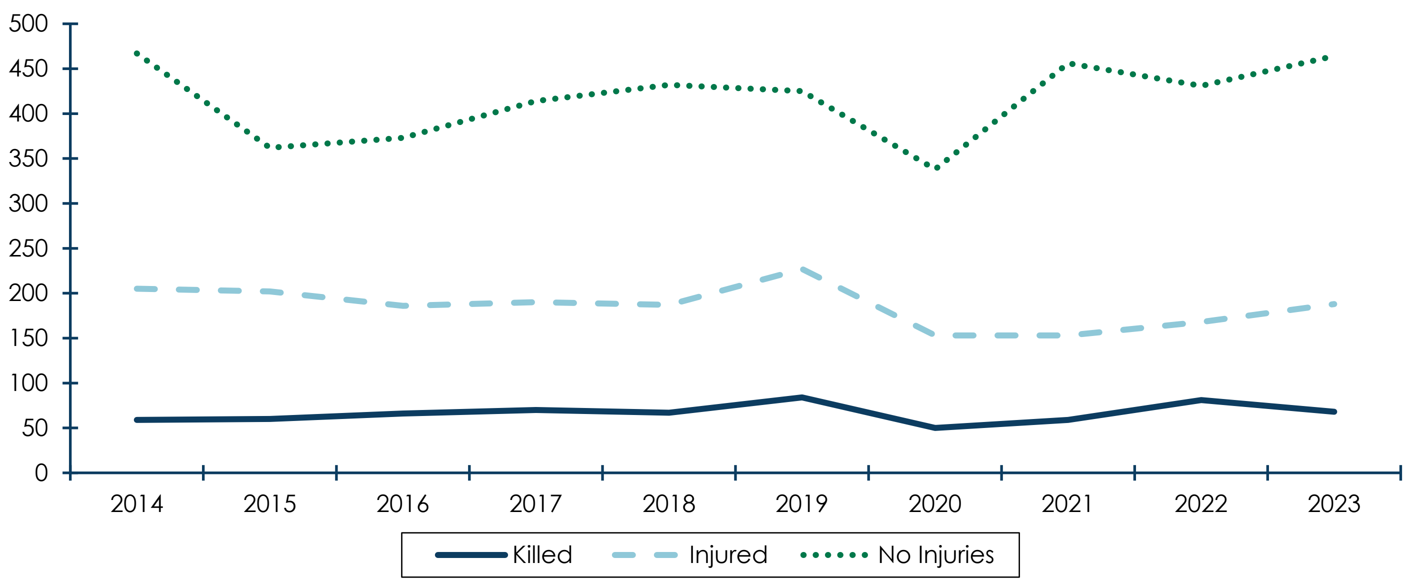
FIGURE 42 AT-GRADE CROSSING CRASHES, ANNUAL AVERAGE 2019–2023



Source: Federal Railroad Administration, Highway-Rail Grade Crossing Accident Data (Form 57).

Between 2014 and 2023, the ITTS region recorded 6,685 at-grade crossing crashes. Figure 43 shows the severity of these incidents. The overall trend showed an increase in at-grade crossing crashes from 2014 to 2019, followed by a decline in 2020. However, the number of crashes rose again from 541 in 2020 to 720 in 2023. 2019 had the highest number of at-grade crossing crashes within the analyzed period, with 736 incidents.

FIGURE 43 AT-GRADE CROSSING CRASHES, 2014–2023



Source: Federal Rail Administration, Highway-Rail Grade Crossing Accident Data (Form 57).

4.1.2 Bridge Conditions

Bridges which cannot handle typical truck sizes or weights may contribute to congestion and lead to significant re-routing as trucks find alternative detours. 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. One of the reasons a bridge can be a barrier for certain trucks is if the bridge is in poor condition. The National Bridge Inventory rates bridges on a 0-10 scale (10 being best condition and 0 being worst) based on numerous factors including their:

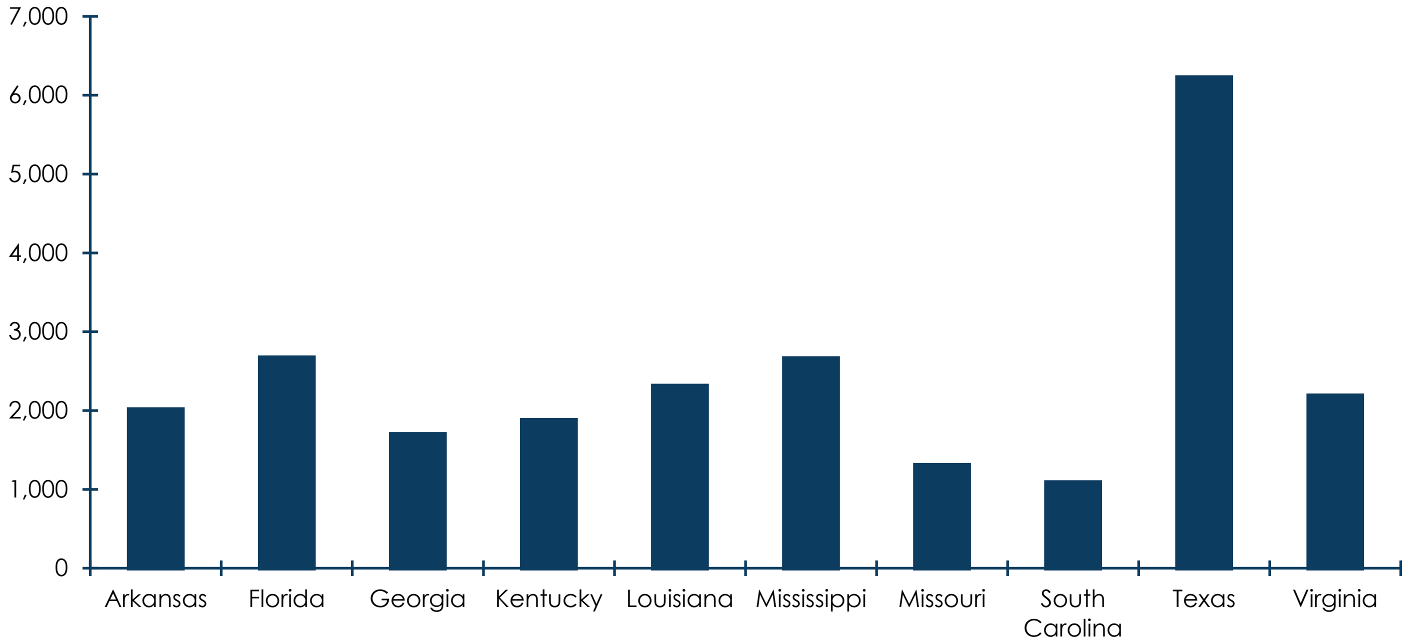
- Deck condition;
- Superstructure condition;
- Substructure condition; and
- Culvert condition.

Per Federal inspection standards, bridges are assigned a rating that represents the general condition of the structure. In accordance with the bridge performance measures final rulemaking, published in January of 2017, bridge condition is determined by the lowest rating of National Bridge Inventory (NBI) condition ratings for Item 58 (Deck), Item 59 (Superstructure), Item 60 (Substructure), or Item 62 (Box Culvert).[43] If the lowest rating is greater than or equal to 7, the bridge is classified as Good; if it is less than or equal to 4, the classification is Poor; if the lowest rating is 5 or 6 the classification is Fair.

As shown in Figure 44, there are 23,990 bridges on National Highway System (NHS) roadways in the ITTS region. Figure 45 shows the condition ratings of these bridges by state. The vast majority of bridges, over 90 percent across all member states, are in good to fair condition. Figure 46 shows Interstate highway bridges rated as being in poor condition across the ITTS region.

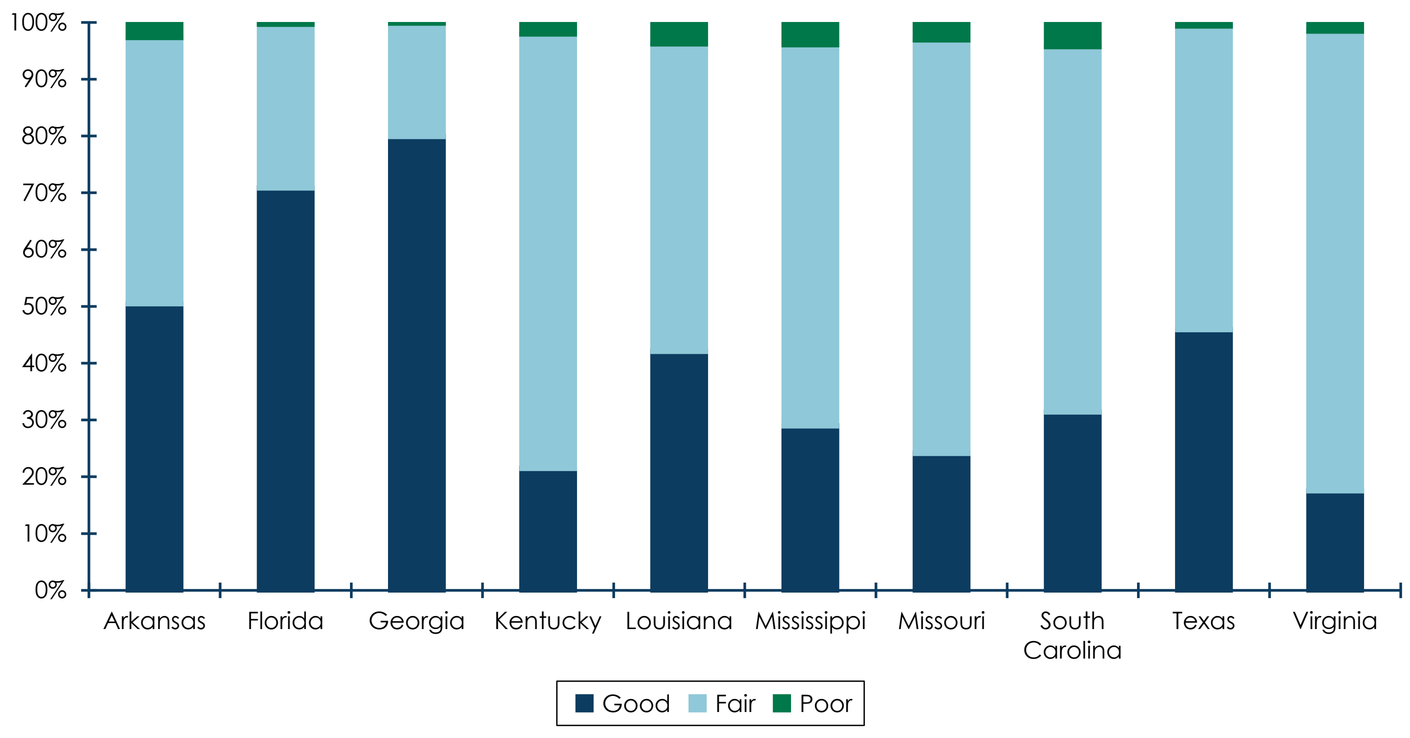
[43] U.S. Department of Transportation. Federal Highway Administration. Bridge Performance Measures. Final Rulemaking. Available at: https://www.fhwa.dot.gov/tpm/pubs/PM2BridgeFactSheet.pdf.

FIGURE 44 NATIONAL HIGHWAY SYSTEM BRIDGES IN THE ITTS REGION



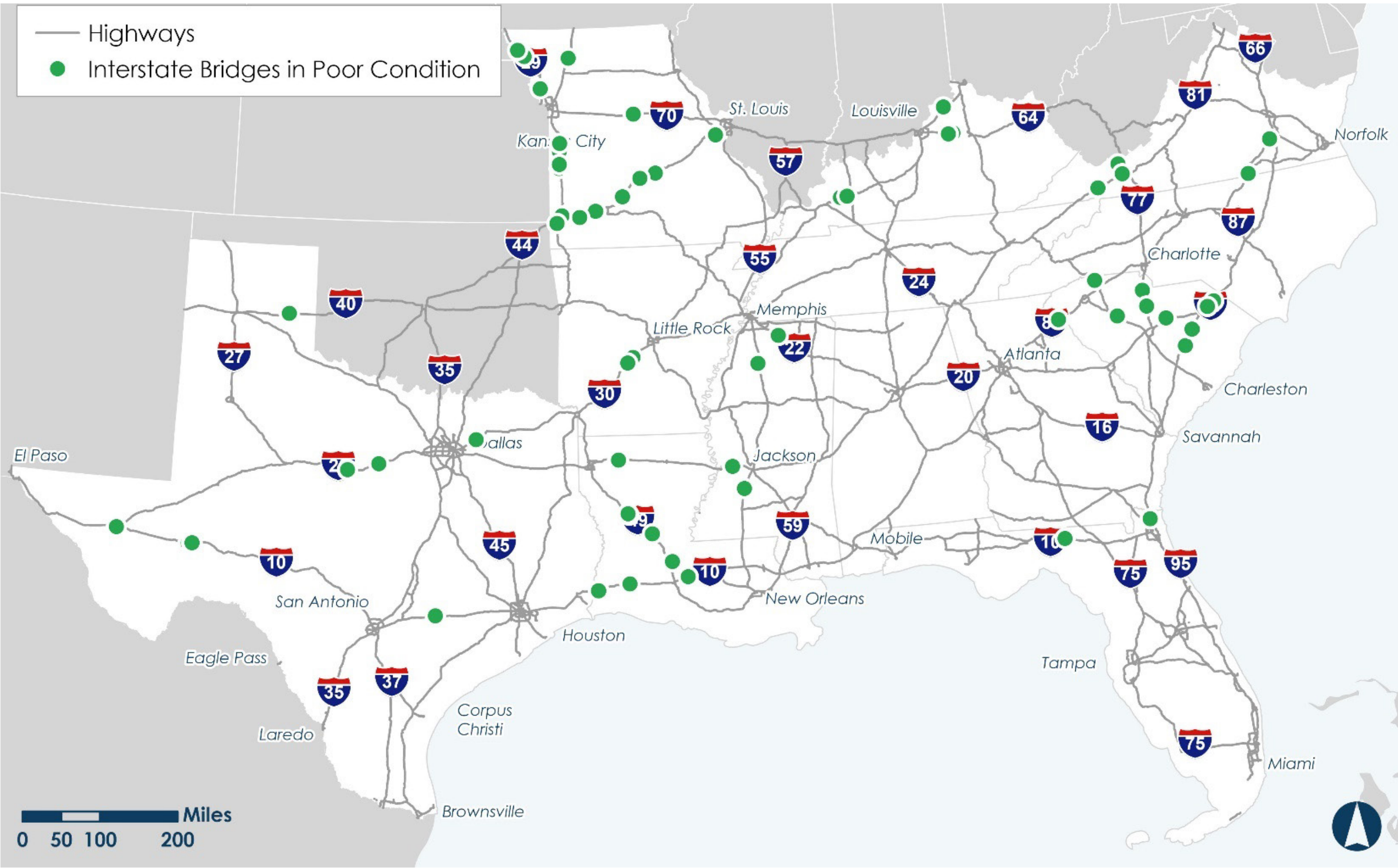
Source: National Bridge Inventory; Texas A&M Transportation Institute; Cambridge Systematics.

FIGURE 45 NATIONAL HIGHWAY SYSTEM BRIDGE CONDITIONS IN THE ITTS REGION



Source: National Bridge Inventory; Texas A&M Transportation Institute; Cambridge Systematics.

FIGURE 46 INTERSTATE BRIDGES IN POOR CONDITION IN THE ITTS REGION



Source: National Bridge Inventory; Texas A&M Transportation Institute; Cambridge Systematics.

4.1.3 Pavement Conditions

Roadway pavement condition can impact the cost and safety of travel for passengers and freight. 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 if vehicles must decrease their speeds to avoid potholes or other condition-related hazards. Pavement conditions may also impact safety performance.

The U.S. Department of Transportation under the Moving Ahead for Progress in the 21st Century Act (MAP-21) and FAST Act requires states to submit pavement performance measure data in a variety of areas to the Federal Highway Administration (FHWA). These last two laws have introduced reforms into the Federal-Aid Highway Program by establishing new requirements for pavement performance management to foster efficient investment of Federal transportation funds. Pavement condition performance measures based on the FHWA rulemaking are shown in Table 6.

TABLE 6 FHWA PAVEMENT PERFORMANCE RATING AND THRESHOLD

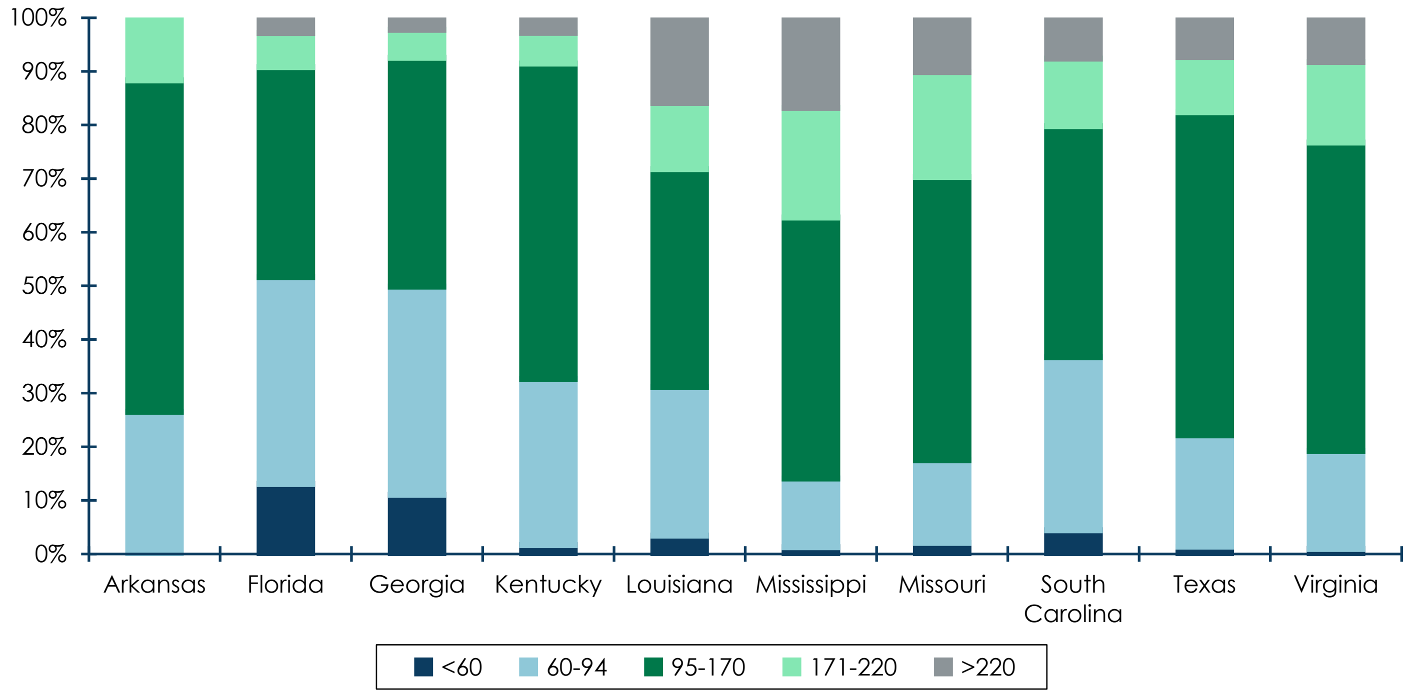
Metric	Good	Fair	Poor
IRI (inches/mile)	< 95	95–170	> 170
PSR (0.0–5.0 value)	≥ 4.0	2.0–4.0	≤ 2.0
Cracking Percent (%)	< 5	CRCP: 5–10	> 10
		Jointed Concrete: 5–15	> 15
		Asphalt: 5–20	> 20
Rutting (inches)	< 0.20	0.20–0.40	> 0.40
Faulting (inches)	< 0.10	0.10–0.15	> 0.15

Source: Federal Highway Administration (FHWA) Rulemaking for pavement.

Notes: IRI stands for International Roughness Index; PSR stands for Present Serviceability Index and may be used only on routes with posted speed limit <40 mph; CRCP stands for Continuously Reinforced Concrete Pavement.

Pavement conditions in the ITTS region based on IRI values are depicted in Figure 47. The IRI is a metric for assessing road surface quality and is expressed in inches per mile (in/mi). Lower IRI values indicate a smoother road surface, while higher values indicate a rougher surface. For most ITTS states, the majority of pavements were reported to be in good to fair condition. Generally, states reported that 60 percent or more of pavements were in good to fair condition.

FIGURE 47 INTERNATIONAL ROUGHNESS INDEX (IRI) BY STATE



Source: Highway Performance Monitoring System; Texas A&M Transportation Institute; Cambridge Systematics.

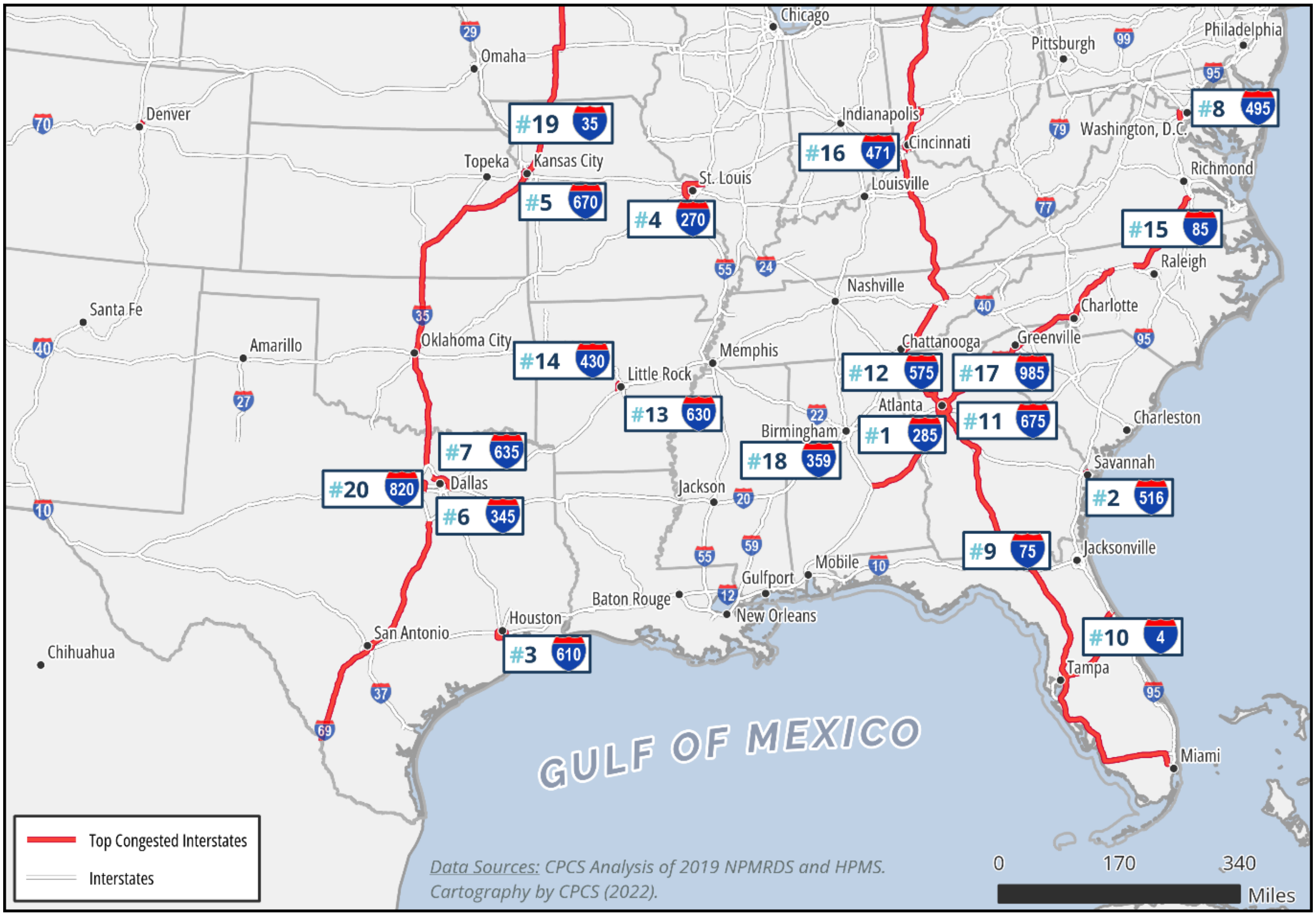
4.1.4 Truck Bottlenecks

The ITTS Regional Bottlenecks Assessment for Goods Movement Study assessed the extent, duration, and severity of truck bottlenecks in the Southeast to facilitate multi-state collaboration on potential recommendations that can be undertaken to reduce top bottlenecks. Truck speed data from the National Performance Management Research Data Set (NPMRDS) and truck count data from the Highway Performance Monitoring System (HPMS) for the year 2019 data were the primary data sources. The analysis contained two main components: segment-based bottleneck analysis and trip-based bottleneck analysis. The segment-based bottleneck analysis provided a common platform for studying top bottlenecks in the Southeast and the trip-based bottleneck analysis showed how bottlenecks in a certain state affect multi-state economic competitiveness. Both analyses exemplify the need for multi-state coordination to address top regional bottlenecks.

The ITTS study calculated the following performance measures: average truck speeds, truck travel time reliability index, truck delay per mile, annual hours of truck delay, and annual cost of truck delay. Congestion was measured in three ways: by state, by interstate, and by roadways aggregated at a county level, while bottlenecks were ranked based on truck delay per mile, total hours of truck delay, and cost of truck delay. The analysis found that in 2019, the Southeast Region experienced 271 million hours of total truck delay, amounting to 470 million gallons in wasted truck fuel and $18 billion in direct costs. Furthermore, among the thirteen member states, Georgia, Tennessee, and Louisiana experienced the highest average truck delay per mile in 2019—amounting to over 2,000 average hours of truck delay per mile. Peak-period traffic—followed by traffic incidents, work zones, and weather—was found to be the top bottleneck cause in the Southeast.

The ITTS freight bottlenecks study also identified the top congested interstates. As shown in Figure 48, the top five congested interstates by truck delay per mile are beltways or auxiliary routes: I-285, I-516, I-610, I-270, and I-670 due to the concentrated congestion levels on these relatively shorter corridors. When measured by total hours and cost of truck delay, the top five congested interstates are I-75, I-285, I-85, I-10, and I-95 due to both high truck volumes and delay.

FIGURE 48 SOUTHEAST STATES—TOP 20 CONGESTED INTERSTATES BY TRUCK DELAY PER MILE (2019)



Source: Institute of Trade and Transportation Studies, ITTS Regional Bottlenecks Assessment for Goods Movement Study, 2022.

In addition to interstates, the study also identified the top congested multi-state trade lanes. The top trade lanes were determined based on multi-state commodity flows and consultations with the member states. Among these, the top twenty congested trade lanes measured by truck delay per mile are shown in Figure 49. A cluster of top congested trade lanes in the region have an origin, destination, or intersection in Atlanta, Birmingham, Chattanooga, Greenville, and Nashville.

FIGURE 49 SOUTHEAST STATES—TOP 20 CONGESTED MULTI-STATE TRADE LANES (2019)

Source: Institute of Trade and Transportation Studies, ITTS Regional Bottlenecks Assessment for Goods Movement Study, 2022.

Freight congestion in the Southeast Region affects economic competitiveness, reduces safety, deteriorates roadway assets more quickly, contributes to air pollution and carbon emissions, and impacts the quality of life for over a third of the U.S. population. As a result, strategies to address freight congestion are critical to ITTS. Southeast states employ a variety of strategies to address top bottlenecks in their states including through policies, partnerships and programs, and projects shown in Figure 50. Many states expressed that collaboration with other states is key to addressing shared bottlenecks across the region from coordinated planning to infrastructure improvement projects, operational improvements, and technology deployments.

FIGURE 50 SOUTHEAST STRATEGIES TO ADDRESS BOTTLENECKS

Policies

- Maintain and improve designated freight networks.
- Identify locations with existing bottlenecks.
- Integrate considerations for and prioritize severe congestion locations.
- Define and implement performance measures.

Partnerships and Programs

- Promote use of freight technologies.
- Consider cost-effective methods of capacity expansion.
- Partner with the private sector.
- Work with multi-state partners.
- Secure funding.

Project Types

- Widen and repave; add lanes; improve intersections and interchanges.
- Enhance routing options.
- Provide truck-only lanes, bypass routes, truck climbing lanes.
- Implement proven technology solutions.
- Other non-traditional capacity improvements to improve congestion
- Other innovative designs to improve capacity.

Source: Institute of Trade and Transportation Studies, ITTS Regional Bottlenecks Assessment for Goods Movement Study, 2022.

4.2 Stakeholder-Informed Assessment of Needs and Challenges

SETTS Phase II stakeholder engagement built on the foundation established during Phase I. Specifically, it conducted a series strengths, weaknesses, opportunities, and threats (SWOT) workshops and survey focused of the ITTS region's multimodal freight network and supply chains. A SWOT analysis is a strategic planning tool to help organizations assess their internal and external environment to understand their current situation and develop strategies for the future. The SWOT engagement activities help to ensure that the findings of the SETTS Phase II study are relevant to contemporary challenges and opportunities faced by the member states as they advocate for improved transportation and trade performance in the region.

The purpose of the SWOT workshops was to provide the ITTS member states information to enhance collective planning activities and develop communal strategies that may benefit the entire Southeast Region.

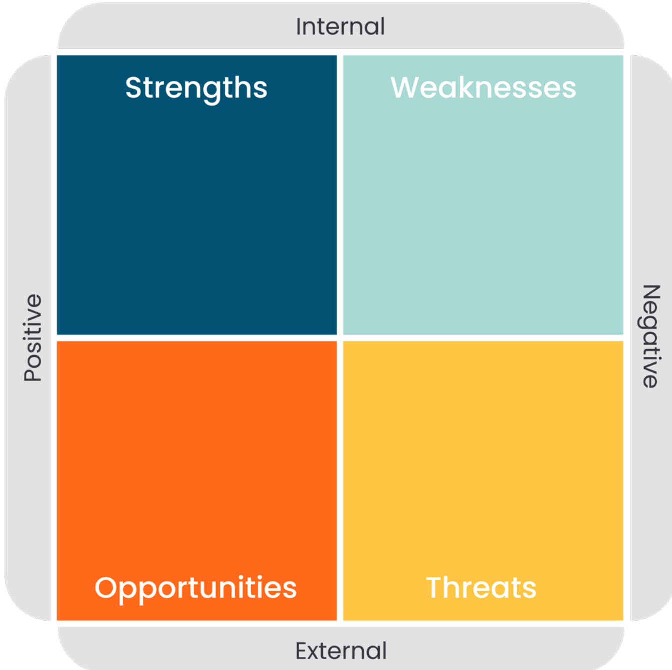
- **Strengths—**These are the internal attributes or resources that give an organization an advantage over others. Strengths can include internal factors that a DOT may control or influence, such as transportation network attributes and state policies, or inherent characteristics of the regions, such as markets and demographic factors.
- **Weaknesses—**These internal factors may limit or hinder performance or success. Weaknesses may include some of the same factors as strengths and can be considered areas for improvement.

- **Opportunities—**These are external factors or situations that may be leveraged to improve the environment where the DOTs operate. Opportunities might include emerging markets, changes in regulations, or technological advancements.

- **Threats—**These external factors could potentially harm or negatively affect an organization. Threats might include market competition, economic downturns, global events, or extreme weather events.

As shown in Figure 51, the SWOT framework can be characterized as a matrix consisting of four quadrants representing each element of SWOT—strength, weakness, opportunity, and threat. Furthermore, along the vertical and horizontal axes lie a range of factors—internal to external, positive to negative—that may potentially impact trade and goods movement in the ITTS region. As shown in Figure 51, these factors were conceptualized within each quadrant of the SWOT matrix as a series of questions to guide the workshops and survey.

FIGURE 51 SWOT MATRIX



Source: Texas A&M Transportation Institute.

TABLE 7 GUIDING QUESTIONS FOR THE SWOT WORKSHOPS AND SURVEY

Strengths	Weaknesses
Strengths of the ITTS region include strong growth in population and labor force, a relatively low cost of living, and a business environment that is generally welcoming of freight intensive industries. The following are key questions to guide the discussion on the region's strengths: • What market attributes are foundational for international trade. • What parts of the supply chain are consistently reliable? • What part of the freight system is critical for to international trade?	Weaknesses for the region include multiple recurring freight bottlenecks, infrastructure conditions and freight assets that are beyond their useful life (e.g., bridges, ports, etc.), a lack of transportation alternatives for commuters which further stresses the highway network, and an insufficient supply of truck parking along key highway freight corridors. The following are key questions to guide the discussion on the region's weaknesses: • What changes in the market could have negative impacts in trade and the economy? • What portions of the supply chain that are prone to failure or delays? • What systematic features of the freight system are unreliable or a significant bottleneck?

Opportunities	Threats
The region's weaknesses also represent opportunities to improve its future outlook. As the region addresses these challenges, it improves its ability to leverage its strengths to facilitate trade and reap the associated economic benefits. Furthermore, advances in transportation and communications technologies create a broader opportunity for the ITTS region to lead in the application of connected vehicle and smart infrastructure solutions to freight transportation challenges. The following are key questions to guide the discussion on the region's opportunities: • What market is untapped and demonstrates potential for increased international trade? • What technology or policy could improve efficiencies in the supply chain or trade? • What investments couple improve the efficiency of the freight system?	Extreme weather, geopolitical conflicts, and public health emergencies are just a few of the external factors that represent threats to the ITTS region's ability to facilitate global and domestic trade. Identifying these potential threats, and strategies to improve the resiliency of the freight transportation network to disruptions, is critical for the economic competitiveness of the region moving forward. Below are key questions to guide the discussion on the region's threats: • What global or national events could have a significant impact to critical markets or trade? • What market factors could have a negative impact on the supply chain? • What external factors pose a risk to the freight system?

Source: Texas A&M Transportation Institute.

Two SWOT workshops and one online survey were conducted as part of stakeholder engagement:

- **OKI Conference on Freight—September 7, 2023.** The OKI Conference on Freight included representatives from ITTS member states as well as other states within or border the ITTS region. This conference provided an opportunity to gather information from a geographically broad array of stakeholders as opposed to those solely within the ITTS region. As a result, this workshop yielded a national perspective on the SWOT characteristics for markets and freight systems and their impact on the ITTS region.

- **Technical Advisory Committee (TAC) Workshop—December 19, 2023.** The TAC SWOT workshop engaged the ITTS TAC and provided them an opportunity to weigh in on the SWOT characteristics that are most important to the ITTS region.

- **Freight Advisory Committee Survey—February 27 to March 25, 2024.** This online survey engaged representatives from ITTS member states' freight advisory committees (FACs). The purpose of targeting these potential participants is that they were able to speak to the broader economic implications of identified strengths, weaknesses, threats, and opportunities to the ITTS region.

During the three activities, sixty-one participants contributed to identifying the needs and opportunities for the region. The following subsections summarize the key findings and results of the outreach. Table 8 summarizes major themes from the SWOT analyses. A more detailed discussion of the results in presented in the subsections that follow.

TABLE 8 OVERVIEW OF MAJOR THEMES FROM THE SWOT OUTREACH

Strengths	Weaknesses
• Business Environment: – Economic Development, Business Friendly • Diverse Economic Base: – Agriculture, Manufacturing—Automobile, Petroleum • Diversity of Modes/Multimodal Network: – Intermodal Connectivity, Ports and Barges, Air Cargo, Highways • Proximity to Domestic Customers: – E-commerce • Access to Markets: – International Gateways, Interstate Trade, Strategic Location • System Resilience and Redundancy • Bipartisan Infrastructure Bill	• Multimodal Network • Reliance on Single Modes, Accommodating Customers, Developing Advanced Air Mobility • Performance • Highway Bottlenecks and Congestion, Trucks on Local Roadways, System Safety • Accessibility • Interstate Highways, Rail/Port Connectivity • Infrastructure • Aging/Condition, Connectivity, Pipeline Capacity, Rail Capacity • Governance • Reactive instead of Proactive, Collaboration between Government and business, Agency Resources • Project Timelines, Loss of Institutional Knowledge, Truck Configurations • Emissions • Truck Parking
Opportunities	**Threats**
• Modernize the Supply Chain • Infrastructure: – Increase Resilience, Increase Capacity, Inland Ports, Expanded Inland Waterways • Policy and Governance: – Bipartisan Infrastructure Law, Leverage Freight Advisory Committees, Multi-state Coordination • Advanced Air Mobility • Modal Shift • Truck Parking • Embrace Technologies • Operations: – Beyond Just-in-Time • Research Partnerships • Education: – Higher Education, Educational Co-ops, Trade Schools • Land Use: – Improved Planning, Right-of-Way Opportunities • Technology: – Automation, Improve Data Sharing, Electric Vehicles and Alternate Fuels What investments couple improve the efficiency of the freight system?	• Environmental Factors: – Weather Impacts on Agriculture, Vulnerable Coastal Infrastructure, Drought Impacting Maritime Routes, Extreme Weather • Land Use: – Competition/Loss of land • Demographics and Labor: – Training and Education, Labor Shortage, Aging Workforce, Shrinking Rural Populations/Migration, Income Disparities • Global Trade : – Currency Rates, Instability of Nearshoring • Policy: – Energy, Funding, Interest Rates, Vehicle Configuration and Size, Transparency in Government, Short-term Policies • International Diplomacy: – War and Conflict, Foreign Investment, Trade Policy • Cyber Security • Fuel Prices • Theft • Cost of Real Estate

Source: Texas A&M Transportation Institute.

The key findings from the SWOT outreach are summarized below:

- **Strengths—**The region has several internal attributes that make it attractive for freight-intensive industries. Among them, the region has a robust multimodal freight network that offers shippers a diverse range of modal options. The redundancy of the region's network enhances its resilience. Furthermore, population growth and a business-friendly environment improves the region's competitiveness for freight-related industries and their supply chains.
- **Weaknesses—**In some instances, the region's strengths are directly related to its weaknesses. Though the region has a robust multimodal freight network, it is aging and has deferred maintenance which hinders its performance. Related to this, there are programmed but unfunded projects to not only bring the system to a state of good repair but to also expand its footprint and improve performance. In addition, the condition and performance of the region's network is negatively impacted by the frequency of inclement weather events.
- **Threats—**The ITTS region is exposed to the same global factors that impact goods movement elsewhere. Global instability, recession, and extreme weather events all negatively impact the region and threaten its economic outlook. As critical infrastructure and supply chain management may be increasingly stressed by these factors, the region develops strategies to plan for and adapt to these external factors.
- **Opportunities—**Transportation technology advancement and innovation, the growth of e-commerce as the preferred method for consuming goods, and new or enhanced trade potential all represent opportunities for the ITTS region. However, taking advantage of these opportunities requires that the region address its weaknesses and mitigate potential threats.

4.2.1 Strengths

The ITTS region's overall business-friendly environment, diverse economic base, and access to all modes of freight transportation were some of the most often cited examples of the region's strengths:

- **Business and Economic Environment.** Stakeholders communicated that the region has an overall positive business environment with strong economic growth. These are regional strengths for supporting trade and freight-intensive industries. Stakeholders mentioned that ITTS states actively promote megasites for manufacturing and other freight-related development which has resulted in a growing manufacturing base.
- **Diversity of Modes/Multimodal Freight Network.** The region's multimodal network is a source of strength due to the diversity of freight modes if offers. Stakeholders communicated that shippers have multiple modal options available to them for managing their supply chains. The ITTS region's robust network of highways, Class I rail, deepwater ports, river ports, airports, and other modes also make for a more redundant (and thus resilient) network.
- **Population Growth.** The ITTS region has strong population growth which translates to a growing consumer base and labor market. Though population growth is uneven across the region with some states

experiencing much more substantial growth than others, overall steady population growth has benefited the region and is a strength for increasing domestic and international trade.

4.2.2 Weaknesses

Weaknesses represent internal factors may limit or hinder the region's performance or success and are often closely tied to its strengths.

- **Funding.** The passage of the 2021 Infrastructure Investment and Jobs Act (IIJA), or Bipartisan Infrastructure Law (BIL), substantially increased the amount of transportation funding available to the multimodal freight system both in terms of formula and discretionary dollars. However, stakeholders communicated that funding remains a weakness across the region as investment needs exceed funding. Across the region there is programmed, but unfunded infrastructure investments that would improve the condition and performance of the freight network which would benefit trade.

- **Aging Infrastructure.** While the region's extensive multimodal freight network with diverse modal options for shippers was viewed as a strength, stakeholders viewed its state of repair as a weakness. Related to funding, stakeholders noted that the region has aging infrastructure that inhibits freight mobility. The region's inland waterway system was raised as a specific example of where deferred maintenance has negatively impacted the performance and attractiveness of the mode as an option for shippers.

- **Natural Disasters.** Portions of the region are susceptible to natural disasters that disrupt supply chains. In recent years, hurricanes, flooding, tornadoes, and other weather events have damaged and disrupted freight assets across the region, especially in coastal areas. Examples include flash flooding which disrupted I-10 in Louisiana in 2023 as well as Hurricanes Idalia and Ian which impacted major freight corridors in Florida and southeast Georgia in 2023 and 2022, respectively.[44] Stakeholders communicated that the prevalence of natural disasters in certain parts of the region is a weakness given their potential to disrupt supply chains and damage critical freight assets.

4.2.3 Opportunities

Opportunities represent external factors or situations that may be leveraged to improve the environment where the member state DOTs operate. Figure 52 shows the SWOT analysis results across the three groups included in the engagement activities. A few major themes are prevalent across the groups which are discussed in the list below.

- **E-commerce.** E-commerce is a strategy for business-to-consumer (B2C) and business-to-business (B2B) sales that leverage digital platforms instead of brick-and-mortar marketplaces. E-commerce increased from about 4 percent of total retail activity in 2010 to nearly 15 percent of total retail sales, over $1 trillion in 2022.[45] The steady growth of e-commerce as a preferred method for purchasing consumer goods has impacted freight traffic and land use patterns in metropolitan areas throughout the ITTS region. The region's metropolitan areas have experienced an influx of warehousing and distribution center developments to

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[44] https://www.wdsu.com/article/interstate-10-partially-closed-amid-flash-flooding/44992623.

[45] U.S. Census Bureau, "Estimated Annual U.S. Retail Trade Sales—Total and E-commerce: 1998–2022," Annual Retail Trade Survey: 2022.

support this economic activity. Stakeholders generally viewed e-commerce as an opportunity for the region, though it should be noted that opportunities related to e-commerce are accompanied by challenges as well. These include increased congestion at ports, changes in truck trip patterns, and sometimes conflicting roadway users at the "last mile."

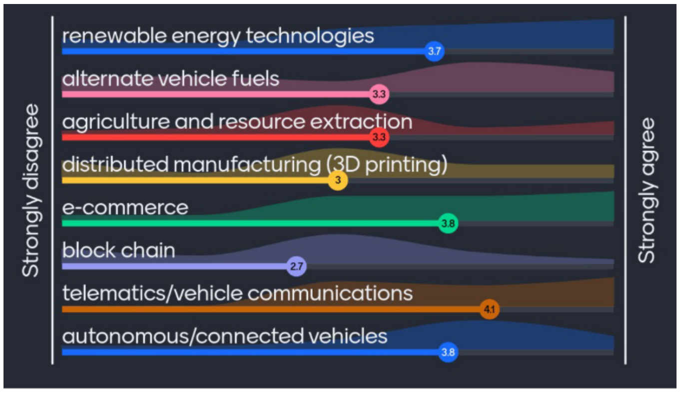
- **Agricultural and Resource Extraction.** Agriculture is one of the largest industries across the ITTS region. Stakeholders viewed this industry, along with extraction industries such as mining and energy exploration, as an opportunity for the region. The population growth experienced across the region along with favorable international trade agreements, such as the USMCA, could be a boon to the region's trade of agricultural goods and natural resources.

- **Telematics/Vehicle Communication.** Stakeholders communicated that telematics/vehicle communication was an important opportunity area for the ITTS region. Connected vehicle (CV) technology utilizes short-range communications (commonly referred to as V2X or vehicle-to-everything) to sense what other travelers are doing and to identify potential hazards. Vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) allow for vehicles to have an awareness of each other's location which could yield safety and operational improvements. For example, with V2I communications vehicles are equipped with transceivers that communicate with roadside infrastructure allowing them to be notified of abrupt stops ahead, curves, wrong-way drivers, or other safety hazards. Regarding operations, V2V technologies enable platooning which could improve fuel efficiency while V2I technologies could divert trucks away from blocked rail crossings as just two examples.

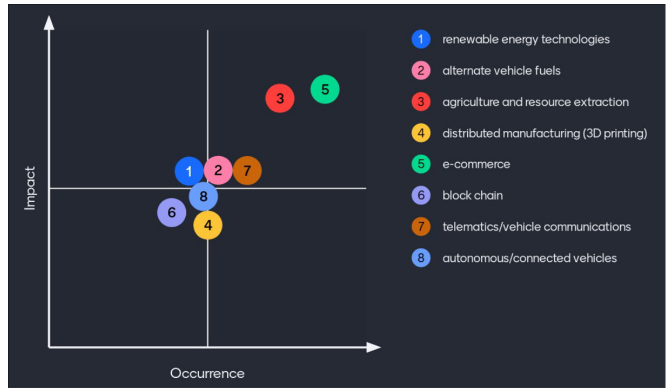
  Telematics/vehicle communication technologies also allow certain vehicle functions to be automated. Automated vehicle technologies for trucking—including driver assistance, autonomous vehicles, and connected vehicles—could substantially reduce fuel, labor, and/or equipment costs for trucking, thereby potentially reducing the cost of truck transportation for the region's freight customers. For example, predictive cruise control, which combines cruise control with GPS and topographical data can optimize fuel performance across varying terrains. Automation could provide meaningful transportation safety benefits by reducing truck crashes through the use of technologies such as forward collision warning, camera systems, and automatic emergency braking.

  Overall, stakeholders indicated that telematics/vehicle communications are an opportunity for the region to increase its competitiveness. Some of these technologies are already being increasingly deployed by the trucking industry. However, it should be noted that higher levels of automation have not yet been proven in real world applications.

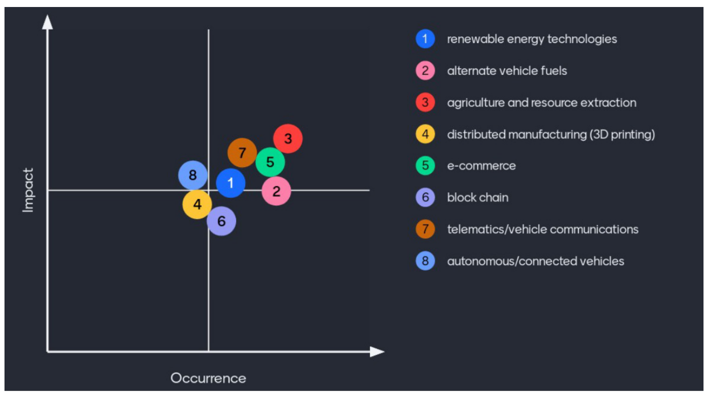
FIGURE 52 STAKEHOLDER FEEDBACK ON POTENTIAL FOR TECHNOLOGY TRANSFORMATIONS



(a) OKI Conference



(b) ITTS Technical Advisory Committee



(c) Freight Advisory Committees

Source: Texas A&M Transportation Institute.

4.2.4 Threats

Threats represent external factors could harm or negatively impact the region, its multimodal freight network, and the supply chains that rely on that network. Figure 53 shows the SWOT analysis results across the three groups included in the engagement activities: OKI Conference attendees, the ITTS Technical Advisory Committee, and the member states' Freight Advisory Committees. Across the three groups, a few major themes are prevalent which are discussed in the list below.

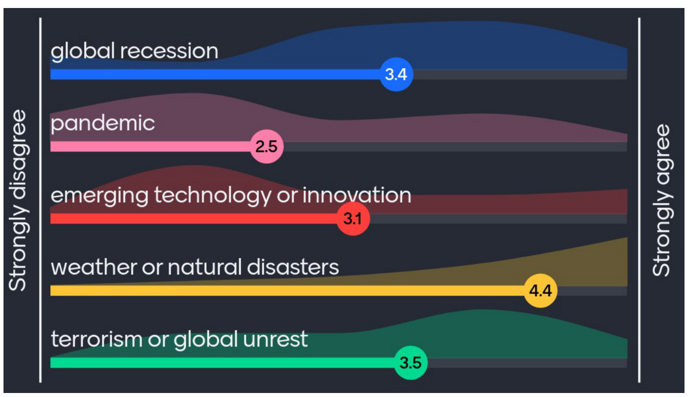
- **Weather or Natural Disasters.** Extreme weather and natural disasters can impact the ITTS region several different ways. They can interfere with crop and agricultural production; create a surge in demand for goods for post-storm recovery; and damage critical freight assets and disrupt supply chains. Stakeholders identified weather and natural disasters as one of the primary threats to the region. As critical infrastructure will be increasingly stressed by these events, it is critical that the region develop strategies to adapt to these changes.

- **Global Recession.** Stakeholders communicated that a global recession represents a serious threat to the region. The "great recession" of 2009 resulted in a substantial reduction in growth in freight-related gross domestic product (GDP) relative to years pre- and post-2009. Another global recession would potentially negatively impact these industries.

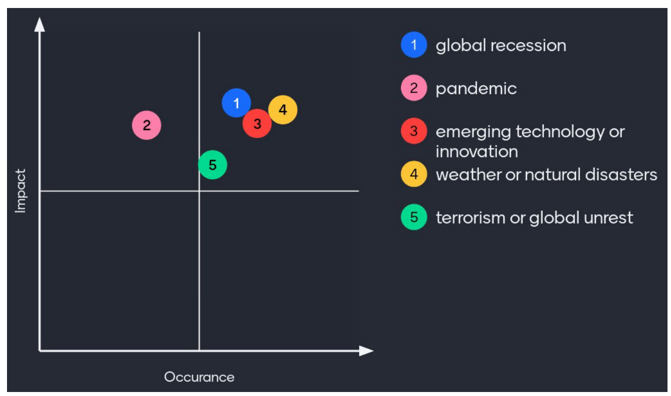
- **Terrorism or Global Unrest.** Global political instability is always a concern and was raised by stakeholders as a threat to the region. As of this writing, Russia and Ukraine remain at war which has disrupted important trade relationships with Ukraine. In particular, Europe may need to source more grains and fuels from North America in lieu of Russian and Ukrainian sources, while the U.S. will need to find replacements for goods currently sourced from Russia and Ukraine.

  Another example is China's relationship with Hong Kong, Taiwan, and its other neighbors that has been increasingly in question over the past two decades, especially so with recent steps to tighten control over Hong Kong. China's ongoing tensions with the Philippines over control of the South China Sea is particularly important for global trade as it is one of the world's most prominent shipping lanes. Furthermore, any unrest or instability involving China would impact the ITTS region given China's economic interdependence with the U.S. and Europe.

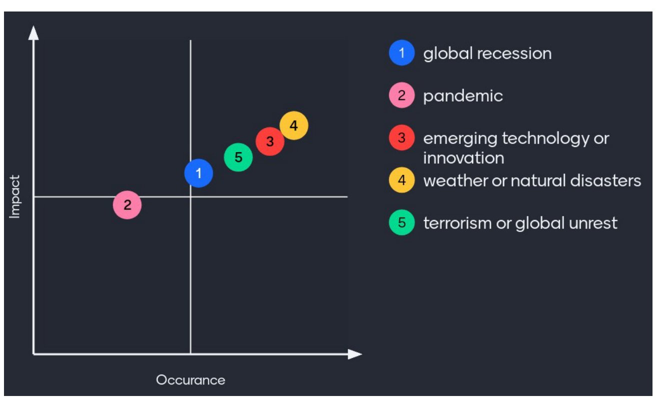
FIGURE 53 STAKEHOLDER FEEDBACK ON POTENTIAL THREATS



(a) OKI Conference



(b) ITTS Technical Advisory Committee



(c) Freight Advisory Committees

Source: Texas A&M Transportation Institute.

4.3 Summary of Regional Needs and Opportunities

Insights from both the performance-based analysis and outreach to stakeholders informs the assessment of regional needs and opportunities. Overall, both indicate that safety, bottlenecks, infrastructure conditions, resiliency, multimodal connectivity (including truck parking), and funding are among the region's most pressing needs. Those needs are categorized as modest, moderate, and acute across the ITTS regional freight network as shown in Table 9. However, it should be noted that the ratings presented in in Table 9 are qualitative and are intended to guide future collaborative initiatives on shared concerns across the region. Each ITTS member state has performed its own detailed needs assessment as part of their state freight plans which determine individual state freight investment needs and priorities.

TABLE 9 NEEDS ASSESSMENT

Need or Opportunity	Condition Rating	Discussion
Safety	🟡	Ensuring a safe transportation network for people and goods is central to ITTS's mission. Safety was listed as a need in every ITTS member state's most recent state freight plan. Furthermore, the analysis of fatal truck-involved crash data indicated that the amount of fatal truck crashes has been increasing throughout the region. As a result, safety was identified as a moderate regional priority. Both safety programs and infrastructure improvements can help to improve safety. Areas with high crash rates may coincide with aspects of the road such as curvature, visibility, speeds, pavement conditions, or other factions.
Bottlenecks	🔴	Fast and reliable freight transportation is critical to supply chains. The ability of the ITTS region to support the supply chains that rely on its freight infrastructure has implications economic competitiveness across the region. The need to address congestion and poor reliability was observed across state freight plans for the member states. The ITTS Regional Bottlenecks Assessment for Goods Movement Study found that truck bottlenecks resulted in substantial costs to the region in the form of wasted time and fuel. As a result, needs related to congestion, unreliability, and bottlenecks is an acute freight transportation planning priority for the region.
Infrastructure Conditions	🔴	Poor pavement and bridge conditions can increase delays, increase wear and tear on vehicles, cause damage to goods in transit, and potentially impact safety. Stakeholders recognized aging infrastructure conditions as a threat to the region. Building and maintaining the region's multimodal freight network to a condition that facilitates the efficient movement of goods is an acute regional need.

Need or Opportunity	Condition Rating	Discussion
Resiliency	🟡	Stakeholders observed that portions of the region, especially coastal areas, are susceptible to natural disasters that disrupt supply chains. Hurricanes, flooding, tornadoes, and other weather events have damaged and disrupted the region's multimodal freight network. Several ITTS member states have performed dedicated resiliency studies and/or resiliency analyses as part of their state freight plans further noting the challenges that extreme events pose to the region. Improving the resiliency of the region's freight network is a moderate need.
Multimodal Connectivity and Truck Parking	🟢	Efficient connections between freight modes via multimodal freight facilities (e.g., intermodal rail terminals, ports, bulk transfer terminals, etc.) are critical for supporting supply chains and the economic activity associated with the industries they serve. Stakeholders viewed the region's multimodal network as a strength due to its diversity of freight modes as shippers have multiple modal options available to them for managing their supply chains. Furthermore, the ITTS region's robust network of highways, Class I rail, ports, and other modes also make for a more redundant and thus resilient network. As a result, improving multimodal connectivity is a modest need. Related to multimodal connectivity needs is the need for improved access to truck parking. Increased demand for goods and services along with changes in the Federal Motor Carrier Safety Administration's Hours of Service (HOS) regulations are among several contributing factors to growing truck volumes and the associated need for truck parking. Commercial drivers seeking to comply with HOS regulations may be forced to park in unauthorized locations when authorized parking is unavailable or the location of authorized parking is unknown. This potentially impacts safety for both truck drivers and the traveling public as fatigue is a contributing factor to truck-involved crashes.
Funding	🟢	Funding is an ongoing need for the region as investment needs exceed the financial resources available to address them. The passage of the 2021 Infrastructure Investment and Jobs Act (IIJA), or Bipartisan Infrastructure Law (BIL), substantially increased the amount of transportation funding available to the multimodal freight system both in terms of formula and discretionary dollars. However, funding remains a weakness and represents a modest need.

Source: Cambridge Systematics; Texas A&M Transportation Institute.

🟢 Modest Need

🟡 Moderate Need

🔴 Acute Need

5 SUMMARY

The ITTS region has prospered, in part, due to the economic benefits that stem from its extensive and diverse multimodal freight network. In addition, the region has successfully leveraged its strengths to become a logistics and manufacturing hub. However, this success has also created challenges in the form of freight-induced congestion, safety, and aging infrastructure conditions, among others.

SETTS Phase I was the region’s first step to comprehensively address the challenges and opportunities brought by recent and emerging trends and developments at the multi-state level. These include the implementation of USMCA; new opportunities brought on by freight vehicle, infrastructure, and data technology; the impacts of changes in manufacturing and logistics to land use, transportation, and distribution patterns; and transformations in supply chain practices brought on by a global pandemic. SETTS Phase II represents the second step with a focus on freight-related industry growth, understanding the region’s role in facilitating key industry supply chains, and the needs associated with supporting supply chains and goods movement generally.

Key findings of SETTS Phase II include the following:

- **Freight Industry Concentration and Growth.** Multiple industries represent opportunities for the ITTS region to promote economic development. Pharmaceutical and Medicine Manufacturing, Other Transportation Equipment Manufacturing, Motor Vehicle Parts Manufacturing, and Medical Equipment and Supplies Manufacturing, among others, were observed to have employment-based growth trajectories that indicate there is potential for even greater growth in these freight-intensive industries.

- **Supply Chains.** The ITTS region’s multimodal freight transportation system has a direct impact on the supply chains it facilitates and international trade. It directly impacts the cost, efficiency, and reliability of moving goods to domestic and overseas markets. The region’s major metropolitan areas are integral to most supply chains. Many of the key industries examined in the supply chain analysis are clustered in a few metropolitan areas across the ITTS region. As a result, last mile connectivity to these areas is critical to improving supply chain fluidity and improving the region’s competitive position. Additionally, the various supply chains rely on common elements of the ITTS multimodal freight network. Certain corridors—I-40 and I-10 as examples—carry significant volumes of freight across all the examined supply chains. As a result, improving the fluidity of the key industry supply chains and enhancing the region’s competitiveness will take a multimodal and collaborative approach.

- **Needs Assessment.** Safety, bottlenecks, infrastructure conditions, resiliency, multimodal connectivity (including truck parking), and funding are among the region's most pressing needs. These challenges impact shared corridors that facilitate supply chains across the region as highlighted in Section 3.0 of this report. The needs assessment performed as part of SETTS Phase II does not supersede the freight investment needs in the state freight plans of member states. Instead, it is a guide meant to highlight opportunities for addressing shared concerns.

SETTS Phase I made several recommendations for continued collaboration across the ITTS region. The development of SETTS Phase II fulfills one of those recommendations, but several others are still valid. Specifically, as next steps in building upon the findings of the Phase I and II, ITTS should take the following actions:

- **Identify and Pursue Multi-State Investment Opportunities on Major Highway Trade Corridors—**This recommendation from SETTS Phase I is still relevant and should be pursued. Many states are working collaboratively to make investments on shared corridors to improve freight performance and safety. For example, the I-10 Corridor Coalition (which includes Texas, New Mexico, Arizona, and California) have developed a truck parking availability system along I-10. As noted in the supply chains analysis presented in Section 3.0 of this report, corridors such as I-20, I-75, I-55, and I-95 carry significant volumes of freight and are shared across multiple ITTS states. The ITTS should identify a set of potential shared corridor investments that would enhance trade opportunities across the region, determine their feasibility and priority for implementation, and encourage its member state DOTs to adopt and pursue the chosen investment. Truck parking should be one of the considered investments as it is a challenge shared across the entire coalition and is amenable to multi-state investment strategies.

- **Identify and Pursue Public-Private Investment Opportunities for Multimodal Assets—**SETTS Phase I found that the region's non-highway freight assets, particularly the rail and waterway networks, carry significant volumes of freight across the region and are essential to supporting supply chains. SETTS Phase II further confirmed this finding and determined that multimodal connectivity is a pressing need for the region as stakeholders viewed the breadth and efficiency of the region's freight modes as a competitive advantage. As a result, identifying and pursuing public-private investment opportunities to benefit the region is still a relevant recommendation.

- **Identify and Pursue Growth Opportunities for Domestic and Global Trade—**SETTS Phase I quantified the economic contribution of the freight-generating sectors and investigated freight flows associated with those industries. SETTS Phase II identified supply chains that offer an opportunity for the region to increase its share of trade associated with the industries those supply chains support. As a next step, ITTS should identify the actions and investments needed to capture those trade opportunities and define the risks and uncertainty associated with them. For example, as the share of Asia to U.S. trade via west coast ports has been declining, ports throughout the ITTS region can potentially benefit from this share shift given specific port, rail, and other investments. Railroads, port authorities, and other modal operators are key partners to include in identifying the specific strategies, actions, and investments for benefitting the region.

- **Conduct a Supply Chain Resiliency Study—**Both Phase I and II noted the importance of resiliency to the multimodal freight network. Freight resiliency entails the ability of the multimodal freight network to withstand disruptions with minimal impacts to safety and the economy. As large-scale disruptions to the freight network and associated supply chains have become more common, resiliency has become a much more important component of freight transportation planning. This observation was reflected in ITTS member states' freight plans as supply chain resiliency was a common theme. As a next step, ITTS should perform a supply chain resiliency and risk study that identifies the risks to which the region's key supply chains are exposed, the freight assets that are vulnerable to those risks, and strategies for mitigating those risks and minimizing supply chain disruptions.

SETTS

Southeast Trade and Transportation Study