# The Importance of Highways to U.S. Agriculture

December 2020

USDA

United States Department of Agriculture

## NOTICE



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## COVID-19 NOTE

The development of this report coincided with the advent of the worldwide COVID-19 pandemic. This pandemic has had multiple impacts that could affect agricultural highway freight, including disruptions to supply chains, shifts in food production and consumption patterns, workforce impacts, and fluctuations in fuel taxes and other revenues. In addition, there have been wide-reaching changes in overall macroeconomic conditions in the United States and overseas, including changes in economic output and exchange rates. The trajectory and long-term consequences of these impacts are difficult to forecast, making it unclear whether and when "normal" conditions may resume. This introduces additional uncertainty into the analysis. It is also important to note that, at the time this report was prepared, the available data sources, estimates, and future projections were largely developed prior to the pandemic and do not reflect these impacts.

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**6. AUTHOR(S)**
Kevin McCoy, Sean Peirce, Gary Baker, Ryan Endorf, Christina Foreman, Rachel Galton, Michelle Gilmore, Danielle Kittredge, Kendall Mahavier, Daniel DJ Mason, David Pace, Sari Radin, Emma Vinella-Brusher

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**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**
John A. Volpe National Transportation Systems Center
U.S. Department of Transportation
55 Broadway Street,
Cambridge, MA 02142

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Agricultural Marketing Service
U.S. Department of Agriculture
Stop 0266
USDA AMS TM TSD
1400 Independence Ave SW 4523-S

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This report provides information to inform the transportation planning and project selection processes that build and maintain the highway infrastructure upon which the agriculture industry relies upon for safe and efficient transportation of goods. It demonstrates the interconnected nature of agricultural freight and highlights the need for cooperation across jurisdictions via 1) A summary of the economic significance of highway infrastructure to the agriculture industry; 2) Identification of High-Volume Domestic Agriculture Highways based on 2018 commodity flows; 3) Modeled projections of future infrastructure conditions and performance; 4) Identification of efforts to improve agricultural freight movements.

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**19a. NAME OF RESPONSIBLE PERSON**
Adam Sparger

**19b. TELEPHONE NUMBER** *(Include area code)*
202-205-8701

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## Agriculture Industry Groups

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*North Carolina Department of Transportation*

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# ACRONYMS

| | |
|---|---|
| **AADT** | Average Annual Daily Traffic |
| **AICP** | American Institute of Certified Planners |
| **AMS** | Agricultural Marketing Service |
| **ATRI** | American Transportation Research Institute |
| **ATWG** | Agricultural Transportation Working Group |
| **BCA** | Benefit-Cost Analysis |
| **BCR** | Benefit-Cost Ratio |
| **BTS** | Bureau of Transportation Statistics |
| **CFS** | Commodity Flow Survey |
| **COFC** | Container-on-flatcar (rail) |
| **COVID-19** | Novel 2019 Coronavirus Disease |
| **CRAB** | County Road Administration Board |
| **CSX** | CSX Railroad |
| **DOT** | Department of Transportation |
| **ERS** | Economic Research Service |
| **FAC** | Freight Advisory Committee |
| **FAF** | Freight Analysis Framework |
| **FARS** | Fatality Analysis Reporting System |
| **FAST** | Fixing America's Surface Transportation |
| **FGTS** | Freight and Goods Transportation System |
| **FHWA** | Federal Highway Administration |
| **FMCSA** | Federal Motor Carrier Safety Administration |
| **FMSIB** | Federal Mobility Strategic Investment Board |
| **GDP** | Gross Domestic Product |
| **HDAH** | High-Volume Domestic Agriculture Highways |
| **HEPGIS** | Federal Highway Administration Office of Planning, Environment and Realty Geographic Information System |
| **HERS** | Highway Economic Requirements System |
| **HPMS** | Highway Performance Monitoring System |
| **ICE** | Infrastructure Condition Evaluation |
| **INFRA** | Infrastructure for Rebuilding America (grant program) |
| **IRI** | International Roughness Index |
| **LIFTS** | Linking Iowa's Freight Transportation Systems (grant program) |

| | |
|---|---|
| **LPA** | Local Public Agency |
| **MDA** | Missouri Department of Agriculture |
| **MPO** | Metropolitan Planning Organization |
| **NACo** | National Association of Counties |
| **NBI** | National Bridge Inventory |
| **NCDOT** | North Carolina Department of Transportation |
| **NFSP** | National Freight Strategic Plan |
| **NHFN** | National Highway Freight Network |
| **NHFP** | National Highway Freight Program |
| **NHS** | National Highway System |
| **NHTSA** | National Highway Traffic Safety Administration |
| **NPMRDS** | National Performance Monitoring Research Data Set |
| **OST** | Office of the Secretary of Transportation |
| **PHFS** | Primary Highway Freight System |
| **RFI** | Request for Information |
| **RPA** | Regional Planning Affiliation |
| **SFP** | State Freight Plan |
| **SR** | State Route |
| **STCC** | Standard Transportation Commodity Code |
| **STIP** | State Transportation Improvement Program |
| **TOFC** | Trailer-on-flatcar (rail) |
| **TRAM** | Travel Analysis Model (Iowa DOT) |
| **TRRA** | Terminal Railroad Association |
| **TTI** | Travel Time Index |
| **TTTR** | Truck Travel Time Reliability |
| **TXDOT** | Texas Department of Transportation |
| **US** | United States |
| **USC** | United States Code |
| **USDA** | United States Department of Agriculture |
| **USDOT** | United State Department of Transportation |
| **VCAP** | Value, Condition, and Performance Model (Iowa DOT) |
| **VMT** | Vehicle Miles Traveled |
| **WSDOT** | Washington State Department of Transportation |

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# SECTION 1

## Introduction

# INTRODUCTION

Agricultural products are transported as part of national and global supply chains that stretch from individual farms and ranches to destinations throughout the United States and abroad. This complex agricultural freight transportation system is multimodal, consisting of highways, railroads, inland waterways, ocean vessels, and air freight. Highways are the backbone of this system, providing critical “first and last mile” transportation connections to higher-capacity modes such as rail, barge, and ocean vessel, and for many products requiring long distance transportation. Almost all agricultural products travel by highway for at least a portion of their journey.

**This report examines the importance of highway infrastructure to the efficient movement of domestic agricultural products and continued market competitiveness.**

Despite the agriculture industry’s reliance on highway infrastructure, State Departments of Transportation (State DOTs), Metropolitan Planning Organizations (MPOs), and Local Public Agencies (LPAs) such as counties and cities, often do not have sufficient data or modeling tools to be able to analyze the performance of highway infrastructure, or to forecast the impacts of investment, for agricultural freight. The transportation planning process is changing to be more performance-based, with data analysis intended to help identify projects that will have the biggest impact on highway performance. However, transportation agencies still generally lack detailed information about how and where agricultural commodities are transported and may have limited direct engagement with agricultural shippers.

### Highways

Many terms are used to refer to roads in the United States. For the purposes of this report, the term “highway” is used broadly, as defined in 23 USC § 101(a)(11), to refer to all roads, streets, parkways, and supporting structures.

This includes both major routes such as Interstates and State Highways, as well as local and rural roads, all of which have important roles in transporting agricultural products.

The August 2019 report *Importance of Inland Waterways to U.S. Agriculture*, (USDA, 2019), documents the critical role of barge transportation for agricultural products - grains and oilseeds in particular. These two reports are intended be used together to identify important infrastructure investments, to inform updates to State Freight Plans and Long-Range Transportation Plans, to inform policy discussions, and to help identify priorities for future research.

This report provides information to inform the transportation planning and project selection processes that build and maintain highway infrastructure that the agriculture industry relies upon for safe and efficient transportation of goods. The report demonstrates the interconnected nature of agricultural freight and highlights the need for cooperation across State and jurisdictional boundaries.

This report includes:

- A summary of the economic significance of highway infrastructure to the agriculture industry;
- Identification of High-Volume Domestic Agriculture Highways (HDAH) based on 2018 commodity flows;
- Analysis of the performance of the HDAH and selected corridors within;
- Modeled projections of future highway freight infrastructure conditions and performance, including planned projects;
- Notable practices for addressing the infrastructure needs of the agriculture industry; and
- A framework for conceptualizing and coordinating efforts to improve agricultural freight movement in highway decision making.

**About the Authors**

This report was prepared by the U.S. Department of Transportation (U.S. DOT) Volpe National Transportation Systems Center (Volpe Center) through a cooperative agreement overseen by the U.S. Department of Agriculture (USDA) Agricultural Marketing Service (AMS). The U.S. DOT Office of the Assistant Secretary for Policy (OST-P) provided technical guidance and support to the project team. This partnership supports AMS's mission to facilitate the efficient, fair marketing of U.S. agricultural products, as well as U.S. DOT's strategic goals of investing in infrastructure and innovation to stimulate economic growth, productivity, and competitiveness by improving the safety and performance of the Nation's transportation system.

## Who Should Read This Report?

This report contains valuable information for transportation and agriculture industry stakeholders alike.

**State Departments of Transportation (State DOTs)** will find:

- Information about how agricultural commodities flow through corridors both within their own States and through neighboring States.
- Notable practices demonstrating opportunities to incorporate agricultural data and considerations into planning and decision-making processes.

**Local Public Agencies (LPAs)** will find information highlighting the importance of local and county roads in supporting a global supply chain for agricultural products, and strategies for overcoming funding, data, and coordination barriers.

**Agricultural freight shippers and carriers** will find examples of the valuable role their perspective and knowledge can play in highway infrastructure planning.

## Background

For more than 100 years, the U.S. Government has recognized well-maintained roads are indispensable to support the transport and economic competitiveness of agricultural goods. A common refrain of the Good Roads Movement of the early 20th Century was that improved roads were needed "to get the farmer out of the mud" (Federal Highway Administration (FHWA), 2001). One such farmer, living 15 miles north of Raleigh, North Carolina, related the condition of the roads in his area with his economic prospects, noting that "a bad road is a relentless tax assessor and a sure collector" (FHWA, 1976). The Federal Aid Road Act of 1916 sought to remedy this situation, establishing the first Federal funding program for roads, which USDA administered. This program launched a decades-long public works effort that built improved rural and county roads, connected to modern highways and eventually Interstates, serving nearly the entirety of the United States.

Today, U.S. DOT administers transportation programs and works to "ensure that our Nation has the safest, most efficient and modern transportation system in the world, which improves the quality of life for all American people and communities, from rural to urban, and increases the productivity and competitiveness of American workers and businesses" (U.S. DOT, n.d.). The USDA Agricultural Marketing Service (AMS) continues to represent the interests of farmers, by "administer[ing] programs that create domestic and international marketing opportunities for U.S. producers of food, fiber, and specialty crops" (USDA, n.d.). This report seeks to support the competitiveness of U.S. agriculture by encouraging continued investment in transportation infrastructure.

**In 2018, the U.S. transportation system moved a daily average of about 49 million tons of freight, valued at nearly $53 billion.**

### Importance to the U.S. Economy

Multimodal freight transportation is essential to the safe and efficient movement of commodities produced across economic sectors and is an important contributor to the U.S. economy.

In 2018, the U.S. transportation system, for all products across all modes, moved a daily average of about 49 million tons of freight, valued at nearly $53 billion.[1] This total is about $19 trillion a year. Furthermore, freight

1 This number will seem large in comparison to U.S. Gross Domestic Product (GDP) given how the freight value is counted—GDP does not count the value of "intermediate goods", only the value of the finished product. However, for the value of freight shipped around the country, there are many intermediate goods that are likely double-counted. Additionally, goods moved by freight may include the value of imports, which would be a negative impact on GDP.

Agricultural freight movement is essential for ensuring goods move at every level of the supply chain from farm to final product, and supports a number of national priorities:

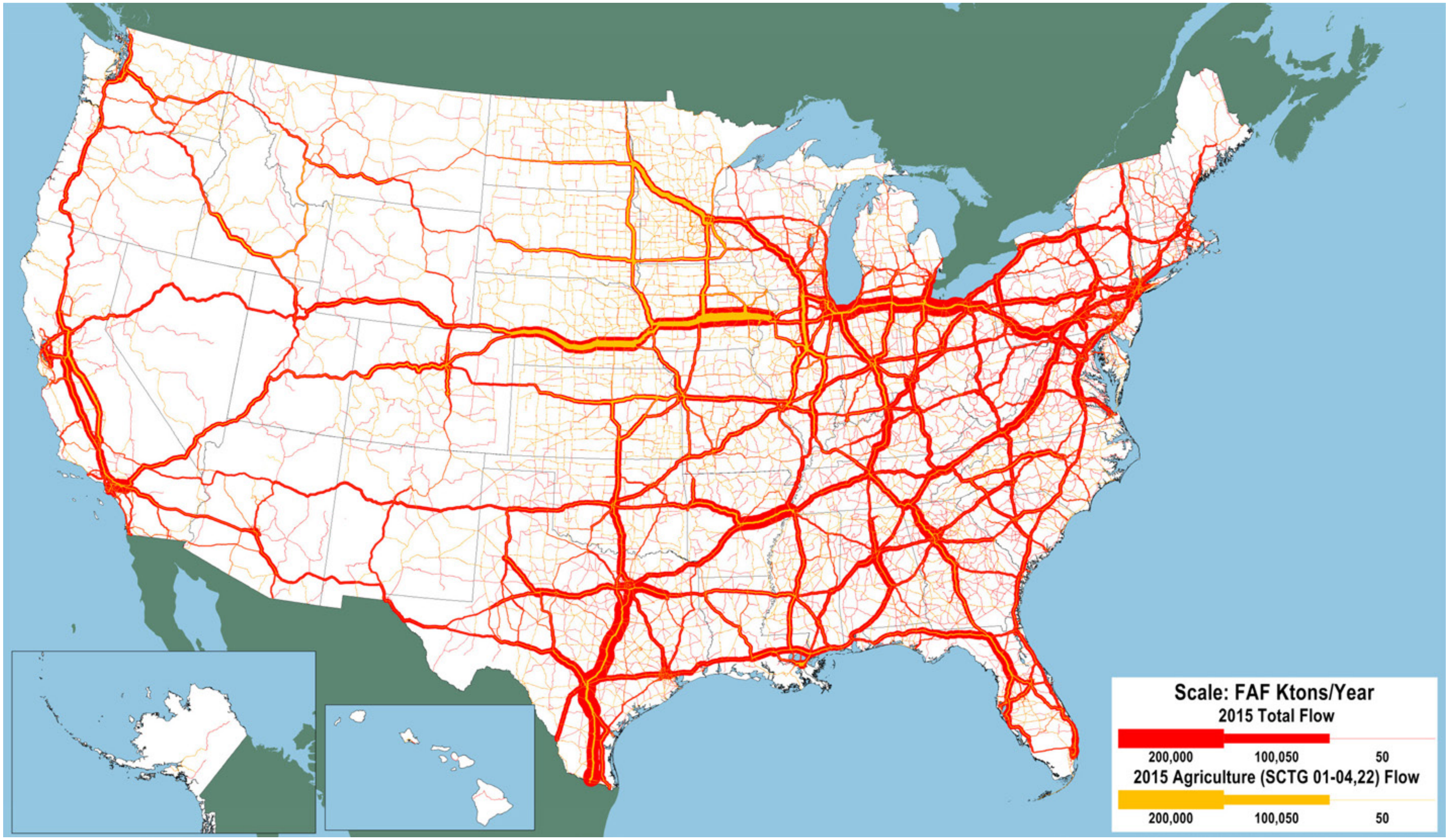
**Domestic food production:** The agriculture industry provides consumers with fresh, high-quality food that allows them to be healthy and productive in other sectors. Efficient transportation helps keep these prices low for consumers and allows for regional specialization and division of labor to move products from fertile agriculture production areas to major population centers.

**Employment:** Agriculture and related industries accounted for 11% of U.S. employment in 2017, equivalent to 21.6 million jobs, including about 2.6 million jobs from direct on-farm employment (USDA, 2018).

**Economic value:** Agriculture commands approximately 5.5% of all U.S. Gross Domestic Product (GDP), a value over $1 trillion in 2017 (USDA, 2018).

**International competitiveness:** The value of agricultural exports account for 10-11% of all U.S. exports, and the freight system contributes to competitive prices (Cooke et al., 2017).

Figure 1: Modeled Agricultural and Total Freight Flows on U.S. Highways, 2015




*Source: Freight Analysis Framework, version 4.3 (Bureau of Transportation Statistics (BTS) and FHWA, 2017)* shipments are expected to increase by a total of 23% over the next 20 years (Bureau of Transportation Statistics (BTS) and FHWA, 2019).

Agricultural products are the single largest user of freight services in the United States, comprising 24% of freight services across all modes by tonnage and 27% of all ton-miles. In 2018, 4.5 billion tons of agricultural products worth $3.1 trillion were moved across all transportation modes. Trucks account for 83% of agricultural freight movements by tonnage and 88% by market value. Trucks account for 56% of agricultural freight ton-miles, primarily due to the key role of rail and waterway modes for transporting grains over longer distances. Figure 1 demonstrates that agriculture is by far the largest component of highway freight by tonnage, on a number of major corridors—particularly in the Midwest, and California (BTS and FHWA, 2019).

**Highway Network**

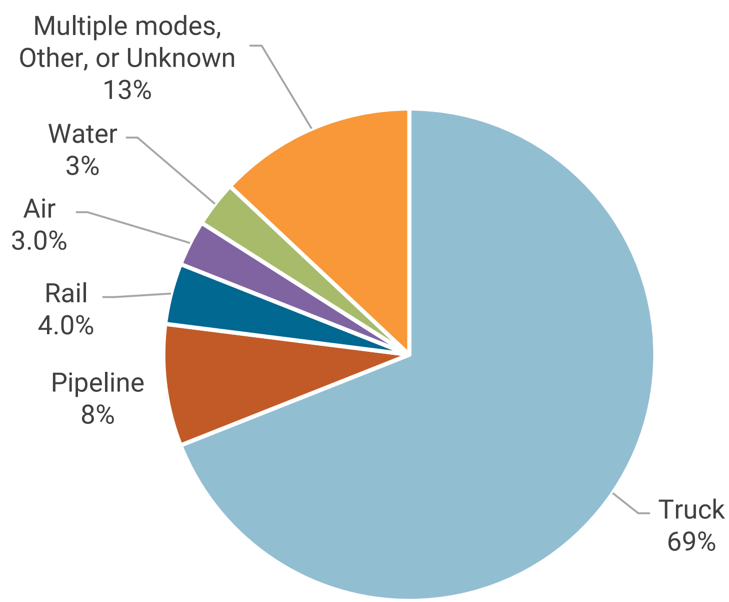
This report uses the term *highway network* to refer to any collection of highways linked together, and not to any specific, statutorily defined highway or freight networks. If a specific network is referred to in this report, its proper name is used (e.g., National Highway Freight Network, National Highway System).

## The majority of freight across all modes is moved by truck, and almost every agricultural freight trip includes at least one truck component.

The movement of agricultural freight is essential to feeding the U.S. population. When supply chains are operating effectively, most consumers likely think very little of the complex series of movements that bring food to their grocery stores and dinner tables. The fact that there are few major disruptions to the supply of food to people across the United States demonstrates the safe and efficient performance of freight systems, and the importance of maintaining this level of performance.

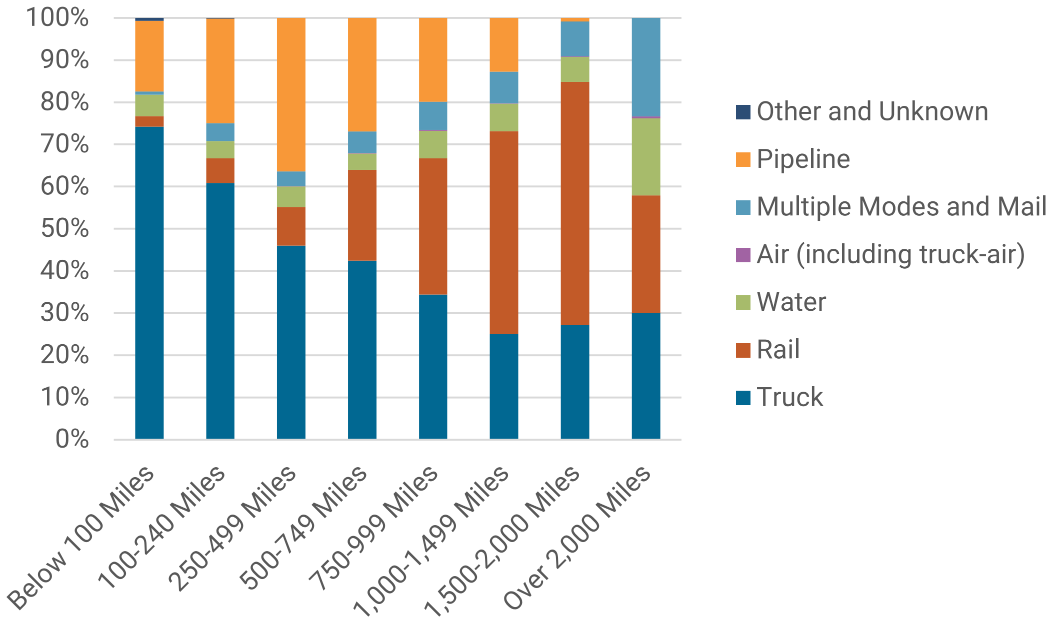
The majority of freight across all modes is moved by truck, and almost every agricultural freight trip includes at least one truck component in the full journey from farm to

Figure 2: Value of U.S. Shipments by Transportation Mode in 2018




*Source: Freight Analysis Framework v4.5.1 (BTS and FHWA, 2019)*

Figure 3: Ton-Miles of U.S. Shipments by Transportation Mode and Distance in 2018




*Note: Air is not visible in the chart given that it accounts for less than 0.05% of total ton-miles for all distances.*

*Source: Freight Facts and Figures (BTS, n.d.)*

final destination. In 2018, trucks carried about 64% of U.S. freight (all commodity types) by weight and 69% by value (Figure 2). Trucks are particularly prevalent for shorter journeys, with modes such as rail becoming more prominent on longer trips (Figure 3).

U.S. investment in multimodal surface transportation systems has ensured that the cost of moving agricultural freight is a small percentage of overall agriculture costs, consisting of 3-4% across all modes (Canning, 2011). Maintaining the performance of the highway system—which is often the most expensive leg of the journey on a per ton-mile basis—is essential to keeping freight costs low and supporting continued economic competitiveness.

Section 2 of this report provides additional detail on the importance of surface transportation to the U.S. economy and movement of agricultural freight. The next section focuses on how highway infrastructure decisions are made and how the agriculture industry plays a role.

## Agricultural Freight in Transportation Planning

Transportation planning is rooted in long-term decision-making processes, drawing from data analysis, modeling, and stakeholder engagement. State DOTs and Metropolitan Planning Organizations (MPOs) undertake planning activities to articulate a long-range transportation plan (20 or more years) and a short-range transportation improvement program (3-5 years) based on that plan. State DOTs and LPAs implement projects and operate highways.

### *Agricultural Freight Data*

Data analysis is a key component of transportation planning and decision-making. State DOTs and MPOs often rely on travel demand surveys and traffic demand modeling to understand how vehicles are using the transportation system and how demand may change over time. These models vary in their complexity and data sources used, but traditionally they have been focused on passenger travel and the peak commuter periods. This focus has begun to change in recent years, as more data have become available and as more advanced, multimodal models have been developed. However, many State DOTs and MPOs still lack detailed data or advanced analysis of freight supply chains. This report presents data about agricultural freight movements on U.S. highways to inform transportation planning, and to demonstrate analysis techniques with an explicit agricultural freight focus.

### *Agriculture Stakeholder Involvement*

Producers and shippers of agricultural products are frequently involved in advocacy for changes in the legislative or policy arenas, but have not historically been frequent direct participants in transportation planning. Agricultural producers and shippers may struggle to engage because the long-range planning time horizons needed for transportation infrastructure do not neatly align with shorter-term business considerations. However, agricultural stakeholders can provide transportation agencies with valuable insights and data, communicate their challenges, and work in partnership to identify projects that will meet the future needs of the industry. A close partnership between transportation agencies and agricultural shippers benefits both groups by increasing the chances that key issues will be addressed and that projects will focus on the safety, congestion, and reliability of shipping routes most critical to the industry.

**Federal Requirements**

The Moving Ahead for Progress in the 21st Century Act of 2012 (MAP-21) and the Fixing America's Surface Transportation Act of 2015 (FAST Act) each introduced freight-specific federal policy requirements for State DOTs.

The National Highway Freight Program (NHFP), introduced in the FAST Act, introduced in the FAST Act, created for the first time a freight-specific funding source in the Federal-Aid Highway Program. To access these funds, State DOTs must develop and implement State Freight Plans that describe the State's primary freight infrastructure across all major modes, the conditions and performance of those facilities, and an investment strategy for how the State's NHFP apportionment will be used.

These acts also strongly suggest that State DOTs more closely engage with freight stakeholders, including agricultural stakeholders, in transportation infrastructure planning. This report takes advantage of the State Freight Plan requirement to examine how State DOTs are planning to invest NHFP funds to maintain and enhance the highway infrastructure.

*Credit: vitpho via 123rf.com*

# KEY TRENDS

**This section identifies seven key trends affecting agricultural freight transportation, based on ideas presented in the National Freight Strategic Plan (U.S. DOT, 2020).**

- Growing Population and Economy
- Changing Urban-Rural Dynamics
- Infrastructure Condition and Funding
- Connected Supply Chains
- Advancing Technology
- Evolving Workforce
- Increasing Safety Concerns

## GROWING POPULATION AND ECONOMY

- The U.S. population grew by 16% between 2000 and 2018, and is forecast to grow at an additional 1% annually. (Transportation Research Board, 2019; FHWA, 2019); approximately 53 tons of freight are moved for each American each year, with agriculture as the single largest contributor (BTS and FHWA, 2019).
- Demand for freight is expected to increase by approximately 1.2% annually by 2040, with demand for trucking expected to grow even faster, at 1.5% annually (BTS and FHWA, 2019).
- Production of the top two agricultural commodities, soybeans and corn, are both expected to grow faster than the rate of population growth, at about 1.2% annually (USDA, 2020b; see Appendix A).

## CHANGING URBAN-RURAL DYNAMICS

- As population has shifted from rural, agriculture-producing areas to urban areas, there is now more stress on urban highway systems where agricultural products often travel for processing, sale, and export (National Academies of Sciences, Engineering, and Medicine, 2019). Today, approximately four out of five U.S. residents now live in urban areas (U.S. Census Bureau, n.d.), and more than half of the population growth through 2040 is expected in just three States: Florida, California, and Texas (Weldon Cooper Center for Public Service, n.d.).
- Dependence on trucking has increased in rural areas due to the lack of, decline of, or withdrawal of rail service (USDA, 2010); in 2016, 47% of truck vehicle miles traveled (VMT) occurs on rural roads (FHWA, n.d.).

## INFRASTRUCTURE CONDITION AND FUNDING

- 14% of the Nation's rural roads have pavements in poor condition, and nearly 9.2% of rural bridges need rehabilitation, repair, or replacement (FHWA, 2019). Poor road conditions contribute to higher operations costs by lowering fuel economy, reducing travel speeds, and increasing maintenance costs for vehicles.
- Locally-managed rural highways are often the first links in the agriculture supply chain, but local transportation agencies often have more constraints on funding and staff resources for infrastructure planning and investment, as compared with State DOTs.
- Today's farming equipment and trucks are larger and heavier than those of the mid-20th century, putting additional stress on rural highways, many of which were originally designed with smaller vehicles in mind.

## CONNECTED SUPPLY CHAINS

- International trade and globalization of supply chains places increased demand on all segments and modes of freight transportation.
- Demand for highway freight is related to the price of shipping via other freight modes; for instance, when the rates of rail transport increase, shippers will switch to highway transport as a lower cost substitute.
- The effects of extreme weather events have demonstrated how disruptions to supply chains in one area can have cascading impacts across the system. For example, Superstorm Sandy temporarily eliminated key supply routes into and out of New York City, and recent flooding events in the Midwest disrupted production and closed highways. Both events caused a breakdown in supply chains and the ability to move agricultural products to market.
- Because rural road networks tend to be less dense than in more urbanized areas, detours due to disruptions often add several miles to a trip.

## ADVANCING TECHNOLOGY

- Advancements in driver-assistive technology such as adaptive cruise control and automatic emergency braking have the potential to improve safety.
- Longer term, automation technology and truck platooning have the potential to reshape the labor dynamics of the trucking industry.
- Advancements in communication technology, including the use of blockchain, may allow the industry to develop and maintain more granular datasets that describe freight volumes and reliability, including where individual products are produced, how and where they move, and where they are exported and consumed.

## EVOLVING WORKFORCE

- Agriculture relies heavily on the trucking industry and the availability of drivers is critical during times such as planting and harvest.
- The trucking industry workforce is aging, and firms describe difficulty in both driver retention and attracting new drivers. (American Trucking Association, 2019).

## INCREASING SAFETY CONCERNS

- The trucking industry ranked “highway safety and crash reduction” a top policy issue for the first time in 2018 after fatal crash rates for large trucks began to climb in 2009 (American Transportation Research Institute (ATRI), 2018).
- Freight crashes have economic costs at every level of the industry. Crashes increase costs for the agriculture industry and contribute to congestion and delay.
- Fatalities resulting from truck-involved crashes made up 89.2% of all freight-related transportation fatalities and 12.8% of all highway fatalities in 2017 (Federal Motor Carrier Safety Administration (FMCSA), 2019).
- Approximately 57% of all fatal crashes involving large trucks occurred in rural areas (FMCSA, 2019). There are higher fatality rates on rural non-Interstate routes, on which many agricultural products travel (TRIP, 2019).
- Excessive driver detention at facilities is a challenge to safety, as a 15-minute increase in average dwell time contributes to fatigue and is estimated to increase the expected crash rate by 6.2% and cost the trucking industry about $300 million annually (FMCSA, 2019).

# SECTION 2

## Economic Significance of Highway Infrastructure to the Agriculture Industry

# Economic Significance of Highway Infrastructure to the Agriculture Industry

*This section summarizes the key findings of the economic significance report (Appendix A) and establishes the importance of continued investment in highway infrastructure for the agriculture industry.*[2]

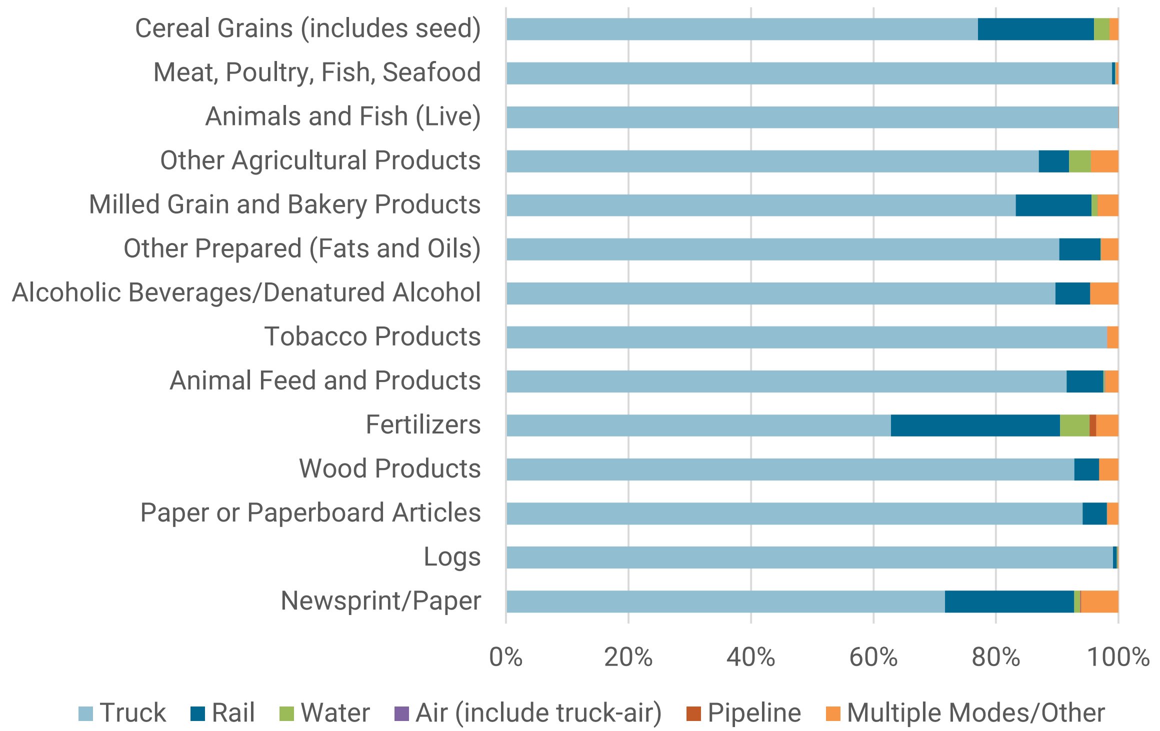
## Why is it important to keep agricultural freight costs low?

According to the Freight Analysis Framework (FAF), agriculture is the single largest user of freight, totaling 4.5 billion tons and $3.1 trillion in value in 2018. Figure 4 demonstrates that trucks carry the majority of agricultural freight across all commodity groups. Truck mode share is especially high for meat, poultry, fish, and seafood (greater than 95%). Even grains, which frequently move long distances by rail and barge, have greater than 70% of tonnage moved by truck (Bureau of Transportation Statistics (BTS) and Federal Highway Administration (FHWA), 2019).[3]

Agricultural freight depends on the smooth functioning of all parts of the transportation

**Trucks carry the majority of agricultural freight across all commodity groups.**

Figure 4: Modal Transportation Characteristics of Agricultural Commodities by Tonnage, 2018




*Note: Commodity categories based on Standard Classification of Transported Goods (SCTG) commodity codes. "Other Agricultural Products" includes soybeans and other oilseeds, vegetables, fruits and nuts, and fresh-cut flowers and plants.*

*Source: Volpe Center analysis of Freight Analysis Framework v4.5.1 (BTS and FHWA, 2019)*

2 Appendix A was completed as an interim deliverable supporting the development of this report. As a result, some statistics presented in the Appendix use different data sources and/or do not reflect subsequent data updates, including Figure 4.

3 This figure drops to 30% on a ton-miles basis due to the key role of rail and waterway modes for transporting grains over longer distances.

## Impact of Infrastructure Investment

The U.S. is in a world economy where transportation costs play a major role in the profitability of many businesses. Farming is the greatest example of the importance of infrastructure because farmers rely on low-cost, effective transportation to literally send their crops to the other side of the world.

**Infrastructure Investment**

**Improved Pavement Condition**
*Through maintenance/repair/rehabilitation*

**Expanded Highway Capacity**
*Through added lanes or improvements in road design*

**Reduction in Truck Operating Costs**

**Maintenance/Repair Costs**
*Through reduced wear and tear on vehicles*

**Labor/Fuel Costs**
*Through reduced travel time and improved reliability*

**Greater Profit for Farmers**

*Lower transportation costs save farmers money and improve profit margins.*

**Improved International Competitiveness**

*Reduced transportation costs could make American goods cheaper on the international market, giving the country an edge over competitors.*

Source: Volpe Center analysis

Credit: vitpho via 123rf.com

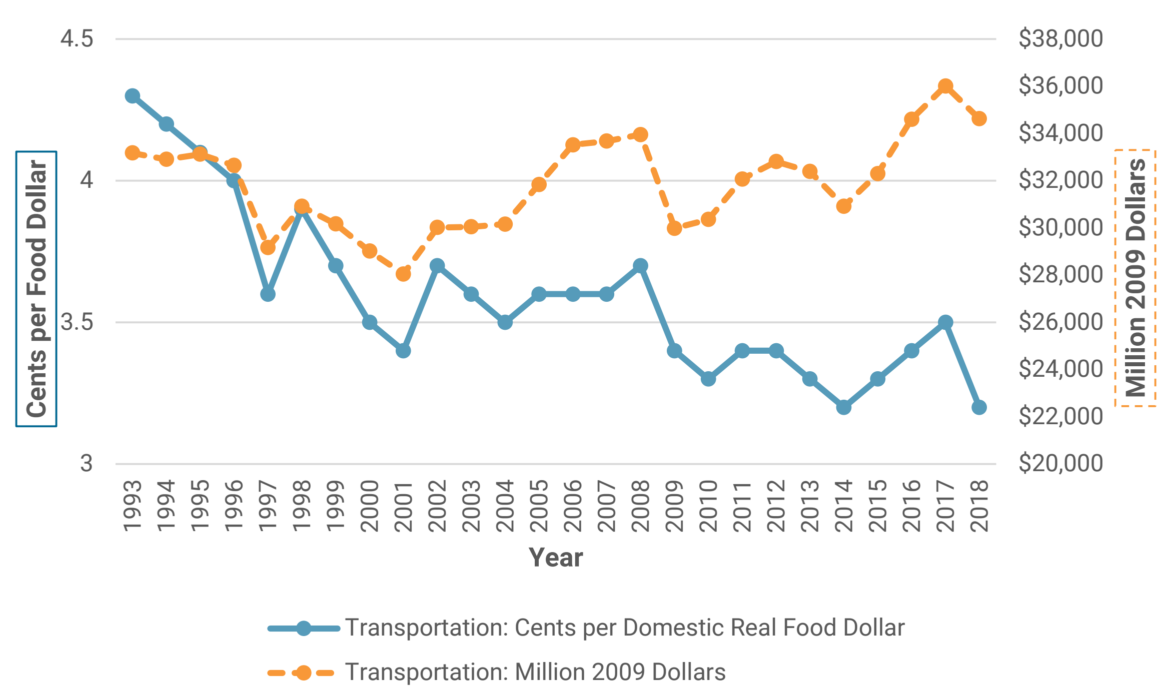
system to efficiently and cost-effectively move goods from farm to market. Transportation's estimated share of the food dollar, in both cents per dollar as well as the total value in millions of dollars, can be seen in Figure 5. The strength of U.S. investment in transportation infrastructure over almost a century has resulted in very low transportation costs, only 3-4% of overall agricultural commodity prices (Figure 5).[4]

**Transportation Cost = 3-4% of overall "food dollar"**

The small percentage of transportation-related costs relative to overall production costs is critical for maintaining farm income and the competitive position of the U.S. agriculture industry. If transportation costs remain low, producers, which must absorb some or all transportation costs, can shift funds previously spent on transportation to other inputs, allowing them to increase their output. Generally, transportation costs have been one of the key ways that the

4 The transportation component of the food dollar comprises all costs related to the transportation industry, excluding any energy-related costs. The other cost categories of the food dollar are: farm and agribusiness; food processing; food retailing; foodservices; energy; packaging; finance and insurance; advertising; and legal, accounting, and bookkeeping. Any transportation service costs incurred in the other industry groups are included in the overall transportation component. For a detailed description of how the food dollar is calculated, please see USDA's report on the methodology (Canning, 2011).

**Figure 5: Transportation Cost in Million 2009 Dollars**




*Source: Food Dollar Series (USDA, 2020a)*

United States remains competitive against other countries, even as land and labor tend to be less expensive elsewhere. Should transportation costs increase, farm income will decrease, and the United States could lose this competitive advantage, particularly if other countries continue to improve their transportation infrastructure.

While the United States has a relatively low cost-to- export ratio for agricultural products, it faces close competition from top competitors for select commodities (Table 1). The Cost-to-Export Indicator measures the fees levied on a 20-foot container in U.S. dollars. All the fees associated with completing the procedures to export the goods are included. These include costs for documents, administrative fees for customs clearance and technical control, customs broker fees, terminal handling charges and inland transport except tariffs or trade taxes.

For example, Brazil is one of the biggest competitors for U.S. agriculture, particularly for the largest U.S. agricultural exports of

Table 1: Cost-to-Export and Key Agricultural Exports by Country

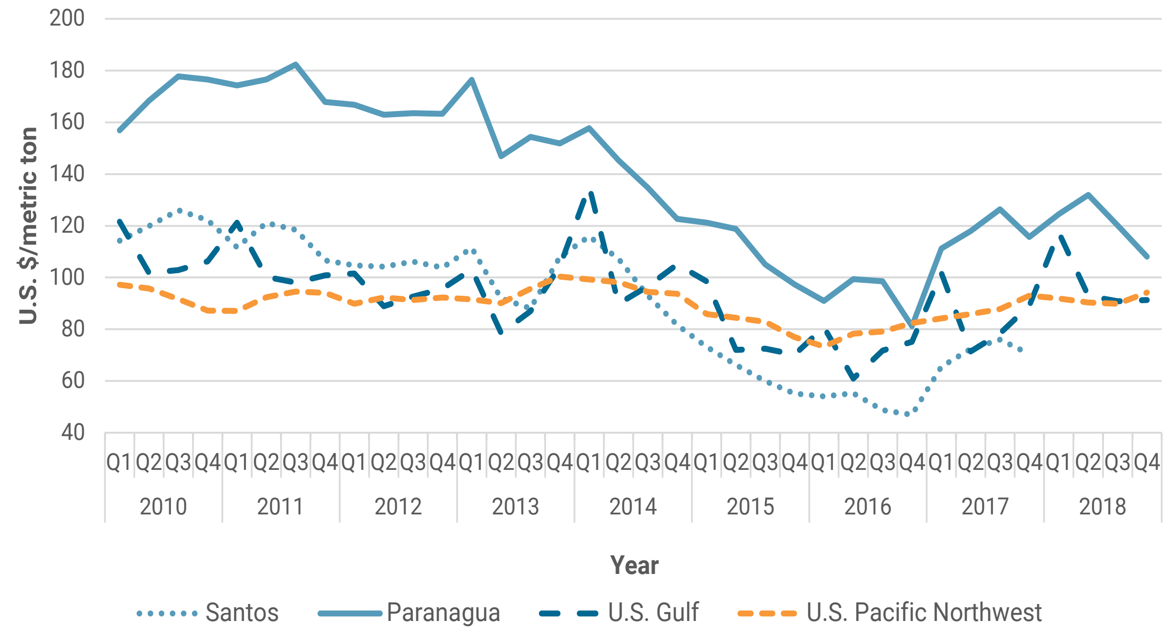
| Country | Cost to Export Indicator | Top Agricultural Exports* |
|---|---|---|
| United States | 1,224 | Soybeans, *Corn*, *Sorghum*, Cotton, Wheat |
| Argentina | 1,770 | Soybeans, Corn, Sorghum |
| Australia | 1,200 | Sorghum, Wheat |
| Brazil | 2,323 | *Soybeans*, Corn |
| Canada | 1,680 | Soybeans, Wheat |
| China | 823 | *Cotton* |
| India | 1,332 | Cotton |
| Russia | 2,401 | *Wheat* |

*An *italicized* commodity means that the country is the largest exporter of that commodity.

*Note: Top agricultural exports from a country that are competitive with the United States in the world export market are listed. A country's top agricultural export may not be listed in this table if it is only a small percent of the entire export market for that product.*

*Source: Doing Business Project (World Bank, 2015)*

Figure 6: U.S. and Brazil Soybean Total Transportation Costs to Shanghai, China



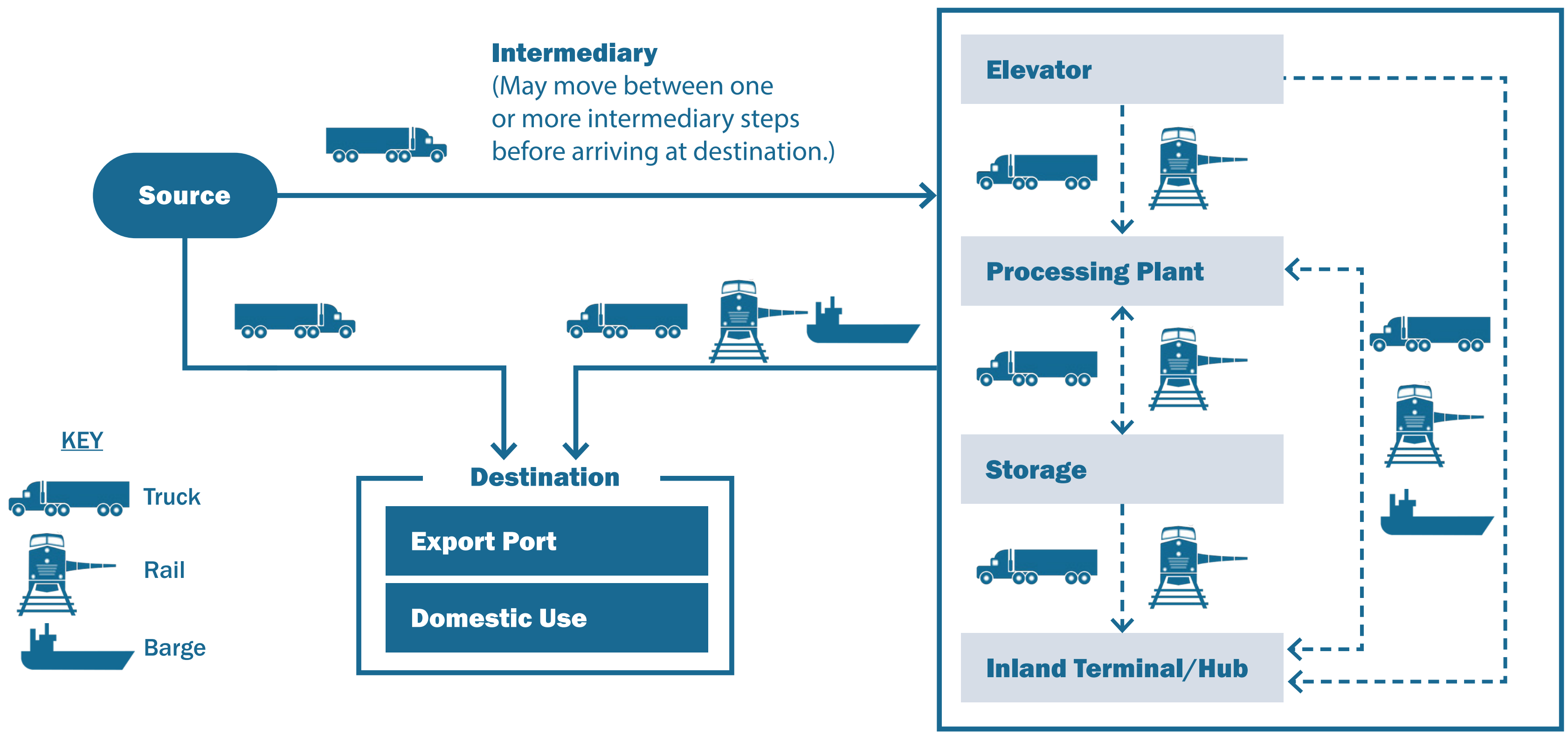

*Note: U.S. Gulf: From Minneapolis, MN, through the U.S. Gulf Coast; U.S. Pacific Northwest: From Fargo, ND, through the Pacific Northwest; Santos: From South Goiás, Brazil, data not available for 2018; Paranaguá: From North Mato Grosso, Brazil.*

*Source: Soybean Transportation Guide: Brazil Archive Reports (USDA, n.d.)*

soybeans and corn. The U.S. used to be the largest exporter of soybeans; however, Brazil overtook the United States in soybean exports in 2013 and has remained the largest exporter since then. Brazil has a lower cost of production than the United States due to lower costs for land and labor (Salin and Somwaru, 2018). Part of what allows the United States to remain competitive is transportation efficiency, but Brazil has been taking steps in recent years to improve its highway and rail systems to lower transportation costs to ports, increasing competitiveness in the export market.

Since 2014, costs for major Brazilian ports have dropped and closely approximate costs in the United States (Figure 6). Because the rail and barge components make up more of the overall cost for exported soybeans, it is possible that improvements to railroads and inland waterways could have a larger effect on the U.S. cost-to-export than improvements to highways. However, improvements to highways are also important, as trucks provide the connections to elevators and processors located along railroads and waterways (Figure 7).

Figure 7: U.S. Agricultural Supply Chain




*Source: Adapted from "U.S. Agricultural Supply Chain for Raw and Processed Products." Study of Rural Transportation Issues (USDA, 2010)*

## What are the potential impacts of investment or lack thereof in surface transportation?

The capacity of the transportation system is expected to continue to take on even higher freight volumes over time. Therefore, investments in transportation infrastructure must keep up with this expansion in order to maintain fluidity and competitiveness.

Producers operate under tight profit margins, and the performance of the transportation system is essential for farm income, domestic food prices, and international competitiveness. In 2013, USDA reported that almost 70% of all farms were in the "critical zone," meaning that their operating profit margin (the ratio of operating profit to gross cash farm income) was less than 10% (Hoppe, 2015). Thus, small changes in costs can have significant impacts on profit margins for farmers, especially smaller farms that have tighter margins than large farms (Hoppe, 2015). Although it varies widely, the average ratio of operating cost to operating revenue is a tight 95% in over-the-road long-haul trucking, demonstrating that the sector is highly competitive, and approaching what economists call atomistic or perfect competition.

Given that trucks are generally more efficient than rail for trips under 500 miles, trucks are particularly crucial for short, domestic movements. For example, trucking is essential to efficiently moving corn from

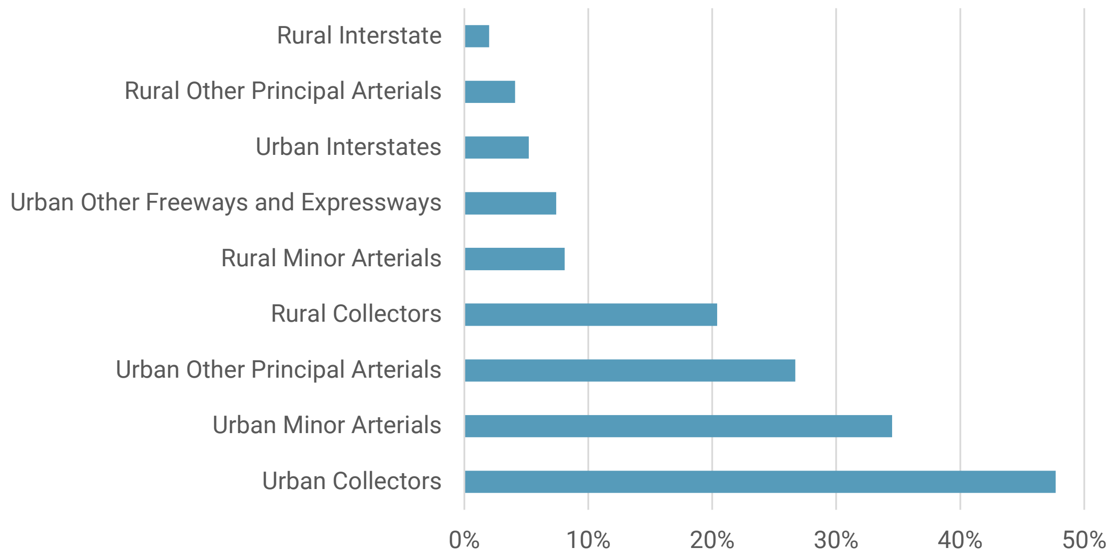
**Poor infrastructure condition and congestion pose increasingly significant challenges to the agriculture industry.**


*Credits: Natalia Bratslavsky via 123rf.com* farms to nearby ethanol plants. For longer trips, trucking is more expensive per ton-mile than rail and inland waterways, but trucks are still essential for transportation between intermodal facilities. Trucking provides a critical link between farmers, ranchers, manufacturers, feedlots, and rail, barge, and port terminals.

Poor infrastructure condition and congestion pose increasingly significant challenges to the agriculture industry. Poor road conditions contribute to higher operations costs by lowering fuel economy and raising maintenance costs for vehicles (Figure 8). Road congestion imposes labor, fuel, and delay costs, ultimately driving up costs and reducing competitiveness. These cost increases could then raise the transportation share of the food dollar from 3-4% to a higher value. Investment must match or exceed the rate of deterioration to keep roads in good condition. Research studies demonstrate a positive return on investment on agricultural output given increases in road disbursements, allowing costs to be shifted to other areas (Onofri and Fulginiti, 2008).

Targeted investments in highway infrastructure can help address condition challenges. The impacts of infrastructure improvements on the agriculture sector are vast, encompassing agricultural productivity, transportation costs, food prices, and international competitiveness. All these areas are important in analyzing where the greatest return on investment could be for agricultural freight projects.

Figure 8: Percent of Roadways in Poor Condition (International Roughness Index (IRI)>170) by Functional System




*Source: Condition of U.S. Roadways by Functional System (BTS, 2019)*

# SECTION 3

## Stakeholder Engagement

# STAKEHOLDER ENGAGEMENT

The project team reached out to stakeholders representing State and local transportation agencies, agriculture industry groups, and a regional freight planning organization to discuss their perspectives on the opportunities and challenges facing agricultural highway freight, and how planning and investment practices can support the best future outcomes. Stakeholders provided input through semi-structured telephone interviews and follow-up conversations.

## The primary goals of the outreach were to:

- Understand how States, regions, and local governments study, plan for, and prioritize investments in highway infrastructure for agricultural freight;
- Identify common challenges for shippers and infrastructure owners; and
- Identify notable practices and strategies for analyzing and prioritizing highway infrastructure for agricultural freight (see Section 6).

## Stakeholder Engagement Themes

Stakeholder perspectives often touch on topics that are not obvious through analysis of national freight datasets and provide greater context for interpreting how agricultural freight infrastructure planning and project development work on the ground.

1. **The "first and last miles" of agricultural truck trips are the costliest part of the overall journey.**
2. **Continued investment in highway infrastructure is critical to improving performance.**
3. **Decentralized local decision making is a barrier for industry stakeholders to communicate challenges and needs.**
4. **Data gaps for rural roads limit transportation agencies' ability to understand how products move from farm to market.**
5. **Building resiliency and redundancy in the transportation system is a critical issue for both public agencies and private shippers.**
6. **The State freight planning process has encouraged State DOTs to think more deeply about network performance.**
7. **State DOTs are studying agricultural-specific freight via corridor studies.**

## Stakeholder Input provided by:

**The Agricultural Transportation Working Group (ATWG):** which is comprised of a wide variety of food and agriculture industry groups representing agricultural shippers and receivers;

**Six State Departments of Transportation (State DOTs):** California DOT (Caltrans), Iowa DOT (Iowa DOT), Missouri DOT (MoDOT), North Carolina DOT (NCDOT), Texas DOT (TXDOT), and the Washington State DOT (WSDOT);

**The St. Louis Regional Freightway:** a regional freight planning organization, part of the Bi-State Development Corporation of Missouri and Illinois; and

**The National Association of Counties (NACo).**

The project team also reviewed responses submitted to a Request for Information which posted to the Federal Register from December 2019 to February 2020 soliciting feedback on the Nation's freight infrastructure barriers, challenges, and opportunities, which was posted to inform the development of the U.S. Department of Transportation's *National Freight Strategic Plan* (U.S. DOT, 2020).

*Credits: (clockwise) Yelizaveta Tomashevska, Baloncici, and Olga Yastremska via 123rf.com*

## 1 The "first and last miles" of agricultural truck trips are the costliest part of the overall journey.

The roads that serve local farms generally have slower speed limits, higher levels of infrastructure deterioration, and less network connectivity. Stakeholders noted that the more productive and industrialized farming practices of the 21st century necessitate larger trucks to haul larger crop yields, and to keep costs manageable, but local roads and bridges are rarely re-built to accommodate these larger vehicles, creating inefficiencies in the highway network. Destinations are often located in urban areas or busy multimodal transfer points where congestion delays are common.

- Narrow or weight-restricted roads and bridges in rural areas often require trucks to use less direct routes, adding cost and reducing efficiency.
- Stakeholders describe areas where side rails on rural bridges were damaged or removed to accommodate wider vehicles, creating maintenance and safety concerns.
- Both private shippers and public agencies identified traffic congestion around common freight destinations, such as ports, intermodals, and grain elevators, as a major issue making the last mile of a truck trip less efficient and more costly.

## 2 Continued investment in highway infrastructure is critical to improving performance.

Highway infrastructure requires continuous maintenance and reinvestment. Transportation agencies must balance a wide range of priorities and needs of diverse users. Freight users have different needs and use patterns than passenger vehicles. Some stakeholders believe that freight projects have not always been appropriately prioritized.

- Stakeholders emphasize that increased overall investment is important to improving future performance.
- Until recently there was not a dedicated source of funding for freight highway infrastructure needs at the Federal level and few dedicated sources at the State and local levels.
- Local governments are particularly stressed in balancing highway infrastructure needs and may not have access to Federal funding.
- There is a perception among some stakeholders that the seasonal nature of agriculture results in a structural disadvantage for how roadway projects are prioritized—while certain roads and bridges are critical to serving adjacent farms during harvest, infrastructure is typically prioritized based on total annual traffic.

## 3 Decentralized local decision-making is a barrier for industry stakeholders to communicate challenges and needs.

There are thousands of county, municipal, township, and other local governments in the United States, each of which is structured to serve its local context. The agriculture industry often tries to communicate infrastructure challenges and priorities to decision-makers. However, industry stakeholders often find it difficult to identify the right people at the right time.

- Most States delegate local road building and maintenance responsibilities to counties, municipalities, or other local jurisdictions, each of which prioritizes and funds infrastructure differently.
- Agriculture industry stakeholders tend to focus communications at the National and State levels where policy and regulatory decisions are made, but they find it more challenging to engage at the local level where infrastructure investment decisions, particularly for rural highways, are often made.
- A mismatch between long-range transportation planning and investment timelines and shorter-range agriculture industry business cycles has made industry participation challenging.

## 4 Data gaps for rural roads limit transportation agencies' ability to understand how products move from farm to market.

Transportation agencies rely on performance data to help identify and prioritize investments, but stakeholders indicate that limited data about freight traffic patterns is a barrier.

- The Freight Analysis Framework (FAF) forms the basis for most freight planning, but because the FAF data is summarized at a regional scale, it provides limited information about agriculture movements within a State or metropolitan area.
- Private data sources are available for more detailed agricultural commodity flows but not below the county level. These data do not show how products move from farms to elevators, intermodal connections with railroads or waterways, or processing locations.

5

## Building resiliency and redundancy in the transportation system is a critical issue for both public agencies and private shippers.

State DOTs described building resiliency and redundancy into the transportation system as a critical function of their freight planning responsibilities. While the agencies interviewed noted they have been thinking about these concepts for several years, they noted that recent supply chain disruptions such as the widespread flooding throughout the upper Midwest in 2019 and the COVID-19 global pandemic highlighted the urgency of building additional resiliency into highway networks.

- Some States are building spatial analysis tools that integrate travel patterns and vulnerability indices to predict where future infrastructure disruptions are most likely to occur, and ensure alternate routes are available.
- Public agencies are developing analysis and funding strategies to balance spending on high-traffic areas with the need for investment in redundant routes.

6

## The State freight planning process has encouraged State DOTs to think more deeply about network performance.

Since 2012, Federal law has encouraged State DOTs to develop and maintain a State Freight Plan which analyzes and articulates infrastructure strategies to optimize freight movement in their States, leading to increased attention on network performance.

- Transportation agencies are investing in freight analysis techniques (i.e., spatial analysis, project prioritization) in order to improve future freight planning and project decision making.
- Several States with strong agricultural economies are working on agriculture industry-specific freight studies to better understand and support the industry's transportation needs.

## 7 State DOTs are studying agricultural-specific freight via corridor studies.

At the statewide level, nearly all State DOTs study freight broadly, rather than focusing on specific industries or products. However, several State DOTs described undertaking corridor-level analyses to better understand the issues of freight in the agriculture industry specifically. These studies are intended to help identify the most pressing agricultural freight challenges in targeted areas.

- States use different methods to identify and define “agricultural corridors.” The scale and complexity of the analyses varies from State to State to serve individual needs (i.e., some States define corridors several miles long, while others are over 100 miles).
- Corridor studies identify specific freight needs of the agriculture industry being served on that route; for instance, large refrigerated trucks carrying perishable goods have different infrastructure design needs than trucks carrying livestock or bulk grain

*Credit: jakobradlgruber via 123rf.com*

# SECTION 4

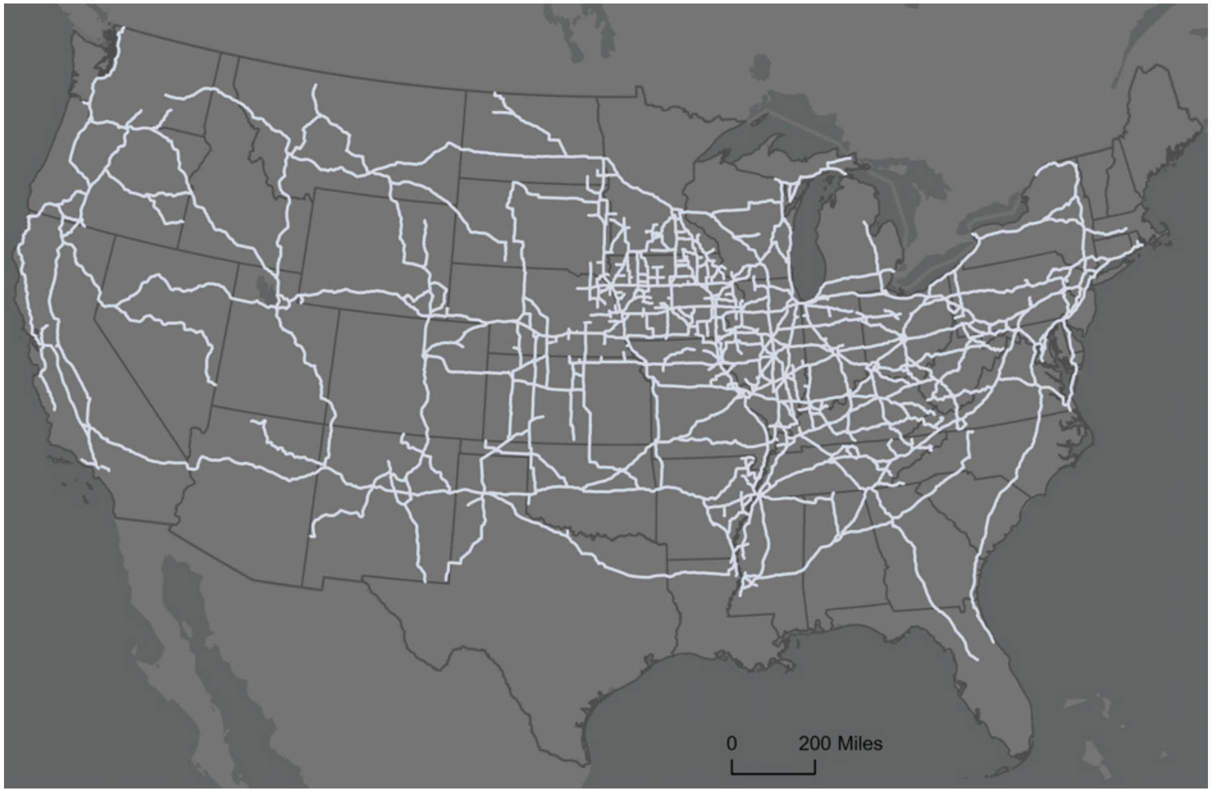
## Agricultural Freight Flows and Performance

# Agricultural Freight Flows and Performance

This section describes where U.S. agriculture is produced, how and where U.S. agricultural commodities move across U.S. highways, and the performance of those highways. The section identifies High-Volume Domestic Agriculture Highways (HDAH) that are the most important for moving the largest volumes of agricultural freight produced in the contiguous United States during 2018. Seventeen analysis corridors within the HDAH are also examined in greater detail to help illustrate how specific agricultural commodities move through the HDAH, and the congestion, reliability, and safety performance characteristics of these corridors.

Figure 9 shows a map of HDAH, which the project team developed based on 2018 agricultural commodity flow data from the IHS Markit Transearch database. The methodology used to identify HDAH is described later in this section (p.36) and in Appendix C.

Figure 9: High-Volume Domestic Agriculture Highways (HDAH)




*Source: Volpe Center analysis of 2018 IHS Markit Transearch data*

## How Agriculture Moves

From the sites of production, agricultural products travel to destinations such as processing centers, grain elevators, multimodal connections, and ports of export. Many of these trips are multimodal trips, including truck, as well as rail or barge components. Figure 10 shows a conceptual map of how agricultural products move throughout the country, including imports and exports, via all transportation modes. This map gives an overall view of the direction of commodity flows across the transportation system. Figure 11 shows freight flows by mode for all U.S. freight (not only agriculture), illustrating the interconnectedness of highway, rail, and waterway modes.

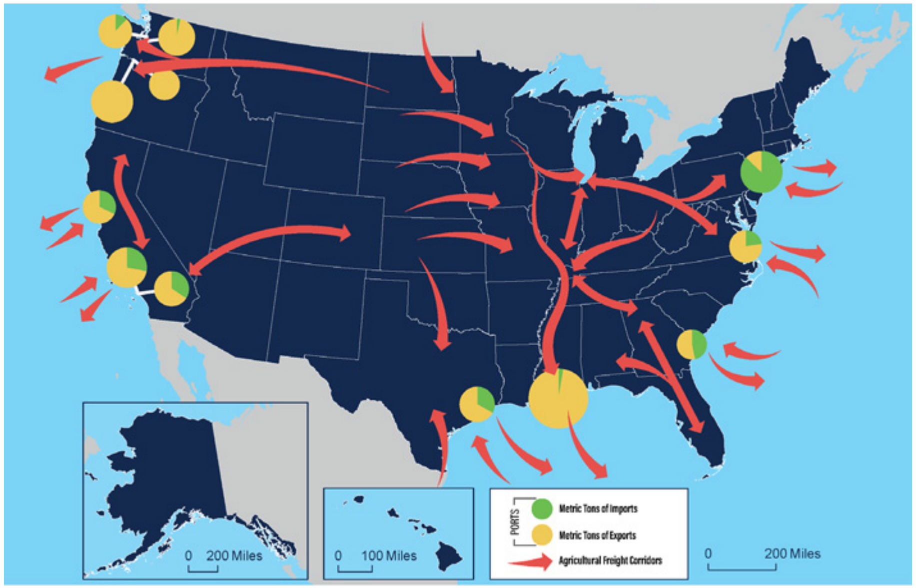
This report focuses on the highway mode, but the multimodal context of agricultural commodity flows is also important to demonstrating the full picture of how transportation factors into the economic competitiveness of the U.S. agriculture industry. For additional detail on the importance of inland waterways, see *The Importance of Inland Waterways to U.S. Agriculture* (USDA, 2019).

Highway freight travel is a mix of short and long-distance trips as described in the *National Freight Strategic Plan* (U.S. DOT, 2020).

Approximately 50% of large freight trucks (trucks with a gross vehicle weight of over 10,000 pounds) operate within 50 miles of their origination and account for about 30% of truck vehicle miles traveled (VMT).[5] By contrast, only 10% of large freight trucks operate more than 200 miles away from their origin, but these large trucks account for more than 30% of overall truck VMT. Long-distance truck travel also accounts for nearly all freight ton-miles and a large share of truck VMT.

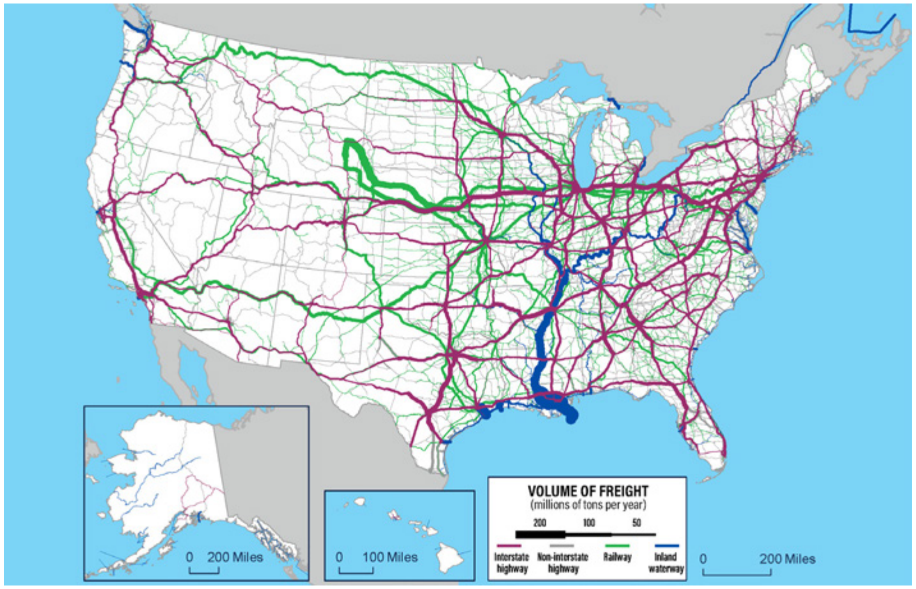
5 FHWA Planning Glossary Definition –"The number of miles traveled nationally by vehicles for a period of 1 year. VMT is either calculated using 2 odometer readings or, for vehicles with less than 2 odometer readings, imputed using a regression estimate." VMT measures the amount of travel for all vehicles in a geographic region for a given period of time, measuring by the sum of the number of miles traveled by each vehicle. https://www.fhwa.dot.gov/planning/glossary/glossary_listing.cfm?sort=definition&TitleStart=V

Figure 10: Conceptual Map of Agricultural Trade Flows




Source: National Freight Strategic Plan (U.S. DOT, 2020)

Figure 11: United States Multimodal Freight Flows




Source: National Freight Strategic Plan (U.S. DOT, 2020)

## Data Sources

In order to identify HDAH and describe freight flows of domestic agriculture production and highway performance, the project team looked at a number of characteristics. They include sites and levels of domestic agriculture production, agricultural commodity flows, highway functional classification, pavement and bridge condition, truck-involved fatal crashes, congestion, and truck travel time reliability (Table 2). Additional details about the data sources and methods used to describe domestic agricultural freight flows and performance are available in Appendix C.

Table 2: Data Sources for Defining and Describing the HDAH

| Data | Data Source (Provider, Year) | Access Level | Description |
|---|---|---|---|
| Agricultural production locations and values for select commodities | 2017 Census of Agriculture (USDA, 2019) | Public | The Census of Agriculture is a complete count of U.S. farms and ranches and the people who operate them, for any plot of land growing fruit, vegetables, or food animals worth more than $1,000 in sales. The Census is taken once every 5 years. |
| Domestic agricultural commodity highway flows | Transearch Database (IHS Markit, 2018) | Commercial | Transearch data predicts U.S. freight flows over 20 years by origin, destination, commodity, and transportation mode. Based on county-to-county level data, it includes volumes routed along individual trade lanes or corridors; the tonnage, value, and units of shipments; and mode share. This dataset is similar to the U.S. Census Commodity Flow Survey and FHWA Freight Analysis Framework, but provides greater spatial and commodity-level resolution. 2018 data is used for this report. |
| Highway functional classification, condition, and traffic volumes | Highway Performance Monitoring System (HPMS) (FHWA, 2017-2018) | Public | The HPMS is a Federal Highway Administration (FHWA) national-level highway information system that includes data on the extent, condition, performance, use, and operating characteristics of the Nation's highways. State Departments of Transportation (State DOTs) submit data annually, which includes functional classification, pavement condition, and annual average daily traffic (AADT). |
| Bridge condition | National Bridge Inventory (NBI) (FHWA, 2019) | Public | The NBI contains bridge data submitted annually to FHWA by State DOTs, Federal agencies, and Tribal governments in accordance with National Bridge Inspection Standards. It includes information on the number, length, and condition of bridges, along with other infrastructure characteristics. |
| Truck-involved fatal crashes | Fatality Analysis Reporting System (FARS) (National Highway Traffic Safety Administration (NHTSA), 2014-2018) | Public | FARS provides annual data on all fatal injuries suffered in motor vehicle traffic crashes, including truck-involved fatalities. Records include details such as the number of passengers, vehicle type, and driving conditions. |
| Congestion: Travel Time Index (TTI) and Truck Travel Time Reliability Index (TTTR) | National Performance Management Research Data Set (NPMRDS) (FHWA, 2018) | Government-only (Logins available for Federal, State, and local) | The NPMRDS is a national data set of average travel times on the National Highway System for use in performance measurement and management activities.<br><br>TTI is the ratio of the travel time during the peak period to the time required to make the same trip at free-flow speeds. TTI is a measure of congestion.<br><br>TTTR is defined by dividing the 95th percentile time (longer travel times) by the 50th percentile time (normal time travel times) for each segment across various times of day. TTTR measures how consistent truck travel times are over different time periods. |

# High-Volume Domestic Agriculture Highways

## Focus Commodities

Agricultural products are grown and raised all over the United States, from large-scale farming operations to small family or community farms. Characteristics of the land and climate influence where specific commodities are produced in larger quantities, and from where they travel to be processed, exported, or consumed.

The analysis in this report is focused on six categories of agricultural commodities. These commodities were selected as a representative sample of overall agricultural production and commodity flows in the United States. The six major categories of commodities used in this analysis are:

- grains,
- fruits and vegetables,
- milk,
- meat,[6]
- livestock, and
- poultry.

The specific commodities included in each category, and the top 10 producing States for each category, are shown in Table 3. Appendix D includes a more detailed table of the total value of these commodities produced in each State.

6 While processed meat is not included in the 2017 Census of Agriculture given that it is not a raw good, it is included in the flow analysis.

Table 3: Focus Commodities and Top 10 Producing States for Each Commodity Group

| Group | Census of Agriculture Variable | Commmodity Name (Standard Transportation Commodity Code (STCC)) | Top 10 Producing States |
|---|---|---|---|
| Grains | Corn, Grain- Acres Harvested | Corn (01132) | IA, IL, KS, MN, ND, NE, SD, IN, MO, OH |
| | Soybeans- Acres Harvested | Soybeans (01144) | |
| | Wheat- Acres Harvested | Wheat (01137) | |
| Perishables - Fruits and Vegetables | Apples- Acres Bearing | Apples (01221) | CA, FL, WA, ID, OR, MI, NY, WI, ME, ND |
| | Strawberries- Acres Bearing | Strawberries (01293) | |
| | Oranges- Acres Bearing | Oranges (01214) | |
| | Melons, Watermelon- Acres Harvested | Watermelons (01392) | |
| | Lettuce- Acres Harvested | Lettuce (01335) | |
| | Dry Onions- Acres Harvested | Dry Onions (01318) | |
| | Potatoes- Acres Harvested | Potatoes other than sweet (01195) | |
| Perishables - Milk & Dairy Products | Heads of Dairy Cows | Dairy farm products (0142) | CA, WI, NY, ID, PA, TX, MI, MN, NY, WA, OH |
| | | Processed whole milk, skim, cream, or fluid products (2026) | |
| Perishables - Meat | N/A- Not in Census of Agriculture | Meat, fresh or chilled (2011) | N/A – Not in Census of Agriculture |
| | | Meat, fresh-frozen (2012) | |
| | | Dressed Poultry, fresh or chilled (2015) | |
| | | Dressed Poultry, fresh-frozen (2016) | |
| Livestock | Cattle, (Excludes Cows) – Inventory | Livestock (0141) | IA, TX, NE, KS, MN, OK, MO, CA, SD, SC |
| | Cattle, Cows- Inventory | | |
| | Cattle, Cows, Beef- Inventory | | |
| | Cattle, Includes Calves- Inventory | | |
| | Cattle, On Feed- Inventory | | |
| | Hogs- Inventory | | |
| Poultry | Chickens, Broilers- Inventory | Live poultry (0151) | GA, AL, AR, NC, MS, TX, MD, MO, SC, DE |

*Note: Appendix D includes a summary table with total values for all commodities by State.*

*Source: Volpe Center analysis of 2017 Census of Agriculture*

Figure 12 shows the county-level production areas for these commodities, and highlights the top 10 agriculture-producing States for all agricultural commodities, based on 2017 Census of Agriculture data. As shown on the map, agricultural commodities are produced all over the United States. However, there are distinct areas where production is concentrated, which helps inform where some of the key roads are located that move agricultural freight.

The HDAH align well with where agricultural commodities are produced. These highways carry the top 80% of the tonnage or market value of the focus commodities produced in the United States, and represent approximately 17% of the lane mileage of the network of highways modeled in the Transearch database. Figure 13 shows the HDAH overlaid with all sites of production and gives a broad picture of where commodities are produced relative to where the highest domestic agricultural freight volumes occurred in 2018.

Figure 12: Map of County-Level Production of Selected Commodities and Top 10 Agriculture Producing States in 2017

*Source: Volpe Center analysis of 2017 Census of Agriculture*

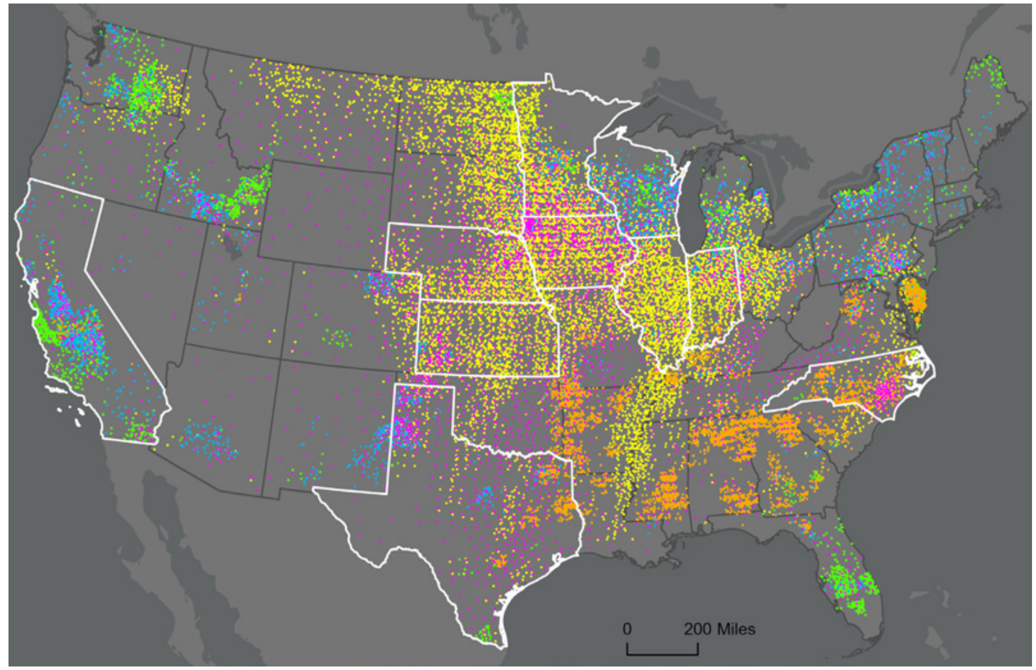
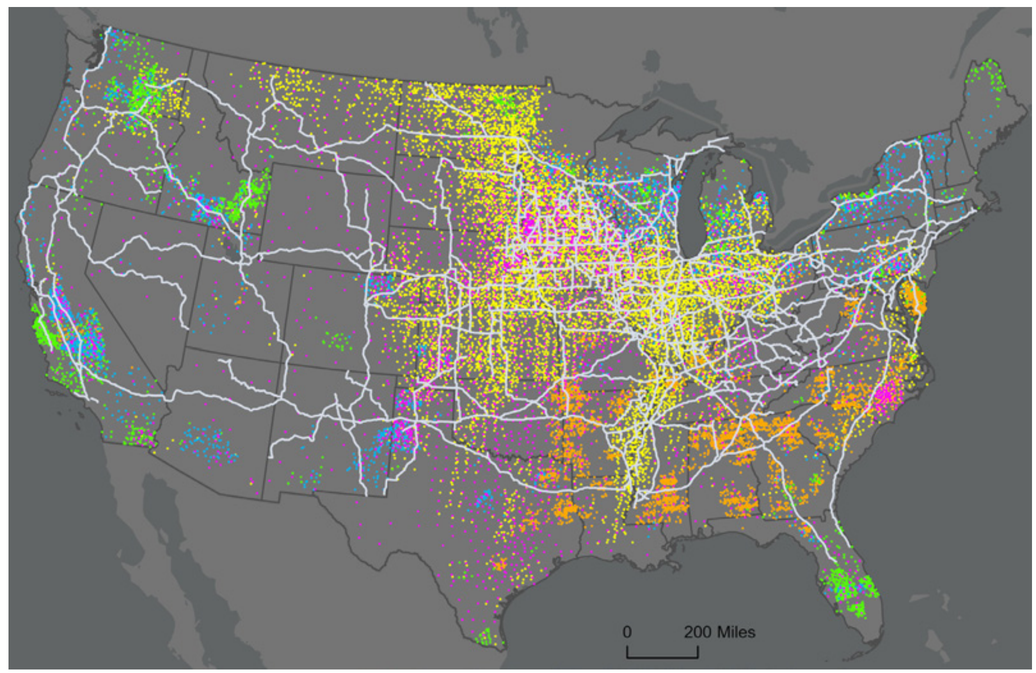



Figure 13: Map of the HDAH Overlaid with County-Level Production of Selected Commodities

*Source: Volpe Center analysis of 2017 Census of Agriculture and 2018 IHS Markit Transearch data*




**Legend**

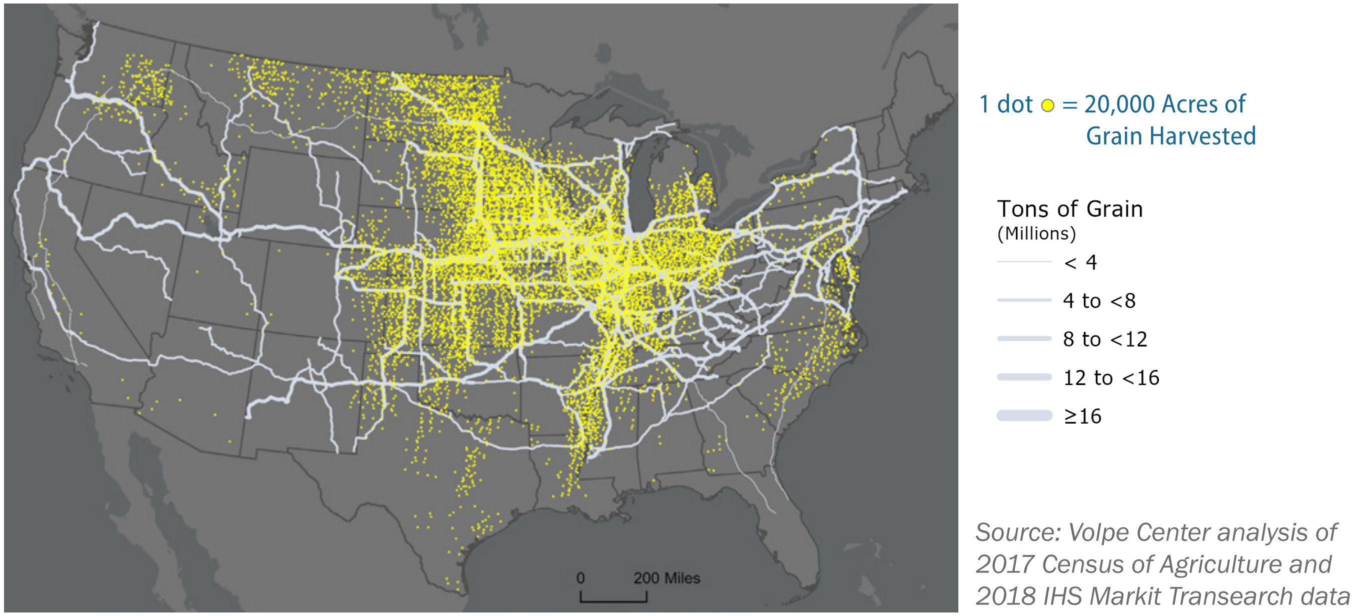
1 dot ● = 1,000 Acres of Fruits & Vegetables Harvested
1 dot ● = 20,000 Acres of Grain Harvested
1 dot ● = 3,000 Heads of Dairy Cows
1 dot ● = 75,000 Heads of Livestock
1 dot ● = 400,000 Heads of Poultry
High-Volume Domestic Agricultural Highways

Figures 14-18 show the county-level production of the focus commodity groups overlaid with the tonnage of commodity flows for that commodity group on the HDAH. These maps provide a high-level picture of where agricultural goods are produced in the United States relative to how they move over the HDAH.

Please note that while these maps may give the impression of long distance, coast-to-coast travel, many of these commodities travel much shorter distances along the HDAH to destinations such as processing centers or intermodal transfer locations. For a more in-depth analysis of how agricultural commodities move across the HDAH, see the corridor analysis section.

**Grain** production is most heavily concentrated in the Midwest, with additional clusters in the Mid-Atlantic, Pacific Northwest, and South along the Mississippi River.

Figure 14: Dot Density Map of Grain Production in 2017, Overlaid With Volume Moved on the HDAH

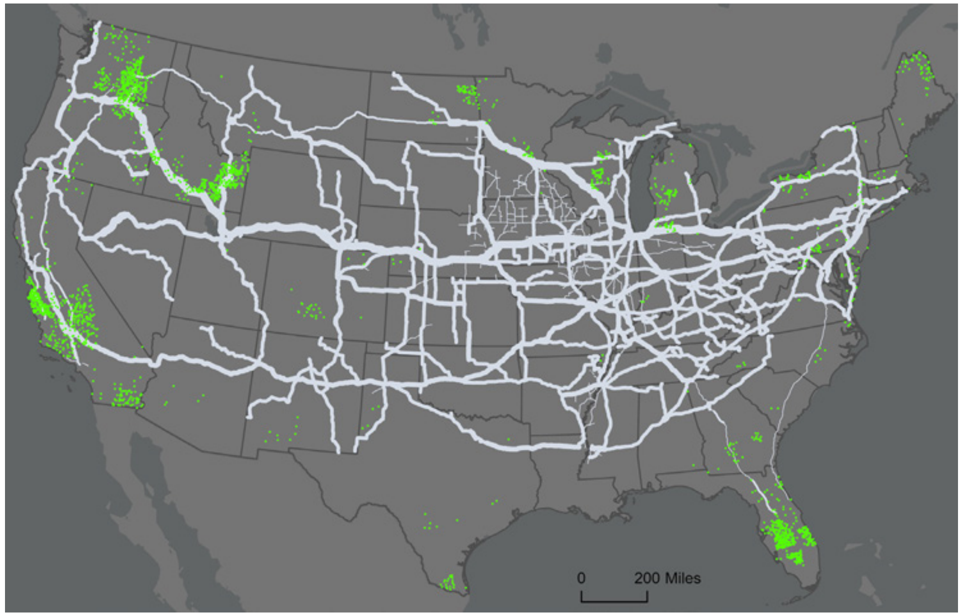



*Source: Volpe Center analysis of 2017 Census of Agriculture and 2018 IHS Markit Transearch data*

**Fruit and Vegetables** included in the focus commodities are produced in major clusters in Florida, California, Washington, and Idaho.

**Milk** is produced across the country, with notable clusters of dairy cows in California, Wisconsin, Idaho, near the Texas/ New Mexico border, and the Northeast.

Figure 15: Dot Density Map of Selected Fruits and Vegetables Production in 2017, Overlaid With Volume Moved on the HDAH



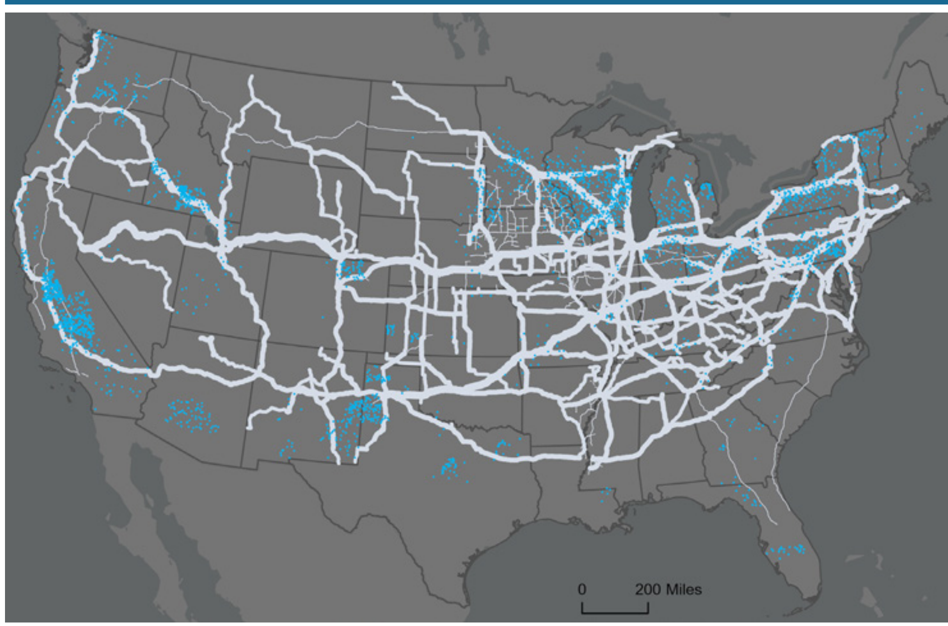

1 dot = 1,000 Acres of Fruits & Vegetables Harvested

Tons of Fruits & Vegetables (Millions)

- <1
- 1 to <2
- 2 to <3
- 3 to <4
- ≥4

*Source: Volpe Center analysis of 2017 Census of Agriculture and 2018 IHS Markit Transearch data*

Figure 16: Dot Density Map of Dairy Cows in 2017, Overlaid With Volume of Milk and Dairy Products Moved on the HDAH




1 dot = 3,000 Heads of Dairy Cows

Tons of Milk & Dairy Products (Millions)

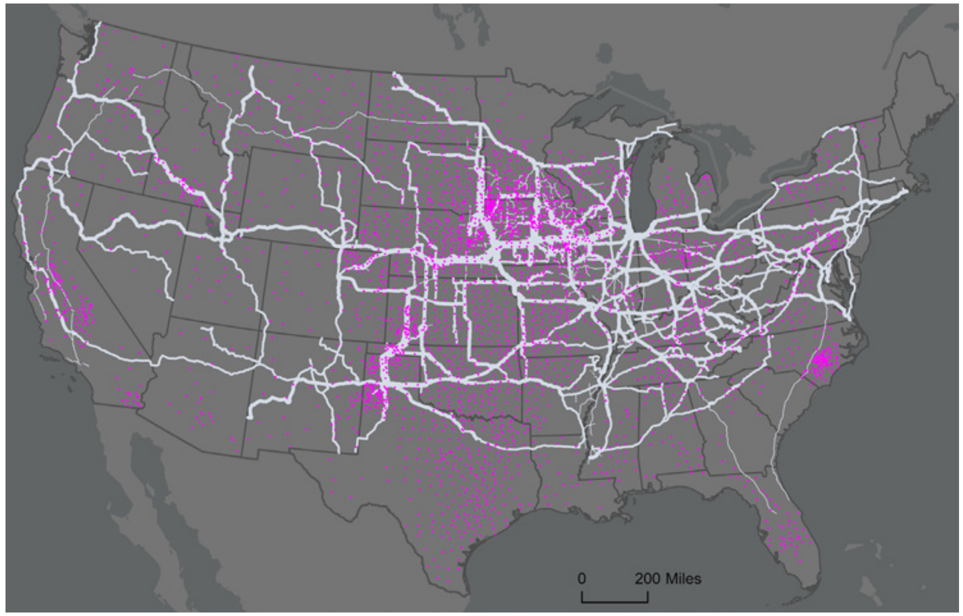
- <10
- 10 to <12
- 12 to <14
- 14 to <16
- ≥16

*Source: Volpe Center analysis of 2017 Census of Agriculture and 2018 IHS Markit Transearch data*

**Livestock** are produced across the country, with clusters in the Midwest, West Texas, North Carolina, and California.

**Poultry** production is notably concentrated across the South and the Delmarva Peninsula in the Mid-Atlantic.

Figure 17: Dot Density Map of Livestock in 2017, Overlaid With Volume of Livestock Moved on the HDAH



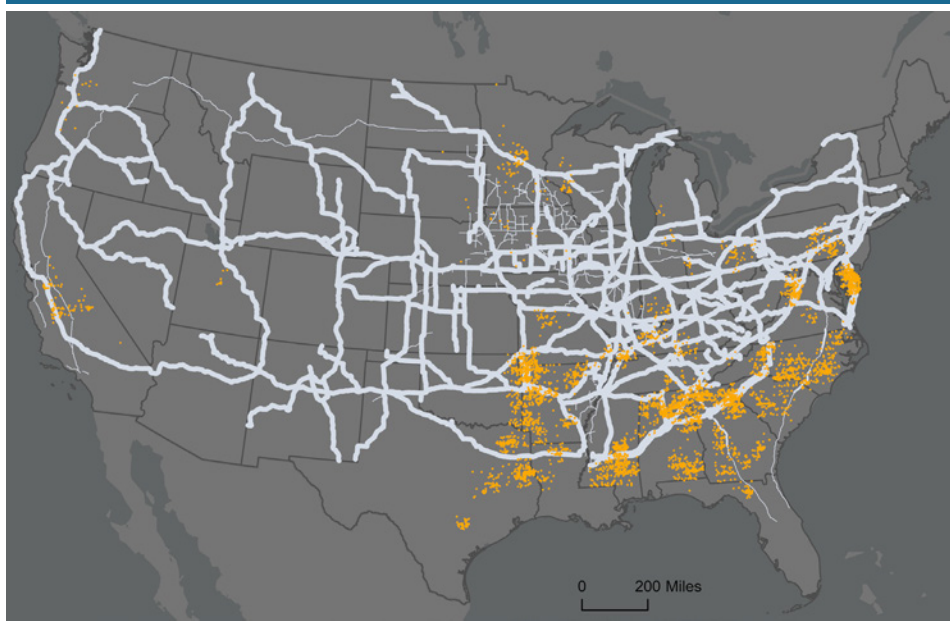

1 dot ● = 75,000 Heads of Livestock

Tons of Livestock (Millions)

- <0.6
- 0.6 to <1
- 1 to <1.2
- 1.2 to <1.6
- ≥1.6

*Source: Volpe Center analysis of 2017 Census of Agriculture and 2018 IHS Markit Transearch data*

Figure 18: Dot Density Map of Poultry in 2017, Overlaid With Volume of Poultry Moved on the HDAH




1 dot ● = 400,000 Heads of Poultry

Tons of Poultry (Millions)

- <0.2
- 0.2 to <0.8
- 0.8 to <1.6
- 1.6 to <2
- ≥2

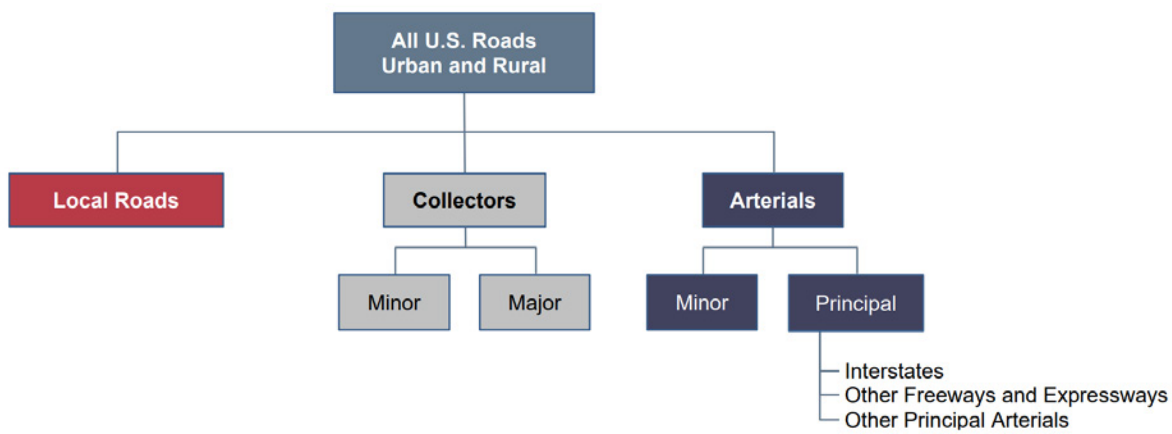
*Source: Volpe Center analysis of 2017 Census of Agriculture and 2018 IHS Markit Transearch data*

## Identifying High-Volume Domestic Agriculture Highways

Identifying highways with large volumes of domestic agriculture moves is useful for determining the most important highways for investment to support the U.S. agriculture industry. The HDAH was developed using domestic agricultural commodity flow data from the IHS Markit Transearch database, as opposed to relying solely on functional classification or overall truck traffic volume. This "bottom-up" approach identifies a subset of highways that carry 80% of domestic (non-import) agricultural commodity flows as measured by volume (tonnage or truck units) and market value (dollars).

The HDAH were identified by narrowing the highway network until 80% of flows remained for each selected commodity, as measured in tonnage or market value. This was done in two stages, first for Interstates and then for non-Interstates. This results in a narrowing of commodity flow data to 17% of the network covered by the Transearch database, which carries 80% of the commodity flows.

Figure 19: Functional Class System




**Local Roads:** These roads account for the largest percentage of all roadways. They provide direct access to destinations in a local area and are not intended for long-distance travel or through traffic.

**Collectors:** These roads gather traffic from local roads and funnel them into the arterial network.

**Arterials:** These roads carry the highest volumes of traffic and span long distances across the country. The highest classification of arterials is the Interstate system.

*Source: Status of the Nation's Highways, Bridges, and Transit, Conditions & Performance, 23rd Edition (FHWA, 2019)*

The HDAH consist of just over 49,000 highway miles of both Interstates and non-interstates. In order to understand the characteristics of the HDAH, it is important to understand the road classification system. In the United States, all roads are categorized into groups in a hierarchical functional classification system with three major categories of roads: local roads, collectors, and arterials (see Figure 19). In this report, the term "highways" refers to all roads except for local roads and rural minor collectors (see. p.2).

Arterial roads are the largest, highest-traffic volume roads in the highway network, and therefore carry the highest volume of agriculture freight and comprise the majority of the HDAH. Over 98% of the mileage of the HDAH is major arterials, including more than 88% on the National Highway System (NHS), and almost 50% on the Interstate System, as shown in Figures 20-22. These highway networks, and other commonly defined U.S. road networks, are described in Table 4 for context. The remaining 1.7% of mileage is collectors. Given that the HDAH are the roads that carry the largest volume of agricultural freight, they do not include any local roads.

Figure 20: Map of HDAH with Segments On and Off the National Highway System

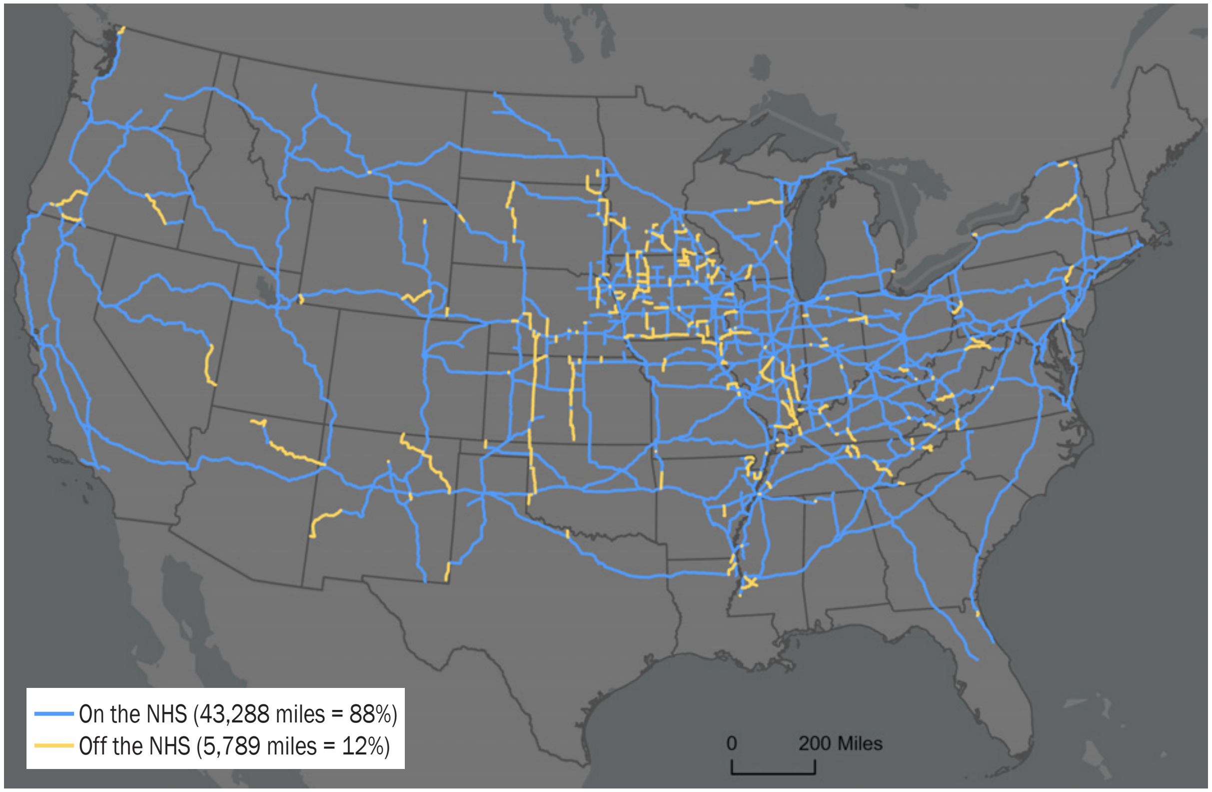



Figure 21: HDAH Mileage by Functional Class

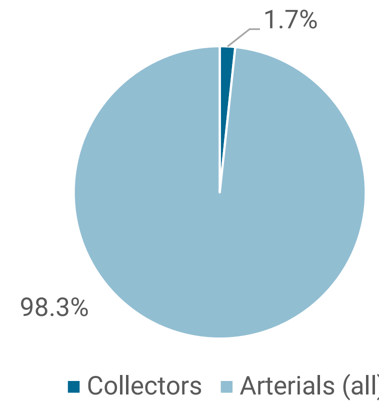
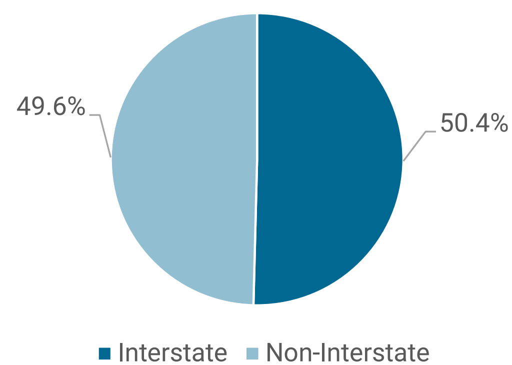



Figure 22: Percentage of HDAH Mileage On and Off the Interstate System




*Figures 20, 21, and 22 Source: Volpe Center analysis of 2018 HPMS data*

### *The Importance of Local and Collector Roads*

Agricultural freight trips typically start with a truck trip from a farm via local roads. From these local roads, products move to larger road networks, or transfer to other modes for longer distance travel. At the end of their journey, many agricultural products return to local roads as they reach a processing center, port, storage, or other final destination. The beginning and ending legs of these trips are referred to as the "first mile/last mile" of the truck journey and are a critical part of agricultural freight journeys.

Although local and collector roads are critical parts of the overall agriculture supply chain, data about their condition or performance, such as congestion or reliability, are often lacking. Stakeholders provide anecdotes indicating these roads tend to be in worse overall condition than arterials, and that in rural areas, bridge closures and outdated design standards contribute to longer and less reliable shipping routes. However, because data for local roads is not available, and because of the national scope of this report, the contribution of local roads to the agricultural freight supply chain is not analyzed in this chapter.

Table 4: Highway Systems and Network Definitions

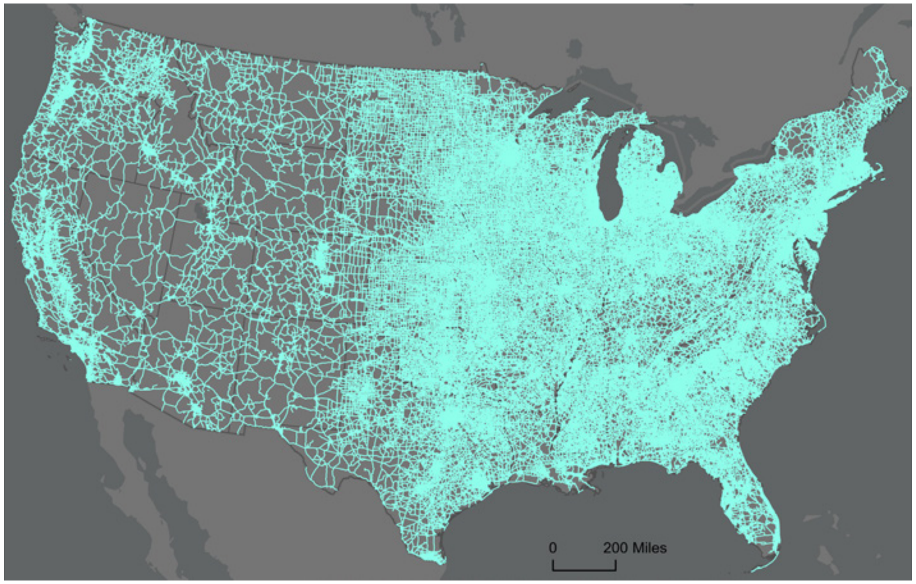
| System | Description | Highway Miles | Percent Share of Total Highway Miles |
|---|---|---|---|
| *Federal-Aid Highways* | Federal-Aid Highways are defined in 23 USC 101(a)(6) as "a public highway eligible for assistance under this chapter other than a highway classified as a local road or rural minor collector." These are the roads that are eligible for most Federal-Aid Highway Program funding. | 1,016,963 | 24.3% |
| *National Highway System (NHS)* | The NHS consists of roads important to the Nation's economy, defense, and mobility. It includes all Interstates, principal arterials, and other highways which serve military installations, major population centers, international border crossings, ports, airports, public transportation facilities, other intermodal transportation facilities, and other major travel destinations. | 226,767 | 5.4% |
| *National Network (NN)* | A system of roadways officially designated to accommodate commercial freight-hauling vehicles authorized by the Surface Transportation Assistance Act of 1982 and 23 CFR 658. The National Network overlaps significantly, but not entirely, with the NHS. This network supports interstate commerce by regulating the size of trucks, while the NHS supports interstate commerce by focusing federal investments. State DOTs may petition FHWA to add non-Interstate highways in their State.* | ~200,000 | ~4.7% |
| *National Highway Freight Network (NHFN)* | A U.S. network of highways established by FHWA to strategically direct Federal resources for improving freight performance. The network includes the Primary Highway Freight System (PHFS), identified as the most critical highway portions of the U.S. freight transportation system by FHWA. About 90% of these roads are on the Interstate system. The NHFN also includes other Interstate portions not on the PHFS, as well as critical rural and urban freight corridors that are designated by the States. | 51,029 | 1.2% |
| *High-Volume Domestic Agriculture Highways (HDAH)* | Highway infrastructure that carry the largest volume of domestically-produced agricultural freight, identified by analysis of agricultural commodity flow data. The majority of the HDAH (88%) is on the NHS. The remainder consists of other principal arterials and collectors. See Appendix C for more details. | 49,077 | 1.2% |
| *Interstate Highway System* | This consists of routes which are of the highest importance to the United States, connecting principal metropolitan areas, serving national defense, and connecting to international border crossings. All Interstate routes are included in the NHS. | 47,944 | 1.1% |

** Note: Several States have given exemptions to Federal truck size and weight limits for the transportation of agricultural commodities. See Compilation of Existing Truck Size and Weight Laws (FHWA, 2015), Appendix A. https://ops.fhwa.dot.gov/freight/policy/rpt_congress/truck_sw_laws/app_a.htm*

*Source: Status of the Nation's Highways, Bridges, and Transit, Conditions & Performance, 23rd Edition (FHWA, 2019); The National Network (FHWA, n.d.)*

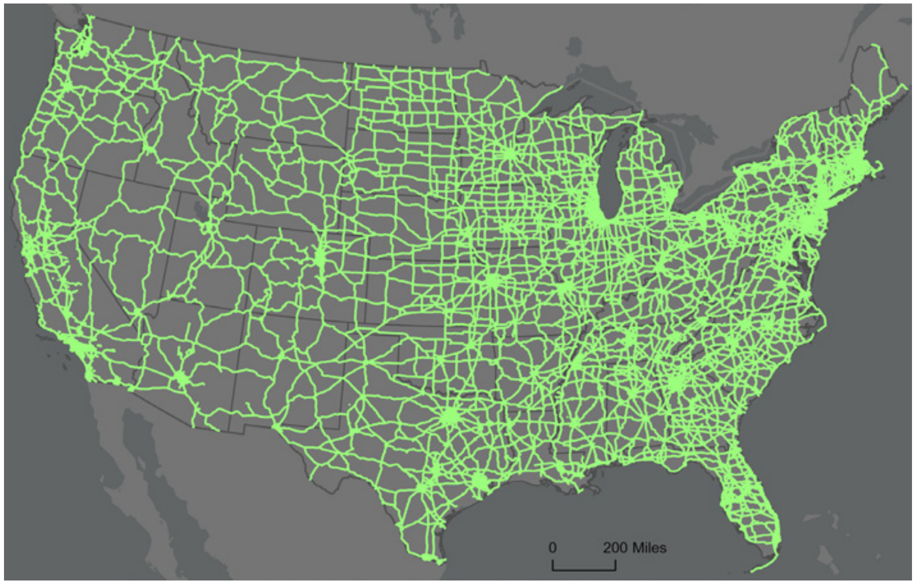
Figures 23-26 show the extent of Federal-aid Highways, the NHS, the NHFN, and the HDAH.

Figure 23: Map of the Federal-Aid Highway Network



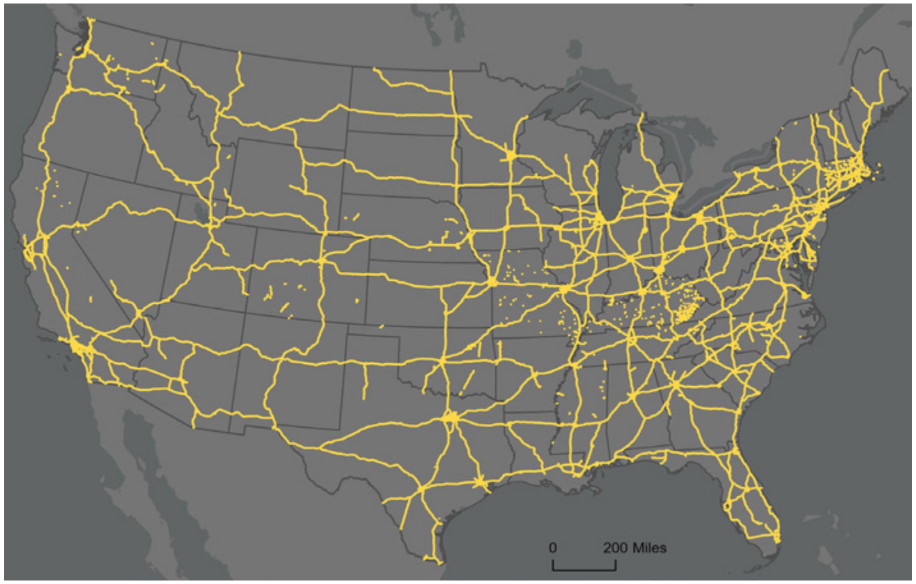

Source: HEPGIS (FHWA, n.d.)

Figure 24: Map of the National Highway System (NHS)



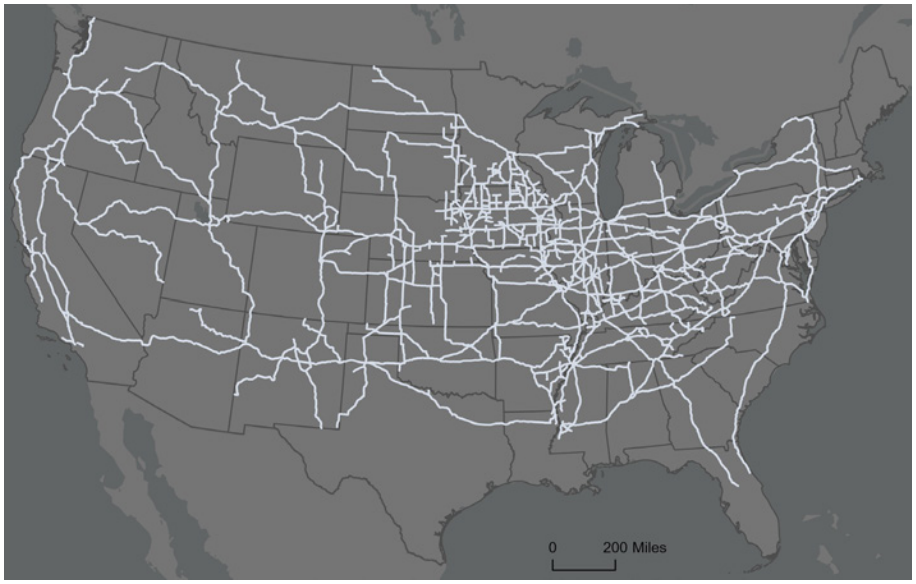

Source: HEPGIS (FHWA, n.d.)

Figure 25: Map of the National Highway Freight Network (NHFN)




Source: HEPGIS (FHWA, n.d.)

Figure 26: Map of High-Volume Domestic Agriculture Highways (HDAH)




Source: Volpe Center analysis of 2018 IHS Markit Transearch data

## Advantages and Limitations of the HDAH

Identifying HDAH based on a small selection of roads (17%) that move the majority of the volume of domestically-produced agricultural goods (80%) allows for a more detailed analysis of the highways most important to moving agricultural freight. Narrowing the extensive highway network in this way helps to provide information that is more comprehensive to State DOTs and agriculture stakeholders about where the greatest volume and market value of agriculture products are moving on U.S. highways, and enables a detailed corridor analysis approach examining the performance of important parts of the HDAH. However, there are limitations to this approach as well.

1. **The HDAH are based on a "snapshot" in time of how domestic agricultural freight moves across U.S. highways.** The Transearch data used to identify the HDAH includes one year of commodity flow data (2018), and only reflects the highest volume domestic movements of key agricultural commodities. Agricultural freight flows vary over time due to several factors, including geographic shifts in agricultural production and various market forces throughout the supply chain. The HDAH will likely shift over time.

2. **The HDAH do not include lower functional class roads and bridges.** While the HDAH capture a smaller selection of highways that move the majority of domestic agricultural freight, all highways are important to agriculture. Lower functional class roads that are not included in the HDAH, including non-NHS arterials, collectors, and local roads, carry agricultural goods from farms to processing centers, storage facilities, and intermodal transfers. Agriculture industry stakeholders often stress the importance of maintaining local roads and bridges to keep farm products moving to markets efficiently. Unfortunately, data about freight movements and performance are less likely to be available for lower functional class roads, and because they tend to carry lower volumes overall, this analysis is unable to meaningfully include them.

3. **Data on modal transfers is not included.** The supply-chain for many agricultural commodities is a multimodal journey, which tends to consist of a truck component as well as a train or barge component before reaching a final destination. Ideally, full multimodal trips of these commodities would be tracked and the volumes being transferred at key intermodals could be reported. However, data are not consistently available to support this analysis, as private supply chain operators do not report information about the commodities they carry in a way that enables this analysis at a national scale.

4. **The HDAH are based on a selection of agricultural commodities, not all agricultural commodities.** The selection of agricultural commodities chosen for this analysis, and which the HDAH are based on, captures many of the most productive agriculture producing regions in the United States. However, this selection does not capture all commodities, and the resulting HDAH therefore do not include all productive regions. For example, the non-contiguous United States (Hawaii, Alaska, and the U.S. territories) is not included in the HDAH, as a result of both smaller agriculture production and the greater reliance on non-highway modes for transportation. The commodity selection may over- or under-represent certain regions in the HDAH.

5. **The commodities selected for analysis are primarily un-processed.** Many agricultural commodities are processed and transformed into other products before being consumed or exported. To gain a full understanding of how highways support the agriculture industry, commodities would ideally be tracked through the full supply chain. However, because of the extraordinary breadth of products produced with agriculture inputs, this is not practical. Thus the analysis focuses on un-processed grains, fruits and vegetables, milk, and livestock, and processed meat. The network flows represent the volume flows from the origin county of production to the first transfer point, which range from marine ports, to processing facilities, to grain elevators.

6. **The analysis does not include data on intra-county commodity movements.** The Transearch data from which the HDAH are developed is based on county-to-county commodity flows. Thus, movements of agricultural goods within counties are not captured. This may underrepresent commodities that tend to be processed or transferred to another mode close to where they are produced.

7. **Imported commodities are not included.** This analysis only includes domestic agriculture production. As such, it does not reflect the movements of all agriculture commodities, only those produced in the United States. This may somewhat limit the usefulness of the analysis for understanding total agriculture freight flows for commodities that are imported into the United States in significant volumes.

Despite these limitations, the HDAH and the analysis of commodity flows that they are based upon, provide a novel framework for understanding the importance of highways to the U.S. agriculture industry. The HDAH provide a shorthand for transportation agencies to quickly assess which highways are of greatest importance to U.S. agriculture producers' economic competitiveness. A smaller, more manageable sized set of highways better lends itself to more detailed analyses of corridor performance and enables agencies to focus on areas of particular importance for agricultural freight with potential performance challenges (see corridor profiles).

## Commodity Flows on HDAH

Trucks traveling on HDAH move approximately 805 million tons of these selected commodities worth over $428 billion annually. Table 5 shows the States that move the highest tonnage of the selected commodities on the HDAH by commodity group. Generally, the top production States align closely with the States with the largest commodity flows. However, there are States that are not top-10 producers, but still have significant flows of the selected commodities. These States tend to include important highway corridors for long distance shipping, be adjacent to high-production States, or contain processing centers, warehouses, or intermodal transfer locations that contribute to heavy flows of specific commodities. Some States are not large producers for certain agricultural commodities, but they may maintain important HDAH used to transport those commodities. Appendix D includes a table of the amount of tonnage moved on the HDAH by State.

*Table Note: Appendix D includes a summary table with total volume moved on the HDAH by State.*

*Source: Volpe Center analysis of 2018 IHS Markit Transearch data*

Table 5: Total Tonnage and Market Value of Focus Commodity Groups Moved on HDAH

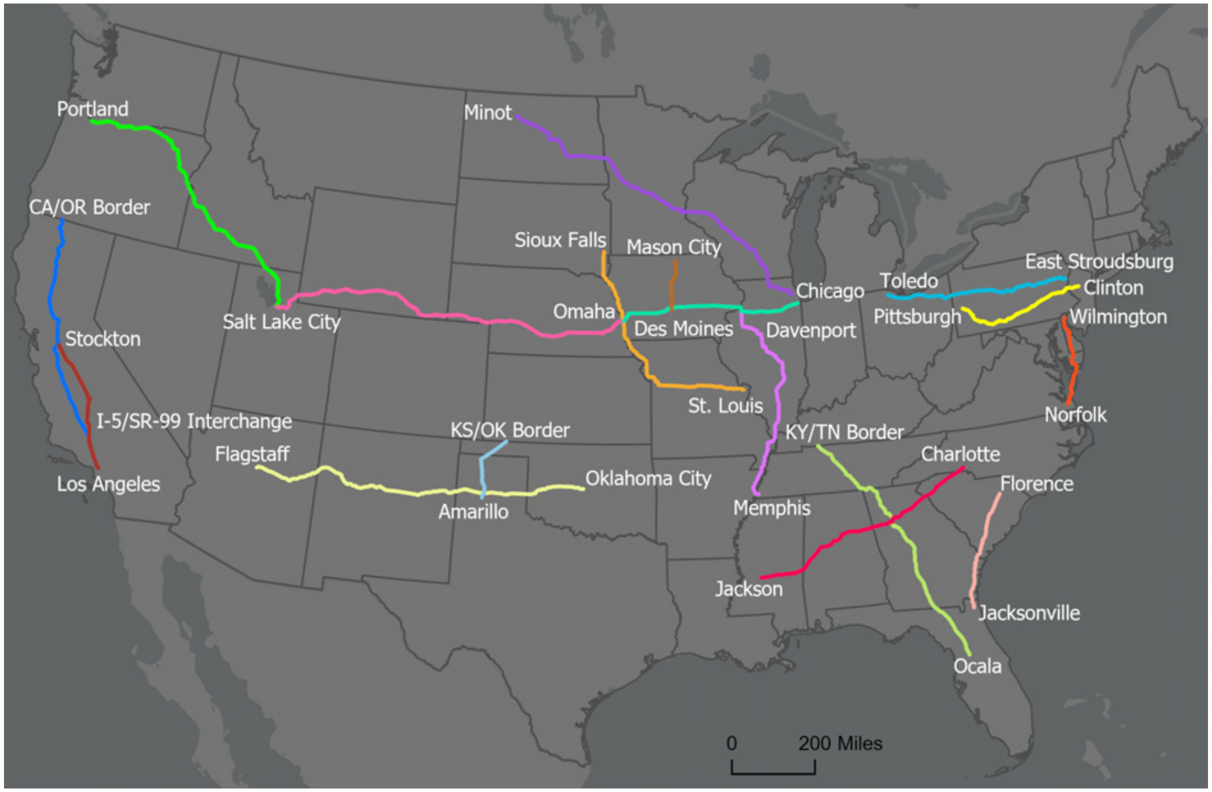
| Group | 2017 Census of Agriculture Variable | Commodity Name (Standard Transportation Commodity Code (STCC)) | Volume Moved on the HDAH (in millions of tons) | Value Moved on the HDAH (in billions of dollars) | States with Highest Tonnage Commodity Flows on HDAH |
|---|---|---|---|---|---|
| Grains | Corn, Grain- Acres Harvested | Corn (01132) | 560.7 | $83.9 | IA, IL, MN, NE, IN, MO, SD, WI, KS, OH |
| | Soybeans- Acres Harvested | Soybeans (01144) | | | |
| | Wheat- Acres Harvested | Wheat (01137) | | | |
| Perishables - Fruits and Vegetables | Apples- Acres Bearing | Apples (01221) | 35.9 | $29.1 | CA, ID, WA, OR, IL, IN, UT, WI, WY, PA |
| | Strawberries- Acres Bearing | Strawberries (01293) | | | |
| | Oranges- Acres Bearing | Oranges (01214) | | | |
| | Melons, Watermelon- Acres Harvested | Watermelons (01392) | | | |
| | Lettuce- Acres Harvested | Lettuce (01335) | | | |
| | Dry Onions- Acres Harvested | Dry Onions (01318) | | | |
| | Potatoes- Acres Harvested | Potatoes other than sweet (01195) | | | |
| Perishables - Milk & Dairy Products | Dairy Cows- Inventory | Dairy farm products (0142) | 119.3 | $58.1 | CA, WI, PA, IL, OH, IN, NY, MN, IA, TX |
| | | Processed whole milk, skim, cream, or fluid products (2026) | | | |
| Perishables - Meat | N/A- Not in Ag Census | Meat, fresh or chilled (2011) | 33.9 | $123.4 | IL, IA, IN, GA, MO, TN, TX, VA, PA, OH |
| | | Meat, fresh-frozen (2012) | | | |
| | | Dressed Poultry, fresh or chilled (2015) | | | |
| | | Dressed Poultry, fresh-frozen (2016) | | | |
| Livestock | Cattle, (Excl Cows)- Inventory | Livestock (0141) | 36.5 | $80.0 | IA, NE, MN, IL, KS, TX, OK, SD, IN, MO |
| | Cattle, Cows- Inventory | | | | |
| | Cattle, Cows, Beef- Inventory | | | | |
| | Cattle, Incl Calves- Inventory | | | | |
| | Cattle, On Feed- Inventory | | | | |
| | Hogs- Inventory | | | | |
| Poultry | Chickens, Broilers - Inventory | Live poultry (0151) | 19.3 | $53.9 | GA, AR, VA, NC, AL, MS, MD, SC, TN, KY |
| | Turkeys- Inventory | | | | |

## Analysis Corridor Identification

Seventeen highway corridors were identified from the HDAH for further analysis of domestic agricultural commodity flows, and corridor performance in terms of pavement and bridge conditions, congestion, reliability, and safety (Figure 27). The corridor analysis approach supports the ability to examine the characteristics and performance of significant corridors on the HDAH in a detailed way that is not possible for all of the HDAH due to data and resource limitations. **In many cases, agricultural freight does not regularly travel the full length of these corridors**, but we can better understand the importance of a corridor by examining the variations in commodity flow and performance along the corridor.

The analysis corridors were chosen by assessing the movement of the agricultural commodities across the HDAH and based on availability of performance data from HPMS and NPMRDS. Corridors were initially identified based on the top 5% of routes that carry the largest share of each of the focus commodities (by tonnage, market value, or truck units). Corridor endpoints were chosen using natural breaks in the commodity flow data and comparison with highway infrastructure and relevant intermodal and processing facilities. Additional corridors that fell just shy of the 5% threshold were added to ensure a geographic balance and incorporate insights from the stakeholder engagement element of the project. Appendix C includes a more detailed description of how the 17 corridors were identified.

Figure 27: Map of 17 Analysis Corridors




*Source: Volpe Center analysis*

The 17 analysis corridors are:

1. CA/OR Border to SR-99/I-5 Interchange
2. Jackson, MS to Charlotte, NC
3. Omaha, NE to Chicago, IL
4. Davenport, IA to Memphis, TN
5. Toledo, OH to East Stroudsburg, PA
6. Flagstaff, AZ to Oklahoma City, OK
7. Florence, SC to Jacksonville, FL
8. KS/OK Border to Amarillo, TX
9. KY/TN Border to Ocala, FL
10. Mason City, IA to Des Moines, IA
11. Minot, ND to Chicago, IL
12. Pittsburgh, PA to Clinton, NJ
13. Salt Lake City, UT to Omaha, NE
14. Portland, OR to Salt Lake City, UT
15. Stockton, CA to Los Angeles, CA
16. Sioux Falls, SD to St. Louis, MO
17. Wilmington, DE to Norfolk, VA

# Analysis Corridor Profiles

This section highlights how domestic agricultural commodities move along each of the 17 analysis corridors. Each corridor narrative provides a high-level overview of the focus commodity agricultural commodity flows, infrastructure conditions, and performance of the route, and describes the importance of the corridor to domestic agricultural freight movement. Detailed statistics and charts for each corridor describing specific commodity flows, infrastructure conditions, and performance can be found in Appendix B.

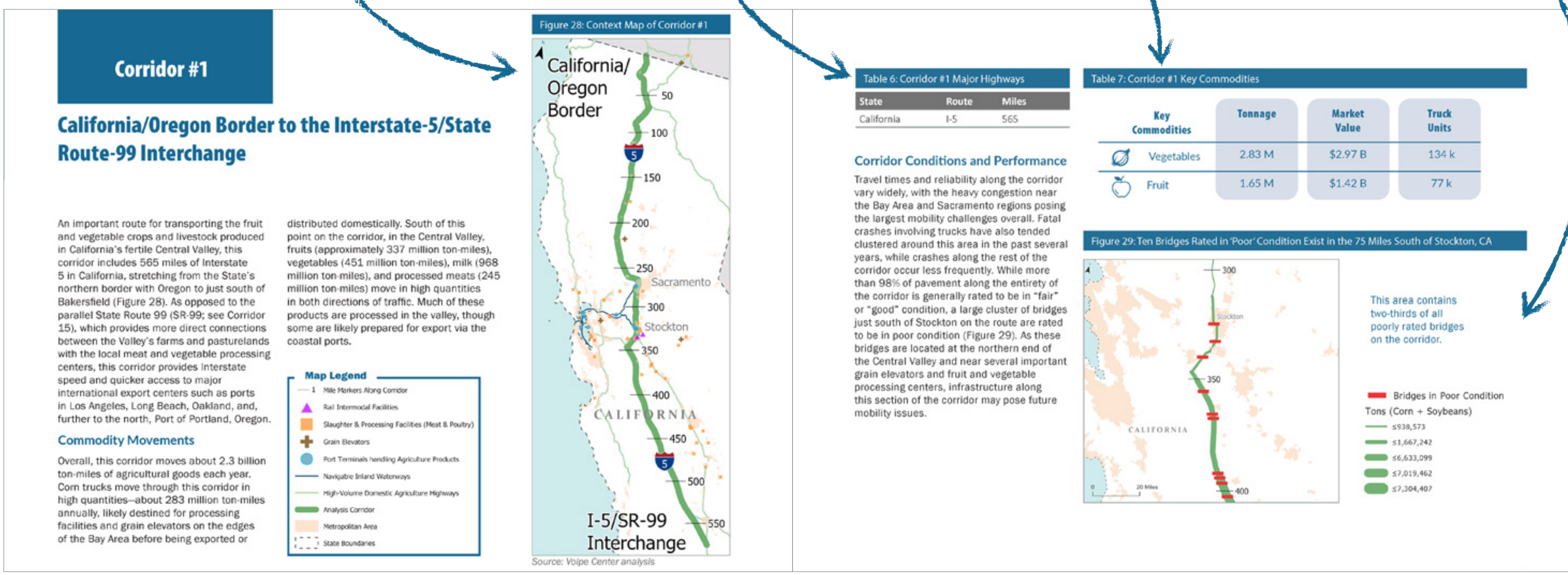
***The corridor profiles contains the following components:***

***Reference map*** *highlighting the proximity of agricultural processing facilities, major metropolitan areas, navigable inland waterways, and other nearby HDAH routes*

***Summary of highways*** *and State routes which together comprise the corridor*

***Key commodities table*** *detailing of the number of truck units, tonnage, and market value of key domestic agricultural commodities that move on the corridor by truck*

***Highlights of notable features*** *throughout the corridor in the form of maps, charts, or descriptive photos*



# Corridor #1

## California/Oregon Border to the Interstate-5/State Route-99 Interchange

An important route for transporting the fruit and vegetable crops and livestock produced in California's fertile Central Valley, this corridor includes 565 miles of Interstate 5 in California, stretching from the State's northern border with Oregon to just south of Bakersfield (Figure 28). As opposed to the parallel State Route 99 (SR-99; see Corridor 15), which provides more direct connections between the Valley's farms and pasturelands with the local meat and vegetable processing centers, this corridor provides Interstate speed and quicker access to major international export centers such as ports in Los Angeles, Long Beach, Oakland, and, further to the north, Port of Portland, Oregon.

### Commodity Movements

Overall, this corridor moves about 2.3 billion ton-miles of agricultural goods each year. Corn trucks move through this corridor in high quantities—about 283 million ton-miles annually, likely destined for processing facilities and grain elevators on the edges of the Bay Area before being exported or

Table 6: Corridor #1 Major Highways

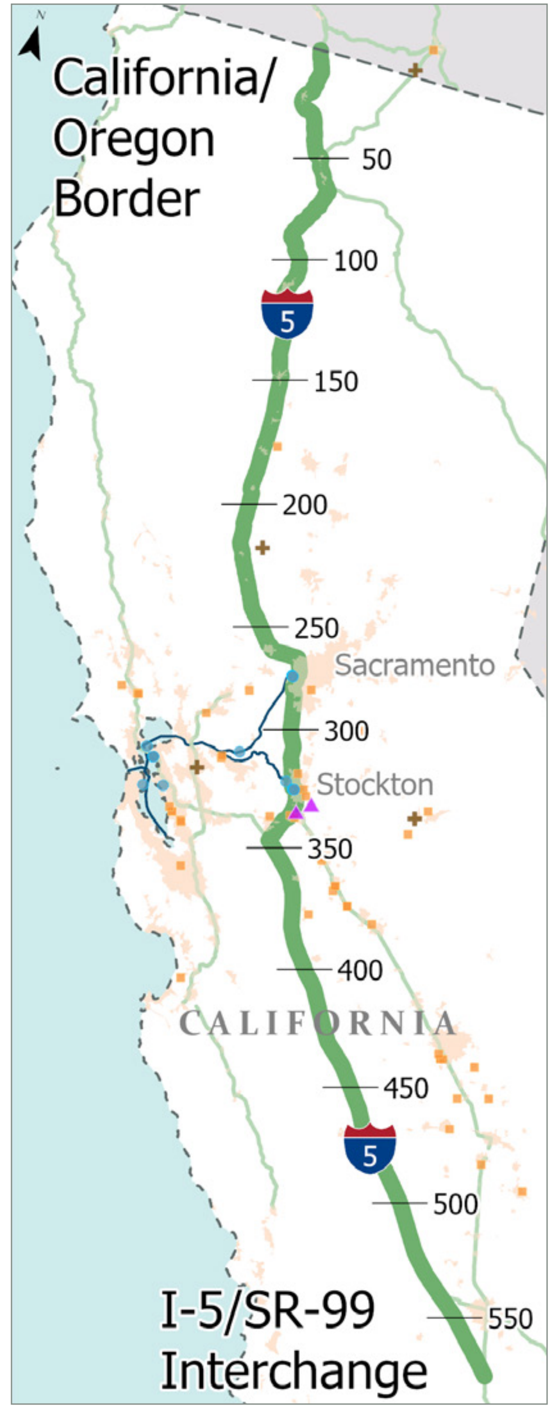
| State | Route | Miles |
|---|---|---|
| California | I-5 | 565 |

*Source: Volpe Center analysis*

**Map Legend**

- 1 Mile Markers Along Corridor
- Rail Intermodal Facilities
- Slaughter & Processing Facilities (Meat & Poultry)
- Grain Elevators
- Port Terminals handling Agriculture Products
- Navigable Inland Waterways
- High-Volume Domestic Agriculture Highways
- Analysis Corridor
- Metropolitan Area
- State Boundaries

Figure 28: Context Map of Corridor #1




*Source: Volpe Center analysis*

distributed domestically. South of this point on the corridor, in the Central Valley, fruits (approximately 337 million ton-miles), vegetables (451 million ton-miles), milk (968 million ton-miles), and processed meats (245 million ton-miles) move in high quantities in both directions of traffic. Much of these products are processed in the valley, though some are likely prepared for export via the coastal ports.

## Corridor Conditions and Performance

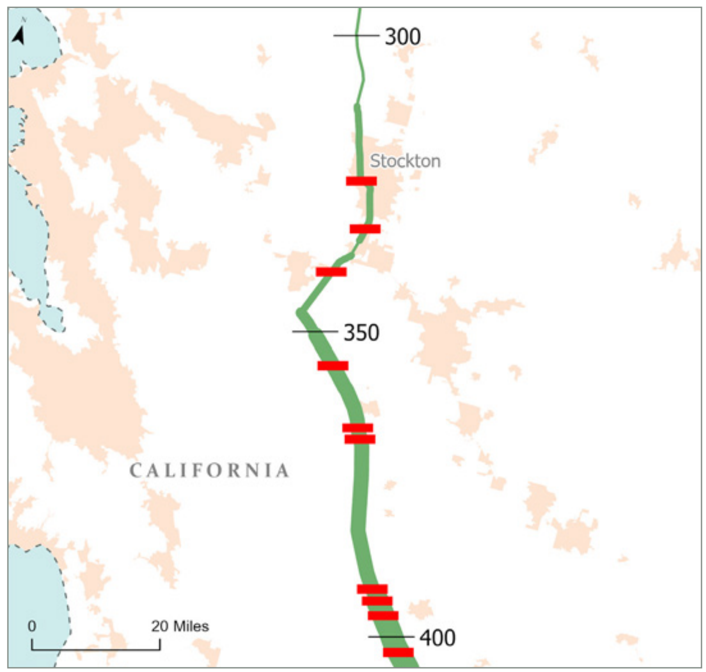
Travel times and reliability along the corridor vary widely, with the heavy congestion near the Bay Area and Sacramento regions posing the largest mobility challenges overall. Fatal crashes involving trucks have also tended clustered around this area in the past several years, while crashes along the rest of the corridor occur less frequently. While more than 98% of pavement along the entirety of the corridor is generally rated to be in “fair” or “good” condition, a large cluster of bridges just south of Stockton on the route are rated to be in poor condition (Figure 29). As these bridges are located at the northern end of the Central Valley and near several important grain elevators and fruit and vegetable processing centers, infrastructure along this section of the corridor may pose future mobility issues.

Table 7: Corridor #1 Key Commodities

| Key Commodities | Tonnage | Market Value | Truck Units |
|---|---|---|---|
| Vegetables | 2.83 M | $2.97 B | 134 K |
| Fruit | 1.65 M | $1.42 B | 77 K |

*Source: Volpe Center analysis of 2018 IHS Markit Transearch data*

Figure 29: Ten Bridges Rated in ‘Poor’ Condition Exist in the 75 Miles South of Stockton, CA



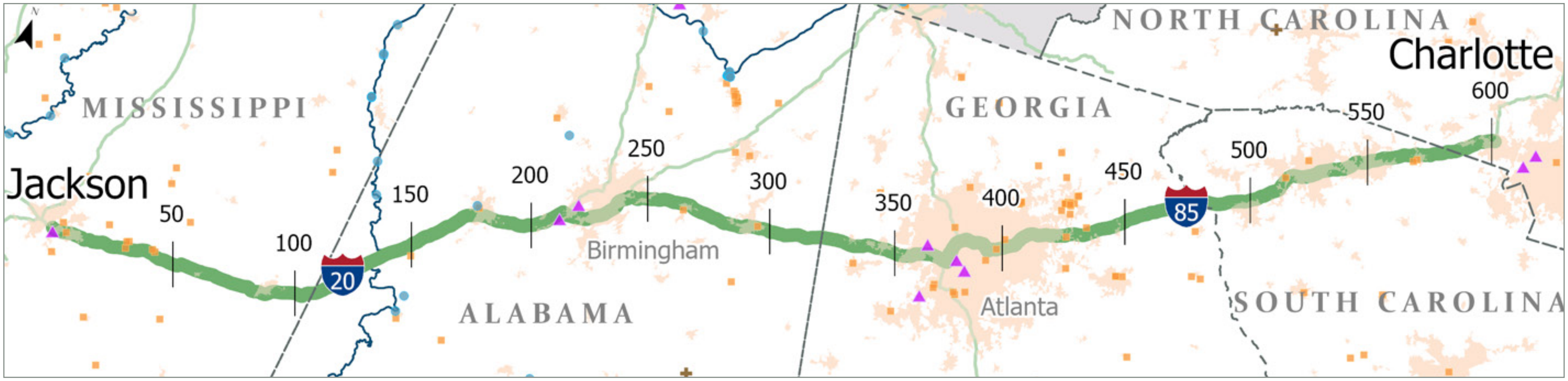

This area contains two-thirds of all poorly rated bridges on the corridor.

*Source: Volpe Center Analysis of 2018 IHS Markit Transearch data and 2018 National Bridge Inventory data*

# Corridor #2

# Jackson, MS to Charlotte, NC

Figure 30: Context Map of Corridor #2




*Source: Volpe Center analysis*

This 603-mile long corridor stretches across the Southeastern region of the United States from Jackson, MS to Charlotte, NC. Interstates 20 (I-20), 59 (I-59) and 85 (I-85) provide an east-west route cutting directly through the region (Figure 30). This route sees more poultry carrying trucks than 95% of the rest of the Nation's roadways, much of which is broiler chickens. The corridor also moves a significant amount of corn, livestock, dairy, and vegetables. A wide range of processing centers are located throughout the corridor, mostly in and around major metropolitan areas where the refined commodities then can be shipped via intermodal transportation facilities to destinations across the Nation.

Table 8: Corridor #2 Major Highways

| State | Route | Miles |
|---|---|---|
| Alabama | I-20 | 78 |
| | I-59 | 106 |
| | I-459 | 30 |
| Georgia | I-20 | 51 |
| | I-85 | 84 |
| | I-285 | 23 |
| Mississippi | I-20 | 84 |
| | I-59 | 23 |
| North Carolina | I-85 | 17 |
| South Carolina | I-85 | 98 |
| | I-520 | 9 |

*Source: Volpe Center analysis*

**Map Legend**

- 1 Mile Markers Along Corridor
- Rail Intermodal Facilities
- Slaughter & Processing Facilities (Meat & Poultry)
- Grain Elevators
- Port Terminals handling Agriculture Products
- Navigable Inland Waterways
- High-Volume Domestic Agriculture Highways
- Analysis Corridor
- Metropolitan Area
- State Boundaries

## Commodity Movements

Large clusters of slaughterhouses and meat processing facilities exist in the Atlanta, GA, region, to which most poultry, cattle, and hog are destined. Annually, more than 400 million ton-miles of poultry and 553 million ton-miles of meat also move westward through western Alabama and eastern Mississippi, likely moving these products from local farms to processing facilities in the Jackson, MS metropolitan area. High volumes of dairy move through the corridor—about 220 million ton-miles each year—likely destined for processing and distribution centers in and around Atlanta. Grains also move at high volumes on this corridor, most often moving from farms in the Carolinas to facilities in the Atlanta metropolitan area for processing and distribution.

Table 9: Corridor #2 Key Commodities

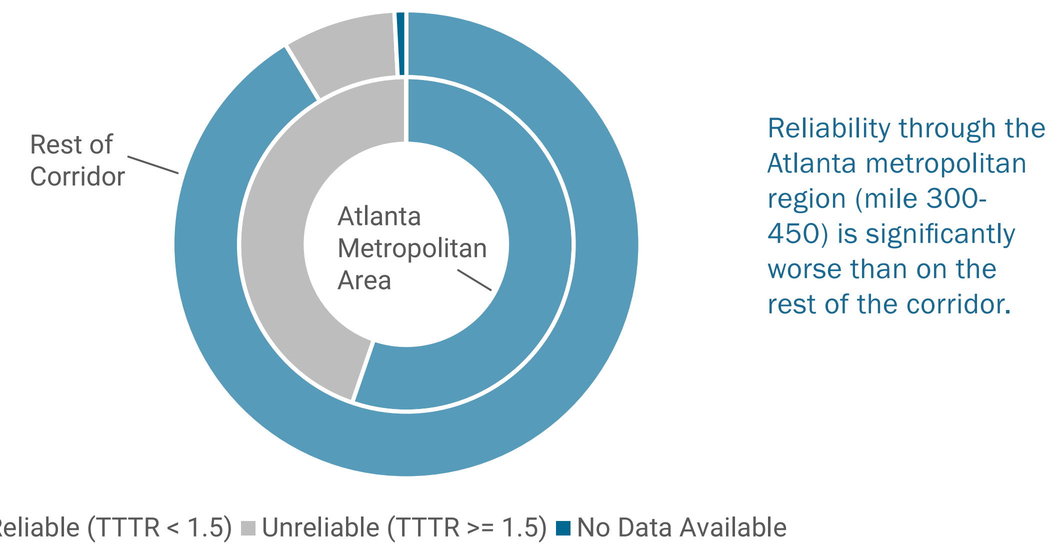
| Key Commodities | Tonnage | Market Value | Truck Units |
|---|---|---|---|
| Poultry | 4.97 M | $13.83 B | 322 K |

*Source: Volpe Center analysis of 2018 IHS Markit Transearch data*

## Corridor Conditions and Performance

More than 80% of mileage along the route moves traffic at consistent travel times. The Atlanta, GA, metropolitan region and Greenville/Spartanburg, SC metropolitan areas see regular congestion, however, and are far less reliable than the rest of the corridor (Figure 31). The route also sees significantly more traffic than many of the other analysis corridors. There are an average of 26.8 fatalities from truck-related crashes on this route each year. This is the equivalent of 0.211 fatalities per 100 million vehicle miles traveled (all traffic)—higher than the 2018 national average (0.159). 99.8% of the pavement and 98.5% of the bridges that make up the corridor are rated to be in “good” or “fair” quality; just 5 bridges out of 339 are rated in poor condition, all of which are located in North and South Carolina between Spartanburg and Charlotte.

Figure 31: Share of Corridor #2 with Reliable Truck Travel Times: Atlanta Metro Compared to the Rest of the Corridor

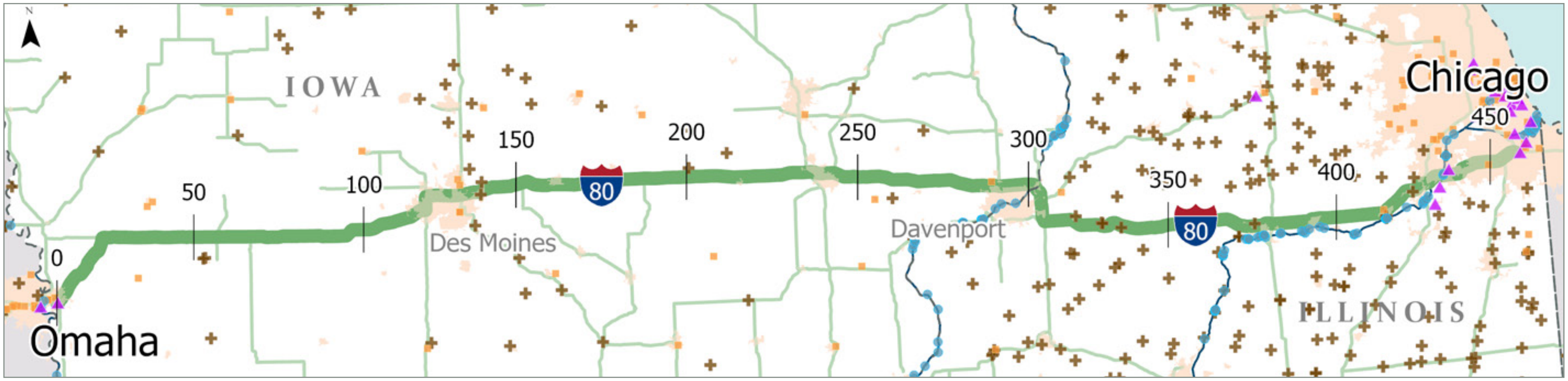



*Source: Volpe Center analysis of 2018 NPMRDS data*

# Corridor #3

## Omaha, NE, to Chicago, IL

Figure 32: Context Map of Corridor #3




*Source: Volpe Center analysis*

This 458-mile long corridor is among the busiest east-west trucking routes in the HDAH, providing the agricultural shippers in the Midwest Interstate access to the western half of the country via I-80 (Figure 32). While a large amount of bulk goods like soybeans and wheat are trucked regionally toward intermodal rail facilities or river barge, a significant portion of these commodities are shipped across the country via truck.

Table 10: Corridor #3 Major Highways

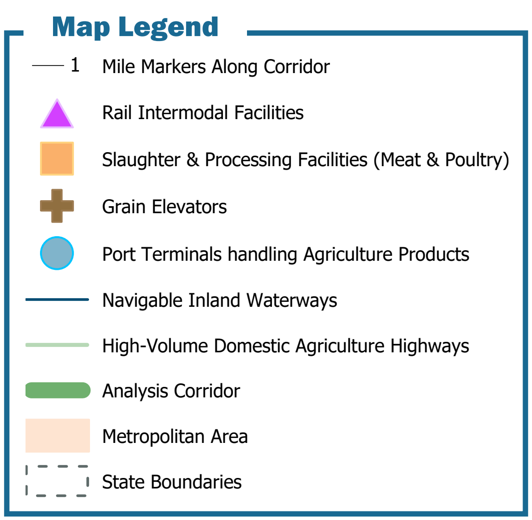
| State | Route | Miles |
|---|---|---|
| Illinois | I-80 | 156 |
| Iowa | I-80 | 302 |

*Source: Volpe Center analysis*

Farms near this corridor also produce livestock, poultry, dairy, and vegetables, each of which travels via I-80 in large volumes. Approximately $31 billion worth of agricultural commodities travel through this corridor annually.

### Commodity Movements

This corridor sees more than 6 billion ton-miles of agricultural commodities trucked across it annually (Figure 33). More than two-thirds of agricultural tonnage on the route moves westward, including large volumes of corn (1.7 billion ton-miles annually), dairy (681 million ton-miles), vegetables (552 million ton-miles), processed meat (541 million ton-miles), soybeans (445 million ton-miles), and livestock (about 148 million



ton-miles). Agricultural traffic volumes greatly increase on the corridor around mile 300 in Davenport, IL. Here, I-74 from the south and I-88 from north converge with the route and travel westward. In the eastbound direction, corn is trucked in especially high volumes (1.25 billion ton-miles annually). Dairy products, soybeans, and processed meats also move in significant volumes, likely headed for processing facilities in central Iowa or the Chicago metropolitan area. At least some of the grains grown in region likely travel through this corridor toward the Mississippi River, where high quantities of bulk grain travel by barge toward to Port of New Orleans for export.

## Corridor Conditions and Performance

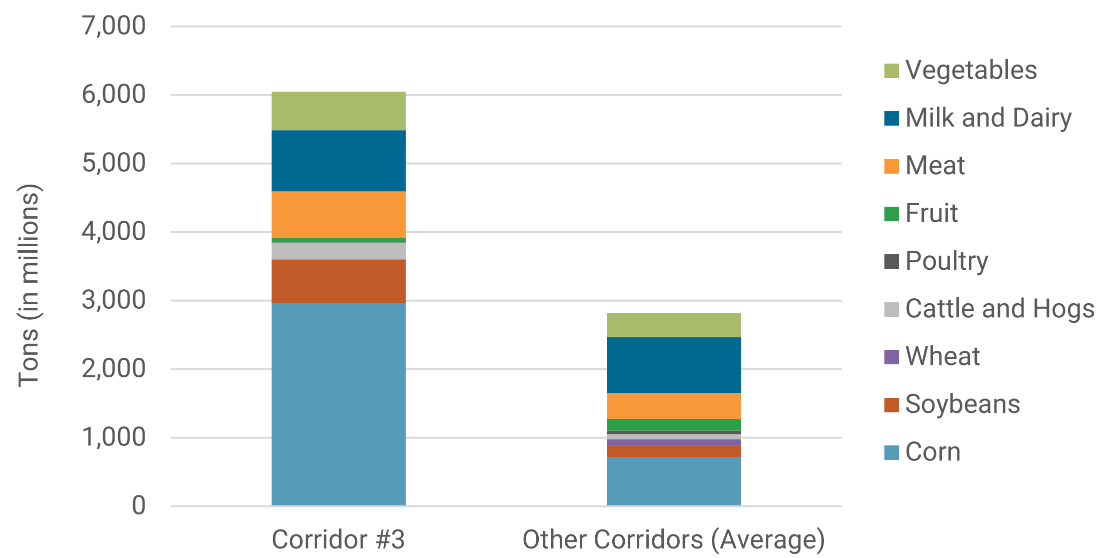
In terms of total vehicle volumes, this corridor sees much more daily traffic than other corridors studied in this report, and the number of truck-related fatal crashes are relatively high as well. About one-third of the route exists in urban areas. The two largest metropolitan areas, Des Moines, IA and Chicago, IL, see the most traffic on average; while this traffic congestion correlates to a large drop in travel time reliability in the Chicago region, the Des Moines region's traffic remains mostly consistent and does not present significant travel time issues. Pavement throughout the entire corridor is rated quite high, with more than 99% of mileage rated to be in either "good" or "fair" condition. However, 14 bridges (or about 6.5% of all bridges on the route) are rated as being in "poor" condition, and are fairly evenly distributed throughout the corridor.

Table 11: Corridor #3 Key Commodities

| Key Commodities | Tonnage | Market Value | Truck Units |
|---|---|---|---|
| Corn | 44.80 M | $4.44 B | 2.90 M |
| Dairy | 5.65 M | $2.64 B | 340 K |
| Meat | 3.78 M | $14.67 B | 164 K |
| Livestock | 3.58 M | $7.85 B | 232 K |
| Vegetables | 1.63 M | $1.32 B | 78 K |

*Source: Volpe Center analysis of 2018 IHS Markit Transearch data*

Figure 33: Corridor #3 Volumes by Commodity Compared to Average Analysis Corridor Volumes




*Source: USDOT Volpe Center*

# Corridor #4

# Davenport, IA, to Memphis, TN

This 519-mile long corridor primarily moves bulk grain products, connecting regional farms with processing locations and the Midwest to the Mississippi River ports, where the grains continue moving southward via barge for export (Figure 34). The proximity to Midwestern grain farms, the Mississippi River system, and a vast network of highways make this route a key transportation element of the grain supply chain. An estimated $8.8 billion in corn and soybean product moves through this corridor on an annual basis.

Table 12: Corridor #4 Major Highways

| State | Route | Miles |
|---|---|---|
| Arkansas | I-40 | 10 |
| | I-55 | 65 |
| Illinois | IL-32 | 33 |
| | I-57 | 160 |
| | I-74 | 74 |
| | IL-121 | 52 |
| | I-155 | 32 |
| | Other | 3 |
| Missouri | I-55 | 66 |
| | I-57 | 22 |
| Tennessee | I-40 | 2 |

*Source: Volpe Center analysis*

## Commodity Movements

This corridor has three distinct agricultural freight patterns, collectively carrying about 3.1 billion ton-miles of agricultural commodities annually. First, just less than 900 million ton-miles of corn and about 690 million ton-miles of soybeans produced to the north and west annually travel southbound via I-74 to Peoria, IL, where they are likely loaded onto river barges destined for international export at the Port of New Orleans. Second, the 125-mile stretch of I-57 between State Route 121 (SR-121) in the North and confluence with Interstate 24 (I-24) in the south serves as a main trunk

**Map Legend**

- 1 Mile Markers Along Corridor
- Rail Intermodal Facilities
- Slaughter & Processing Facilities (Meat & Poultry)
- Grain Elevators
- Port Terminals handling Agriculture Products
- Navigable Inland Waterways
- High-Volume Domestic Agriculture Highways
- Analysis Corridor
- Metropolitan Area
- State Boundaries

Figure 34: Context Map of Corridor #4


*Source: Volpe Center analysis*

highway connecting several different common trucking routes. Here, meat (179 million ton-miles annually), vegetables (35 million ton-miles), and milk (173 million ton-miles), travel southward, likely moving toward Nashville, Chattanooga, or Atlanta, and in similar volumes northbound toward Chicago. Finally, south of the confluence of I-57 and I-55 in southeastern Missouri, about 690 annual ton-miles of soybeans move southbound toward river ports West Memphis, also destined for the Port on New Orleans. The farmlands surround the Mississippi River in Arkansas and Missouri are among the highest soybean producing regions in the Nation.

## Corridor Conditions and Performance

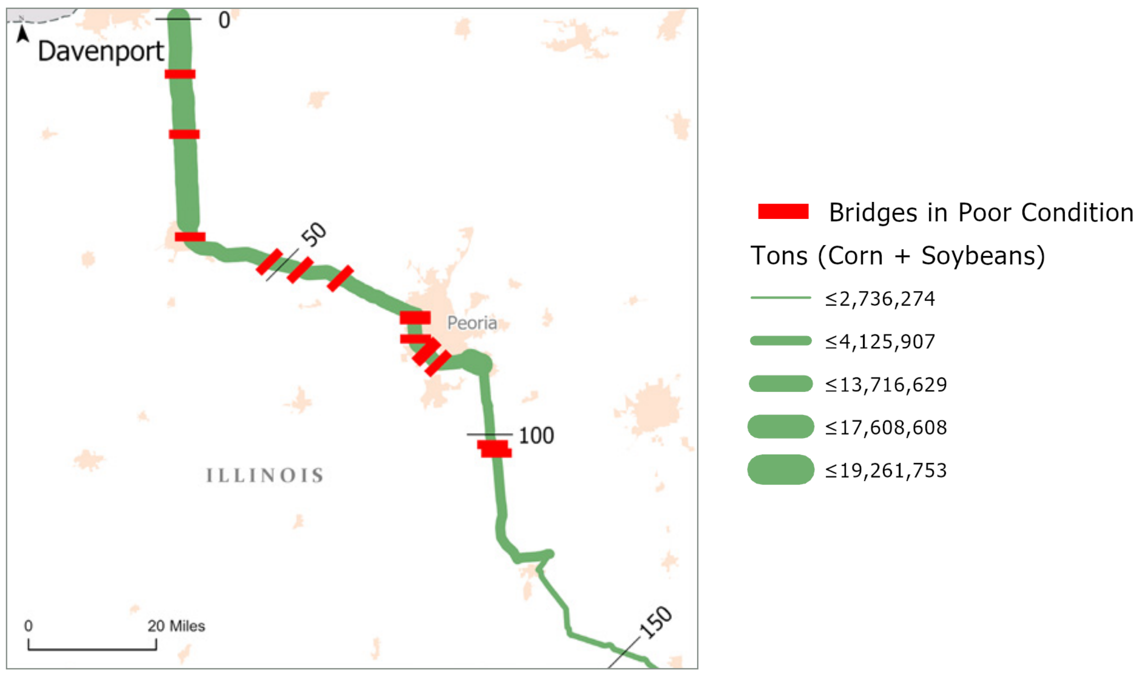
A total of 27 bridges—approximately 15% of all bridges on the route—are rated in "poor" condition. Nearly half of these bridges fall on the section of I-74 in northern Illinois connecting Davenport and Peoria (Figure 35). It is in this area that a large majority of soybeans and corn grains travel, posing a potential issue for the movement of those goods should the bridges not be addressed. The corridor sees many more fatal accidents involving trucks on the southern half of the corridor, likely because the northern half is more rural and comprised of less Interstate mileage. Overall, the corridor averages 0.25 truck related fatalities per 100 million vehicle miles traveled (all traffic), about 50% more than the 2018 national average. Generally, travel times along the Interstate portions of the corridor are reliable, though several portions of SR-121 Decatur and Peoria, IL experience significant delays.

Table 13: Corridor #4 Key Commodities

| Key Commodities | Tonnage | Market Value | Truck Units |
|---|---|---|---|
| Corn | 31.36 M | $3.11 B | 2.03 M |
| Soybeans | 16.78 M | $5.77 B | 1.09 M |

*Source: Volpe Center analysis of 2018 IHS Markit Transearch data*

Figure 35: Twelve Poorly Rated Bridges Exist in a Less Than 100 Mile Span on Corridor #4




*Source: Volpe Center analysis of National Bridge Inventory (FHWA, 2019)*

# Corridor #5

# Toledo, OH to East Stroudsburg, PA

Figure 36: Context Map of Corridor #5


*Source: Volpe Center analysis*

This 471-mile long corridor stretches across Ohio and Pennsylvania (Figure 36). An important corridor for dairy products produced in eastern Ohio and throughout Pennsylvania, commodities on this corridor travel mostly in an eastward direction to the New Jersey/Pennsylvania border. The route connects important Midwestern hubs like Detroit and Cleveland with distribution and export centers on the East Coast like New York and Philadelphia.

## Commodity Movements

I-80 is a main thoroughfare for agricultural commodities travelling across the United States. Along the section of the Interstate making up this corridor, approximately 829 million ton-miles of milk, 373 million ton-miles of meat, 337 million ton-miles of corn, and 321 million ton-miles of vegetables move from western Ohio to eastern Pennsylvania, likely destined for processing and distribution facilities located in the greater New York City metropolitan area. On the western edge

Table 14: Corridor #5 Major Highways

| State | Route | Miles |
|---|---|---|
| Ohio | I-80 | 166 |
| Pennsylvania | I-80 | 305 |

*Source: Volpe Center analysis*

**Map Legend**

- 1 Mile Markers Along Corridor
- Rail Intermodal Facilities
- Slaughter & Processing Facilities (Meat & Poultry)
- Grain Elevators
- Port Terminals handling Agriculture Products
- Navigable Inland Waterways
- High-Volume Domestic Agriculture Highways
- Analysis Corridor
- Metropolitan Area
- State Boundaries

of the corridor in Ohio, between Toledo and Youngstown, additional commodities such as wheat, soy, fruits, and cattle move in lower volumes (between 20-50 million ton-miles each). Near Youngstown, volumes of these goods drop quickly, likely exiting the route onto Interstate 76 (I-76) and traveling toward Pittsburgh, PA (see Corridor #12). Corn and poultry volumes pick up near milepost 375 on this route, likely traveling from farms in and around Williamstown and other parts of northern Pennsylvania and traveling toward the route via I-180. These increased volumes carry on to the end of the corridor at the New Jersey border.

## Corridor Conditions and Performance

Trucks move at fairly consistent travel times along the corridor. However, travel reliability decreases considerably between route miles 175 and 225, likely due to the influx of traffic from neighboring I-76, I-79, and other State highways in both Ohio and Pennsylvania. Infrastructure on the corridor is in overall good condition, with 99% of pavement and 98% of bridges rated as either “good” or “fair.” About 8.5 traffic fatalities on this route involved a truck between 2014 and 2018 on the route, equivalent to about 0.181 fatalities per 100 million vehicle miles traveled (all traffic).

Table 15: Corridor #5 Key Commodities

| Key Commodities | Tonnage | Market Value | Truck Units |
|---|---|---|---|
| Dairy | 8.68 M | $4.61 B | 505 K |

*Source: Volpe Center analysis of 2018 IHS Markit Transearch data*

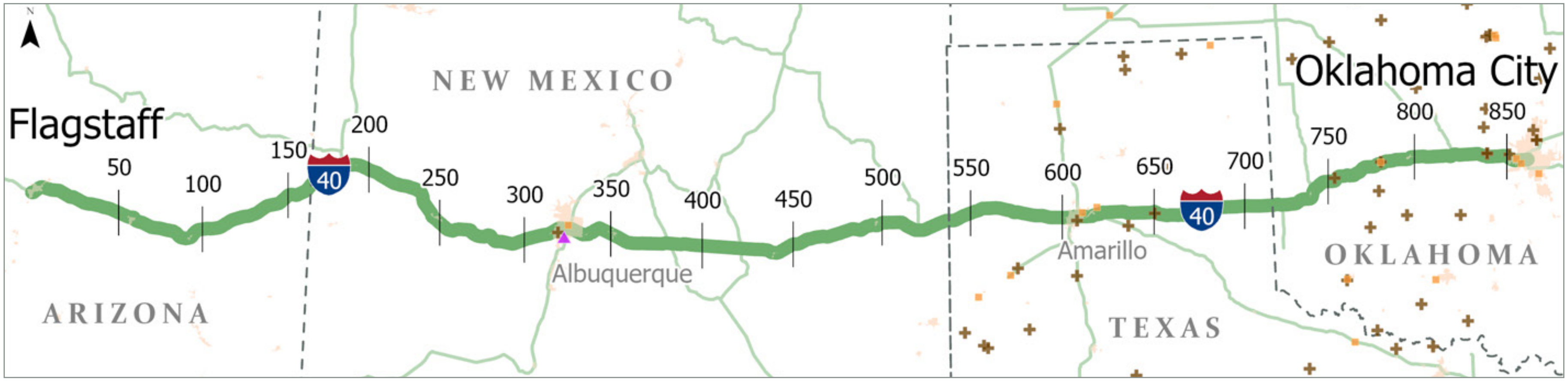
Figure 37: Bulk Liquid Truck Loading Milk - Dairy Travels in Very High Volumes Across Pennsylvania, Which Has More Dairy Farms Than Every State Except Wisconsin

*Credit: Ralph Fiskness via 123rf.com*

# Corridor #6

# Flagstaff, AZ to Oklahoma City, OK

Figure 38: Context Map of Corridor #6




Source: Volpe Center analysis

This corridor is made up of 861 miles of Interstate 40, stretching from Oklahoma City, OK, to Flagstaff, AZ, passing through Amarillo, TX (where it also connects to Corridor #8), and Albuquerque, NM (Figure 38). Traffic from several different roads all begins to converge and aggregate onto this corridor near Oklahoma City to travel westward. Approaching Albuquerque, traffic begins to branch off into several different directions, with potential destinations including the Port of Los Angeles and Long Beach, the Port of Oakland, or Mexico—not all of this westward traffic will necessarily travel by truck, as some will switch to rail. This is an important east-west agricultural freight connecting the export facilities and production areas in the West with those in the Midwest and beyond.

## Commodity Movements

Large shifts in agricultural volumes and commodity types occurring in the Amarillo, TX, metro area are the defining feature of this corridor. Here, high volumes of milk enter the corridor, most of which continues

Table 16: Corridor #6 Major Highways

| State | Route | Miles |
|---|---|---|
| Arizona | I-40 | 164 |
| New Mexico | I-40 | 370 |
| | Other | 3 |
| Oklahoma | I-40 | 147 |
| Texas | I-40 | 177 |

Source: Volpe Center analysis

**Map Legend**

- 1 Mile Markers Along Corridor
- Rail Intermodal Facilities
- Slaughter & Processing Facilities (Meat & Poultry)
- Grain Elevators
- Port Terminals handling Agriculture Products
- Navigable Inland Waterways
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- Analysis Corridor
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- State Boundaries

traveling eastbound via I-40. In total, the corridor carries about 1.97 billion ton-miles of dairy products each year, making up nearly half of all agricultural ton-miles on the corridor. Livestock and meat also travel in high volumes in this pattern, with approximately 33 million and 177 million ton-miles, respectively, moving toward Oklahoma City annually. Westbound traffic from Amarillo carries even higher volumes of meat—about 783 million ton-miles annually—likely destined for consumption, processing, or export along the West Coast. Fruit (174 ton-miles) and vegetable (682 million ton-miles) products travel eastward along the corridor in large quantities, likely originating in California and destined for distribution and consumption in the southern and eastern parts of the country. On the easternmost edge of the corridor in Oklahoma, corn and wheat bulk grains enter this corridor in large quantities, ultimately making up about half of the agricultural truck traffic by units around the Oklahoma City metropolitan region.

## Corridor Conditions and Performance

At 0.33 fatalities per 100 million miles traveled (all vehicles), truck-related fatalities occur on this corridor at more than twice the rate of the national average. Travel times and reliability along the corridor are fairly consistent, with only a few small spikes in congestion in some of the urban areas along the corridor. Pavement along this the corridor is generally rated to be in “fair” or “good” condition, and the bridges are similarly mostly in either “fair” or “good” condition, although far more bridges are “fair” than “good.” Infrastructure along this corridor may not present mobility issues at the present, but the large number of “fair” bridges will need maintenance or rehabilitation in the future to ensure that they do not further degrade into “poor” condition and to ensure the efficient operation of this important agricultural freight corridor.

Table 17: Corridor #6 Key Commodities

| Key Commodities | Tonnage | Market Value | Truck Units |
|---|---|---|---|
| Dairy | 6.30 M | $2.48 B | 394 K |
| Meat | 2.82 M | $10.69 B | 123 K |
| Livestock | 1.06 M | $2.33 B | 69 K |
| Fruit | 0.39 M | $0.46 B | 18 K |

*Source: Volpe Center analysis of 2018 IHS Markit Transearch data*

Figure 39: Large Herd of Angus Cross Beef Steers - Corridor #6 Carries an Especially High Volume of Live Cattle, Processed Meat, and Dairy Products

*Credit: Tracy Fox via 123rf.com*

# Corridor #7

## Florence, SC to Jacksonville, FL

This corridor is made up of 290 miles of Interstate 95 (I-95), and serves as a main route to transport fresh fruits produced in Florida northward toward processing and distribution centers, and, in the other direction, to provide access to the Ports of Savannah and Jacksonville for commodities produced in the Carolinas (Figure 40).

### Commodity Movements

Citrus and other fruits moving northbound from farms in Florida make up the vast majority of traffic along this corridor, with trucks moving about 215 million ton-miles each year. The products move in particularly high volumes near the Port of Jacksonville, likely destined for processing facilities in the region or for distribution centers that can move these perishables across the country for consumption. In lesser but still significant volumes, milk (140 million ton-miles) and meat products (180 million ton-miles) move southbound on the corridor in refrigerated trucks from production sites in the Carolinas, likely destined for either the Port of

Table 18: Corridor #7 Major Highways

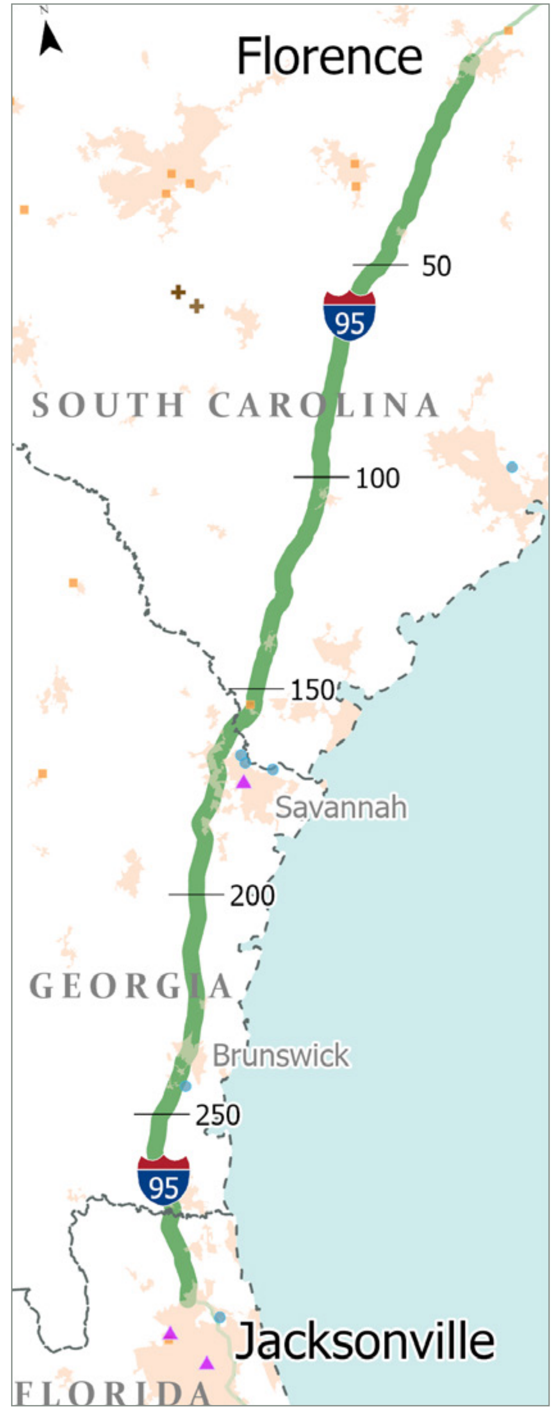
| State | Route | Miles |
|---|---|---|
| Florida | I-95 | 18 |
| Georgia | I-95 | 112 |
| South Carolina | I-95 | 160 |

*Source: Volpe Center analysis*

**Map Legend**

- 1 Mile Markers Along Corridor
- Rail Intermodal Facilities
- Slaughter & Processing Facilities (Meat & Poultry)
- Grain Elevators
- Port Terminals handling Agriculture Products
- Navigable Inland Waterways
- High-Volume Domestic Agriculture Highways
- Analysis Corridor
- Metropolitan Area
- State Boundaries

Figure 40: Context Map of Corridor #7




*Source: Volpe Center analysis*

Savannah and the Port of Jacksonville to be exported or distribution across the country. Bulk grains (corn, wheat, and soybeans) produced further north on the eastern seaboard also move by truck southward via this corridor to the Port of Savannah, totaling about 51 million ton-miles. These are likely destined for international export or to local processing centers.

## Corridor Conditions and Performance

Infrastructure conditions and travel times along this route are in comparatively good condition. One hundred percent of the pavement on the corridor is rated to be in either "good" or "fair" condition. Just one bridge out of 137, located near Jacksonville, is rated to be in 'poor' condition. Travel times along the corridor tend to remain consistent and reliable, with one exception near Savannah, GA, where increased levels of congestion create periodic delays. Truck-related traffic fatalities occur at a rate of 0.118 every 100 million vehicle miles traveled (all traffic), about in-line with the national average.

Table 19: Corridor #7 Key Commodities

| Key Commodities | Tonnage | Market Value | Truck Units |
|---|---|---|---|
| Meat | 1.30 M | 4.43 B | 57 K |
| Fruit | 850 K | 584 M | 40 K |

*Source: Volpe Center analysis of 2018 IHS Markit Transearch data*

Figure 41: Semi-Trailer Full of Oranges - Citrus Fruits Move in High Volumes Along Corridor #7

*Credit: Jim Vallee via 123rf.com*

# Corridor #8

# Kansas/Oklahoma Border to Amarillo, TX

This 171-mile long corridor travels along US-54, Interstate 287 (I-287), and Interstate 87 (I-87) (Figure 42). The lands surrounding this corridor are densely settled with cattle ranches and farmland. Primarily, this corridor serves to connect the agricultural production in this region with Interstate speed and east-west access of I-40 (see corridor #6), as well as meat processing plants near Amarillo.

## Commodity Movements

Large volumes of milk (118million ton-miles), meat (76 million ton-miles), and livestock (164 million ton-miles) travel through this corridor each year. Bulk grains such as corn and wheat also travel in significant volumes on this corridor (375 million and 88 million ton-miles, respectively). The commodities primarily travel south toward Amarillo, TX, and much of this volume likely continues traveling eastward on Corridor #6. Some of these goods are also processed nearby, most often just north of the Amarillo metro area, where several grain elevators and slaughterhouses exist. Northbound agricultural commodities move in lower volumes, and primarily include livestock (78 million ton-miles) and dairy products (77 million ton-miles).

Table 20: Corridor #8 Major Highways

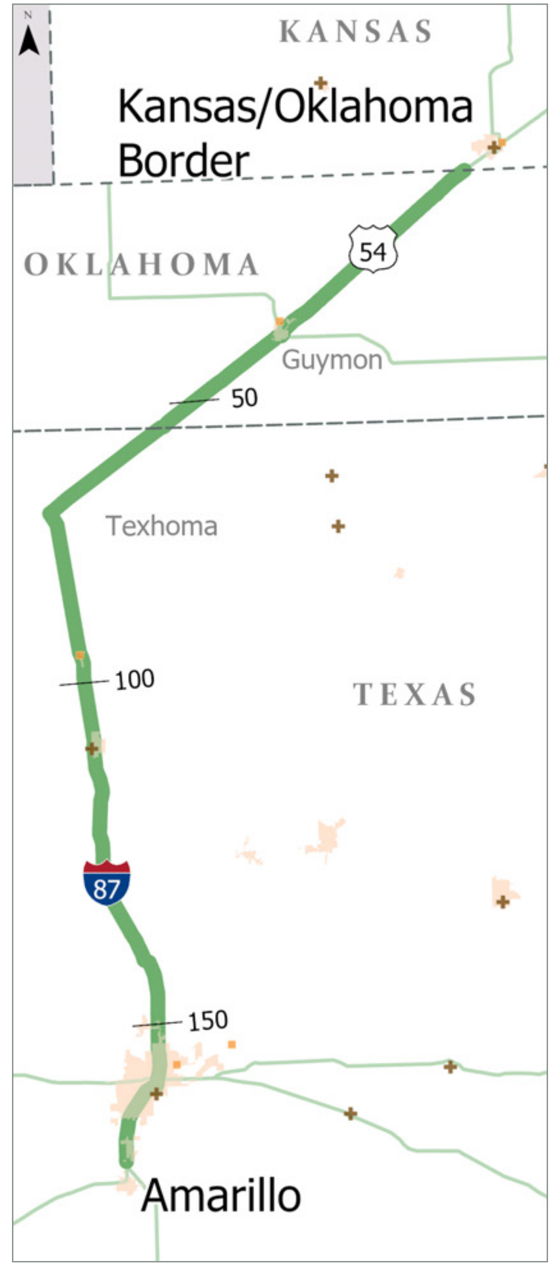
| State | Route | Miles |
|---|---|---|
| Oklahoma | US-54 | 56 |
| Texas | I-27 | 13 |
| | US-54 | 20 |
| | US-60 | 2 |
| | US-87 | 47 |
| | US-287 | 33 |

*Source: Volpe Center analysis*

**Map Legend**

- 1 Mile Markers Along Corridor
- Rail Intermodal Facilities
- Slaughter & Processing Facilities (Meat & Poultry)
- Grain Elevators
- Port Terminals handling Agriculture Products
- Navigable Inland Waterways
- High-Volume Domestic Agriculture Highways
- Analysis Corridor
- Metropolitan Area
- State Boundaries

Figure 42: Context Map of Corridor #8




*Source: Volpe Center analysis*

## Corridor Conditions and Performance

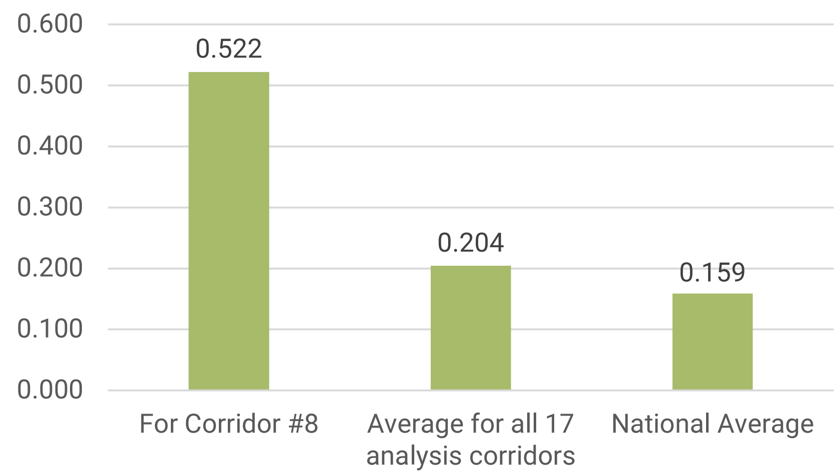
The rate of truck-related fatalities on this corridor is more than three times the national average, with .588 fatalities occurring for every 100 million vehicle miles traveled (Figure 43). Overall, congestion is rare throughout the entirety of the route. The area with the largest congestion and reliability issues is in the Amarillo metropolitan area—this is also the area with the most through lanes on the corridor, and the pavement condition in the area is a mix of “fair” and “good.” There is one bridge in “poor” condition near Amarillo that could present a mobility challenge in the future, but the corridor overall is in reasonably good condition, with less than 1% of pavement in “poor” condition, which is concentrated near the Kansas/Oklahoma border.

Table 21: Corridor #8 Key Commodities

| Key Commodities | Tonnage | Market Value | Truck Units |
|---|---|---|---|
| Dairy | 4.23 M | $1.48 B | 270 K |
| Livestock | 2.67 M | $5.87 B | 173 K |
| Meat | 1.81 M | $7.09 B | 79 K |
| Wheat | 1.07 M | $0.18 B | 69 K |

*Source: Volpe Center analysis of 2018 IHS Markit Transearch data*

Figure 43: Average Annual Fatalities Involving a Truck per 100 Million Vehicle Miles Traveled on Corridor #8, 2014-2018




The average incidence of truck-related fatalities per vehicle miles traveled on corridor #8 is more than 3 times higher than the national average, and 2.5 times higher than the analysis corridor average.

*Source: Volpe Center analysis of 2014-2018 FARS data*

# Corridor #9

## Kentucky/Tennessee Border to Ocala, FL

This 682 mile corridor connects Midwestern and Florida crops with important distribution hubs via Interstate 24 (I-24) and Interstate 75 (I-75) (Figure 44). The route connects with rail intermodal facilities in Nashville, TN, and Atlanta, GA, and the Tennessee River ports in Chattanooga, TN, which provide east-west rail and port access for broader distribution of the wide array of agricultural commodities traveling through the route.

### Commodity Movements

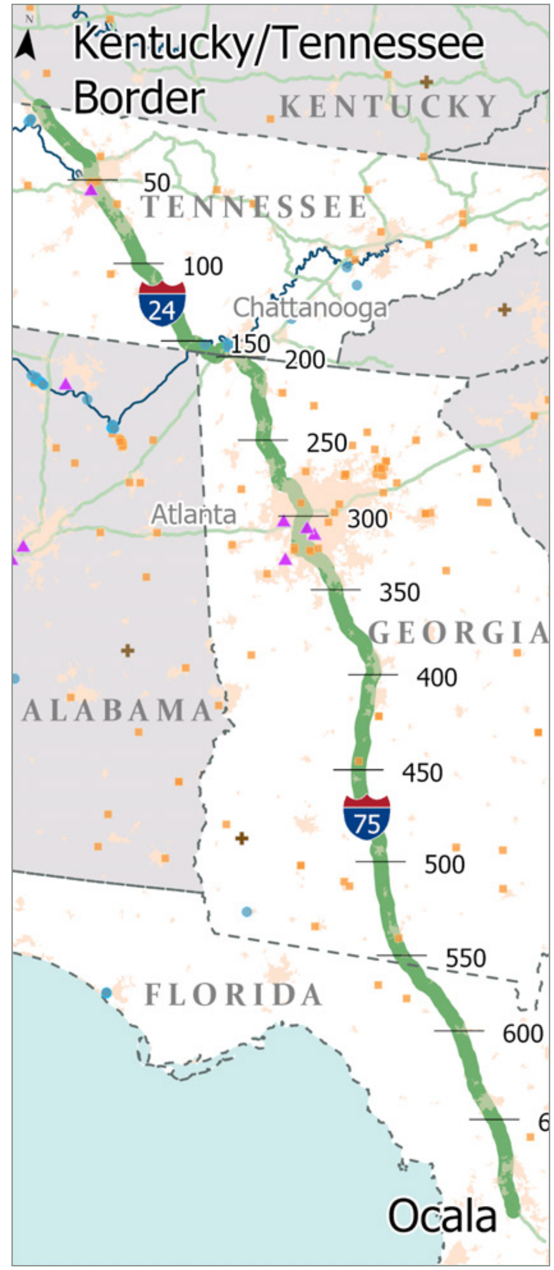
Grains, perishables, and livestock all move in large volumes through this corridor. Corn (246 million ton-miles), livestock (23 million ton-miles), poultry (100 million ton-miles), meat (412 million ton-miles), milk (337 million ton-miles), and vegetables (194 million ton-miles) from Kentucky and beyond move southward on the corridor toward Nashville. Here, a drop in southbound volumes on the corridor for these commodities suggests that these goods either begin moving east-west via Interstate 40 (I-40), or switch to rail via Nashville's CSX Intermodal Rail facility on Interstate-65 (I-65). Still a significant portion of these commodities continue moving southward

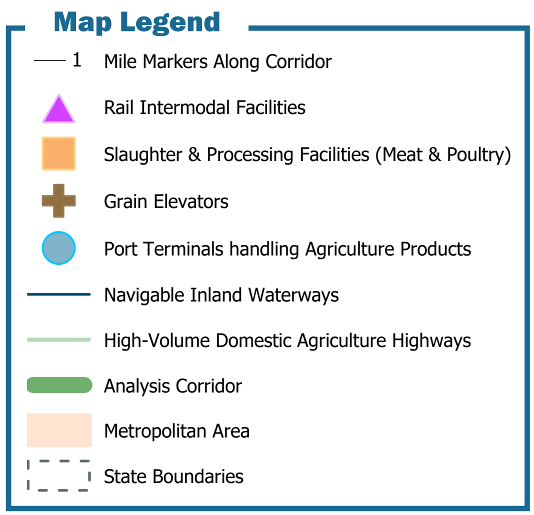
Table 22: Corridor #9 Major Highways

| State | Route | Miles |
|---|---|---|
| Florida | I-75 | 142 |
| Georgia | I-24 | 4 |
| | I-75 | 353 |
| Tennessee | I-24 | 177 |
| | I-65 | 6 |

*Source: Volpe Center analysis*

Figure 44: Context Map of Corridor #9




*Source: Volpe Center analysis*

toward Atlanta and Macon, likely destined for the many processing and distribution facilities in those regions. Fruit moves in especially high volumes in a northbound direction on this corridor, totalling about 371 million ton miles annually. Citrus fruit produced in high quantities in central Florida moves northward via I-75, joined by high volumes of watermelon around central Georgia. Poultry is also produced in especially high quantities in this region (193 million ton miles annually), and consistently high volumes of the commodity travel both north and southbound between Chattanooga and Atlanta, connecting poultry farmers and the nearby slaughterhouses and processing facilities.

## Corridor Conditions and Performance

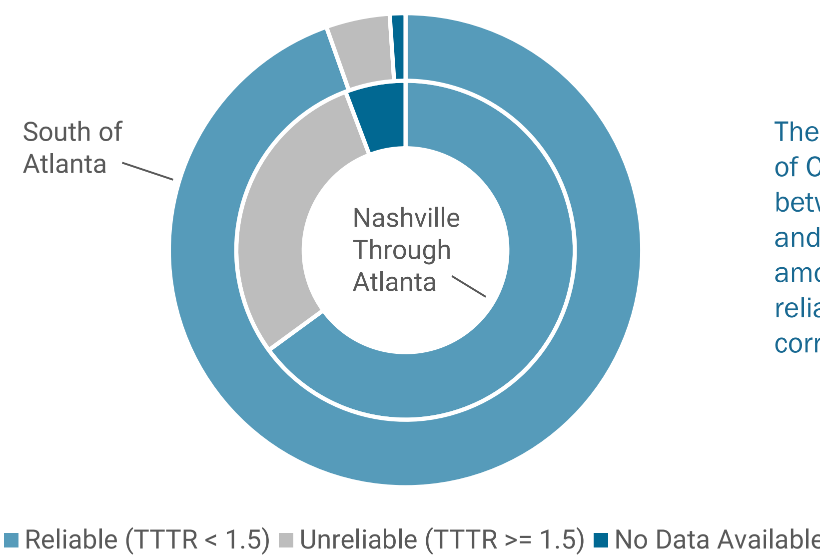
Travel times on this corridor are highly variable, particularly in the 275 mile stretch connecting Nashville, Chattanooga, and Atlanta (Figure 45). Travel Time Index (TTI) values increase to 1.5 In Nashville and Atlanta in particular, meaning average travel times increase by up to 50% for large stretches of the route. An average of about 19 fatal collisions involving trucks occur on this corridor annually, equal to about .203 fatalities per 100 million vehicle miles traveled (all vehicles). More than 99% of both bridges and pavement mileage on the route are rated in “good” or “fair” condition. Three bridges are rated “poor” condition, all of which fall on I-24 through Tennessee—one in Nashville and two in Chattanooga.

Table 23: Corridor #9 Key Commodities

| Key Commodities | Tonnage | Market Value | Truck Units |
|---|---|---|---|
| Meat | 5.62 M | $19.29 B | 245 K |
| Poultry | 3.45 M | $9.60 B | 224 K |
| Fruit | 1.63 M | $1.23 B | 77 K |

*Source: Volpe Center analysis of 2018 IHS Markit Transearch data*

Figure 45: Share of Corridor #9 with Reliable Truck Travel Times: Nashville to Atlanta Compared to the Southern Half of the Corridor




The section of Corridor #9 between Nashville and Atlanta is among the least reliable of the 17 corridors analyzed.

*Source: Volpe Center analysis of 2018 NPMRDS data*

# Corridor #10

## Mason City, IA, to Des Moines, IA

Iowa is among the most agriculturally productive States in the Nation. This route, composed of 120 miles of Interstate 35 (I-35), primarily provides access between farms in northern Iowa and southern Minnesota to local grain elevators, slaughterhouses, and other processing facilities (Figure 46). The route's southern endpoint in Des Moines connects the region to Interstate-80 (I-80), a key east-west corridor, and allows goods produced in Iowa to be moved elsewhere in the Midwest for processing and consumption. A significant amount of the grains produced in the area likely move along I-35 to I-80, and are eventually loaded onto barges for transport along the Mississippi River and destined for international export.

### Commodity Movements

Corn moves through the corridor in significantly higher quantities than any other commodity, making up two-thirds of all agricultural traffic with 766 million ton-miles moving through the route. Soybeans (129 million ton-miles annually), dairy (142

Table 24: Corridor #10 Major Highways

| State | Route | Miles |
|---|---|---|
| Iowa | I-35 | 116 |
| | I-235 | 4 |

*Source: Volpe Center analysis*

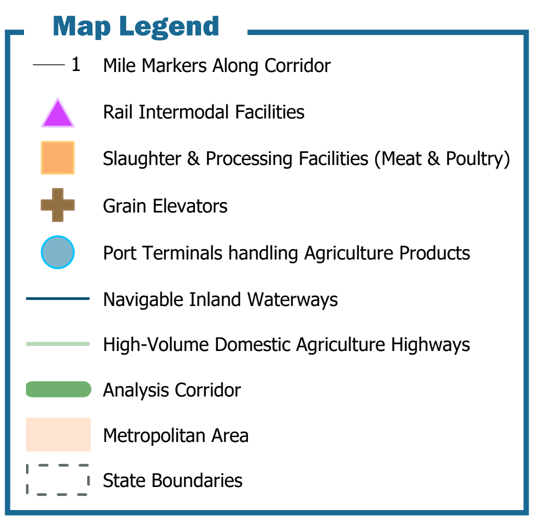
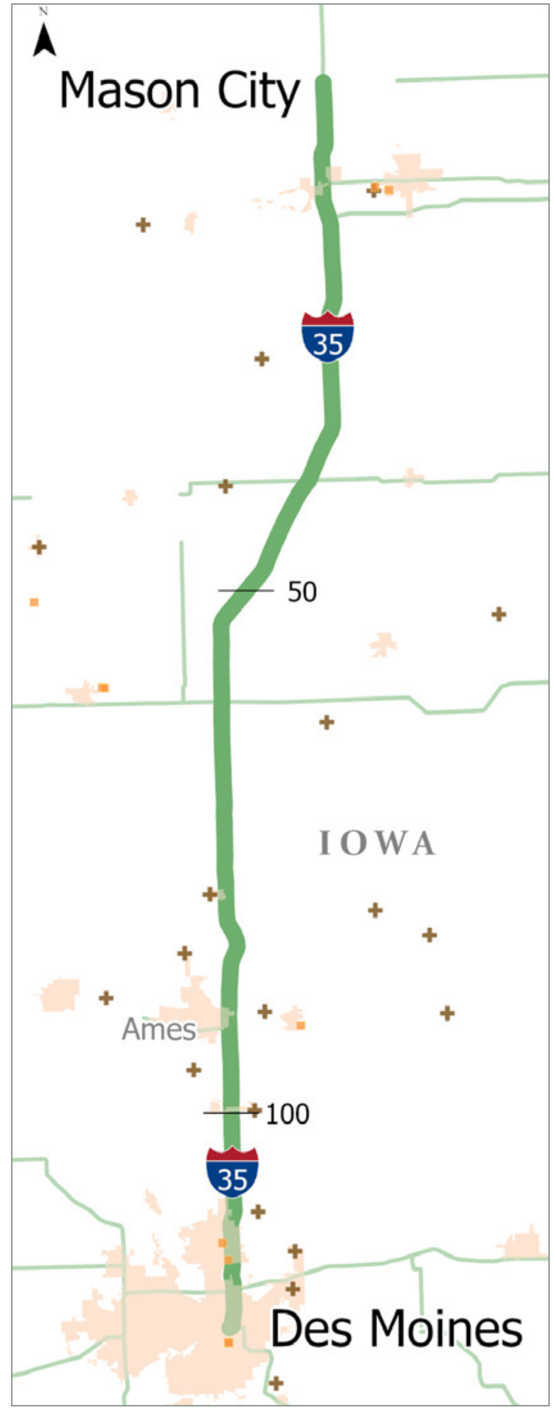



Figure 46: Context Map of Corridor #10




*Source: Volpe Center analysis*

million ton-miles), and livestock, mostly pork (68 million ton-miles) also travel along this corridor in high quantities. While corn and soybeans tend to travel large quantities both northbound and southbound—likely destined for one of the several grain elevators located along the route—trucks carrying hogs tend to move southbound (48 million ton-miles), most likely destined for the slaughterhouses and meat processing facilities in and around Des Moines.

## Corridor Conditions and Performance

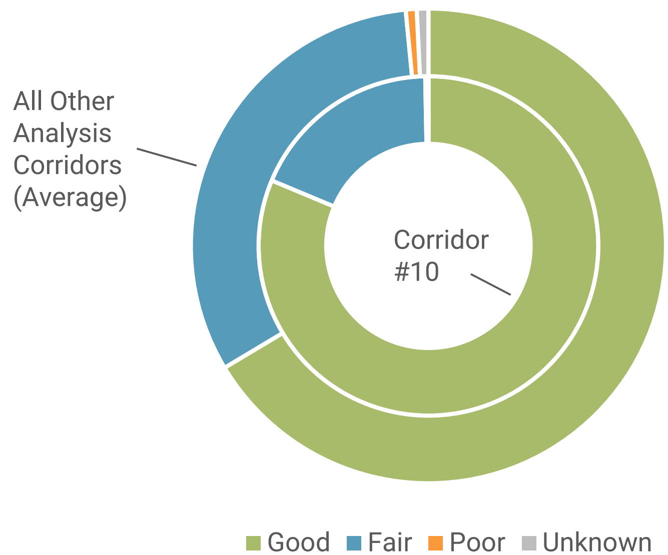
The physical and operational conditions of the corridor are very good. Likely due to the rural nature of the corridor, travel times are very reliable and tend to be uncongested. Nearly all of the route's pavement is rated to be in "good" condition (81.3%) or "fair" condition (18.4%) (Figure 47). Similarly, no bridges along the corridor are rated less than "fair." On average, the corridor sees less than one fatal crash per year involving a truck. Its truck-related fatality rate of .08 deaths per 100 million vehicle miles traveled (all traffic) is the lowest of any of the 17 corridors analyzed, and half the rate of the 2018 national average.

Table 25: Corridor #10 Key Commodities

| Key Commodities | Tonnage | Market Value | Truck Units |
|---|---|---|---|
| Corn | 15.38 M | $1.53 B | 997 K |
| Livestock | 1.28 M | $2.82 B | 83 K |

*Source: Volpe Center analysis of 2018 IHS Markit Transearch data*

Figure 47: Pavement Condition Rating of Corridor #10 Compared to Average of All Other Analysis Corridors



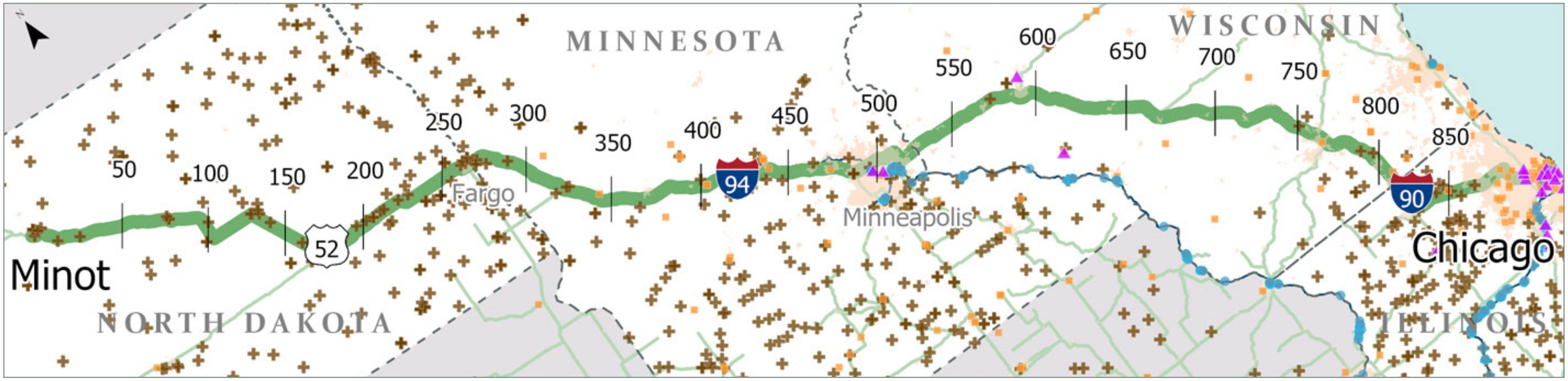

Pavement condition on Corridor #10 is in very good condition (inside pie chart), especially compared to the average of the other 16 analysis corridors (outside pie chart).

*Source: Volpe Center analysis of 2018 NPMRDS data*

# Corridor #11

## Minot, ND, to Chicago, IL

Figure 48: Context Map of Corridor #11




*Source: Volpe Center analysis*

This 895-mile long corridor connects producers in the upper plains and Midwest regions to the processing facilities and shipping routes that exist further south in the region (Figure 48). An important area for wheat, fruits, vegetables, and dairy in particular, each of which travels along the corridor at some of the highest rates in the country. Agricultural goods produced in the Dakotas, Minnesota, and Wisconsin generally travel southbound toward either the Mississippi River system or the intermodal facilities in the Chicago region for export, processing, and domestic consumption.

Table 26: Corridor #11 Major Highways

| State | Route | Miles |
|---|---|---|
| Illinois | I-39 | 17 |
| | I-90 | 51 |
| | Others | 16 |
| Minnesota | I-94 | 234 |
| | I-694 | 23 |
| | Others | 2 |
| North Dakota | US-52 | 45 |
| | I-94 | 38 |
| | Others | 4 |
| Wisconsin | I-39 | 78 |
| | I-90 | 63 |
| | I-94 | 147 |

*Source: Volpe Center analysis*

**Map Legend**

- 1 Mile Markers Along Corridor
- Rail Intermodal Facilities
- Slaughter & Processing Facilities (Meat & Poultry)
- Grain Elevators
- Port Terminals handling Agriculture Products
- Navigable Inland Waterways
- High-Volume Domestic Agriculture Highways
- Analysis Corridor
- Metropolitan Area
- State Boundaries

### Commodity Movements

Moving 5.5 billion ton-miles of agricultural goods each year, this corridor is among the busiest in the agricultural network. High volumes of fruits (386 million ton-miles) and vegetables (657 million ton-miles) produced in Western States travel eastbound on Interstate 94 (I-94). North of I-94, through Minot, approximately 200 million-ton miles of soybeans produced throughout eastern North Dakota move northbound toward the grain elevators and processing locations in the State. In the other direction, wheat that is produced in the eastern Dakotas and western Minnesota moves southbound toward Minneapolis (354 million ton-miles), where most is likely loaded onto river barges to continue its journey southward. Wisconsin has more dairy farms than any State in the Nation, and is second only to California in production volume. Unsurprisingly, dairy travels in high quantities through the State (1.35 billion ton-miles), mostly southbound (963 million ton-miles) to processing facilities throughout Wisconsin and Illinois. Meat products are also produced in high volumes in Wisconsin (303 million ton-miles), and follow similar travel patterns as dairy.

Table 27: Corridor #11 Key Commodities

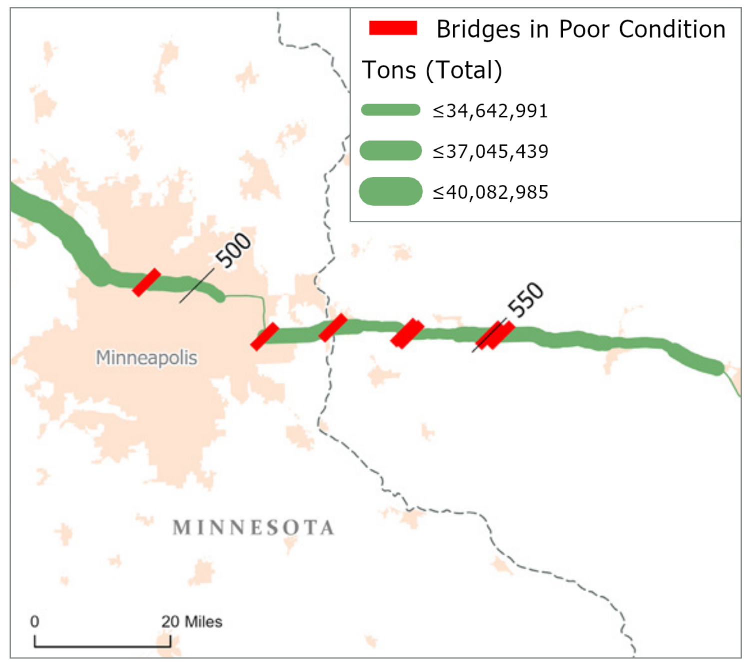
| Key Commodities | Tonnage | Market Value | Truck Units |
|---|---|---|---|
| Dairy | 13.38 M | $5.53 B | 829 K |
| Wheat | 3.99 M | $0.68 B | 258 K |
| Vegetables | 2.49 M | $1.66 B | 120 K |
| Fruit | 0.68 M | $0.43 B | 32 K |

*Source: Volpe Center analysis of 2018 IHS Markit Transearch data*

## Corridor Conditions and Performance

Travel times are fairly consistent throughout most of the corridor, though a nearly 100 mile stretch of the Minneapolis-St. Paul metropolitan region sees a marked drop in truck travel time reliability. Additionally, travel through both Bismarck, ND, and the northern suburbs of Chicago see shorter segments of unreliable travel times for trucks. Thirteen bridges out of 286 (4.5%) are rated to be in "poor" condition, most of which are in Minneapolis-St. Paul and areas to the east along I-94 (Figure 49). The sustained unreliability across such a long distance and clustering of bridges in poor condition in this important agricultural trade hub poses a potential concern for the movement of agricultural goods. Pavement condition is very good throughout the entire 899-mile route, with more than 99% rated in "good" or "fair" condition. The corridor is comparatively safe as well, seeing 0.09 truck-related fatalities per 100 million vehicle miles traveled in 2018 (all traffic)—about 45% lower than the national average.

Figure 49: Poorly Rated Bridges in the Minneapolis region on Corridor #11, an Important Hub for Grains Processing

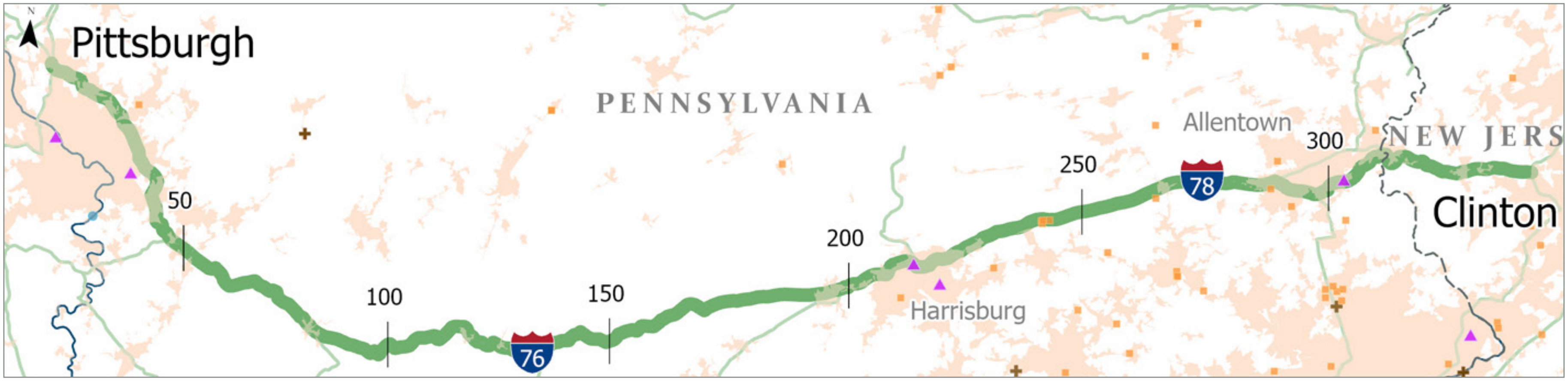



*Source (Figure 49): Volpe Center analysis of National Bridge Inventory (FHWA, 2019)*

# Corridor #12

## Pittsburgh, PA, to Clinton, NJ

Figure 50: Context Map of Corridor #12




*Source: Volpe Center analysis*

This 344-mile long corridor runs through the southern half of Pennsylvania via Interstate 76 (I-76) and Interstate 78 (I-78), and is among the Nation's most densely traveled corridors for milk products (Figure 50). Pennsylvania contains more dairy farms than any other State except Wisconsin, and is seventh in total milk production. The area south of I-78 and east of Harrisburg is particularly dense with dairy farms, and nearby processing centers in nearby Philadelphia and the New York City metropolitan area provide access to pasteurization facilities and cheese and yogurt production.

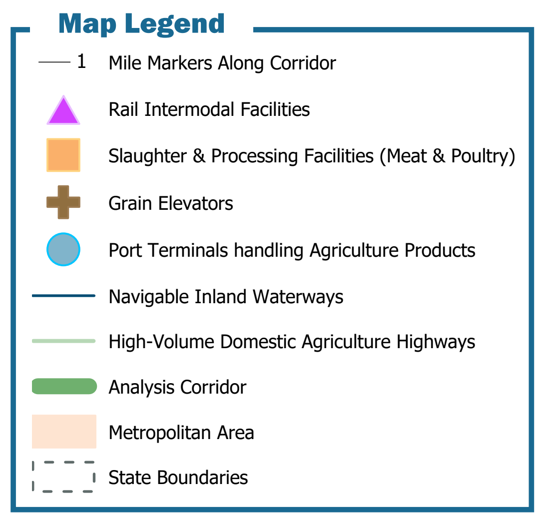
Table 28: Corridor #12 Major Highways

| State | Route | Miles |
|---|---|---|
| New Jersey | I-78 | 31 |
| Pennsylvania | I-76 | 198 |
| | I-78 | 78 |
| | I-81 | 37 |

*Source: Volpe Center analysis*

### Commodity Movements

Dairy, meats, and corn produced in eastern Ohio and western Pennsylvania travel eastbound along I-76 in high volumes (522, 254, and 285 million ton-miles annually, respectively) between Pittsburgh



and Harrisburg. Interstate-81, running north from dairy, cattle, and grain farms in northern Maryland and Virginia, converges with the route just east of Harrisburg; here, a particularly large volume of agricultural products move as traffic from both Interstates merge to form I-78 and provide direct access to the fertile south-central region of Pennsylvania. Meat and dairy processing locations are spread throughout this region of the State as well.

## Corridor Conditions and Performance

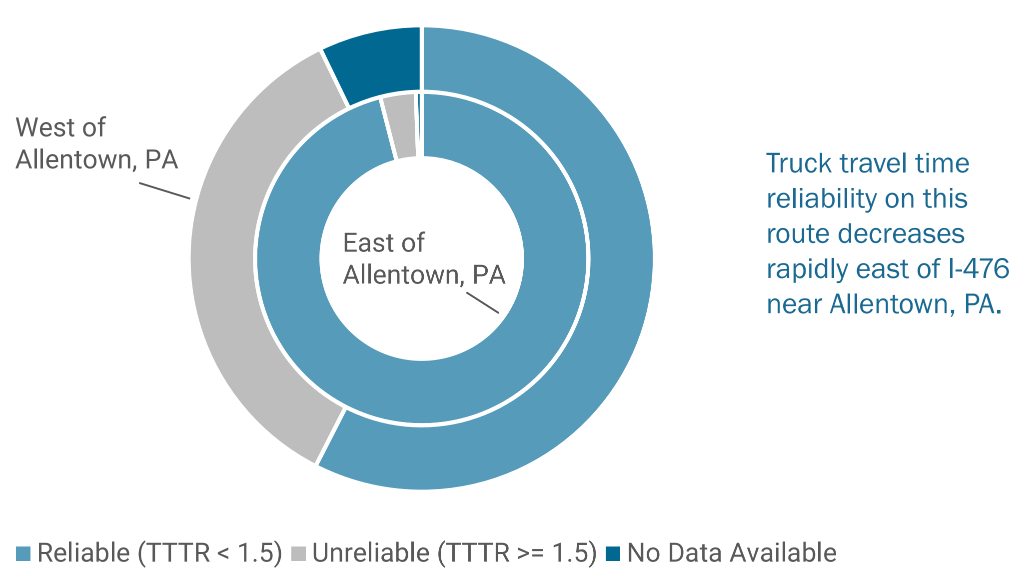
Infrastructure and travel conditions vary between the I-76 and I-78 sections of this route. Generally, the section of the corridor between Pittsburgh and Harrisburg are quite reliable, with slight variations in travel time near the eastern edge of the Appalachian Mountains near mile 175 of the route (Figure 51). However, travel times begin to vary greatly near the convergence of I-81 and I-76 in Harrisburg and as the route enter larger urban areas to the east, especially east of Allentown. The area between Allentown, Pennsylvania and Clinton, New Jersey also has several bridges rated to be in “poor” condition; overall, 15 bridges (7.5% of the total) on the route have a rating of “poor,” half of which fall between these cities. Truck-related traffic fatalities also increase on this section of the route.

Table 29: Corridor #12 Key Commodities

| Key Commodities | Tonnage | Market Value | Truck Units |
|---|---|---|---|
| Dairy | 7.87 M | $4.44 B | 449 K |

*Source: Volpe Center analysis of 2018 IHS Markit Transearch data*

Figure 51: Share of Corridor #12 with Reliable Truck Travel Times: East and West of Allentown, PA

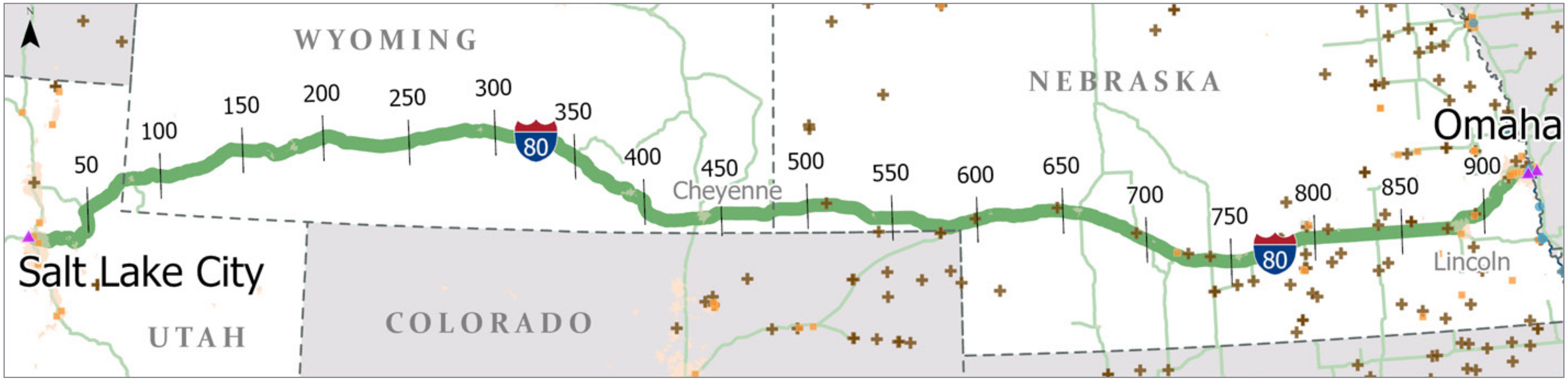



*Source: Volpe Center analysis of 2018 NPMRDS data*

# Corridor #13

# Salt Lake City, UT, to Omaha, NE

Figure 52: Context Map of Corridor #13




*Source: Volpe Center analysis*

An important route connecting the Midwest to the West, this corridor is made up of 938 miles of Interstate 80, reaching from Omaha, NE, to Salt Lake City, UT, passing through Cheyenne, WY (Figure 52). This route is similar to the parallel (but much further South) Corridor #6 in that it provides east-west transportation for Midwestern agricultural producers. From Salt Lake City, trucks can head north along Corridor #14 to Oregon or goods can switch from truck to rail to reach other western ports, such as the Port of Oakland or the Port of Seattle/Tacoma. This corridor also provides access to the Missouri River and the large number of grain elevators and meat processing facilities in southern and eastern Nebraska.

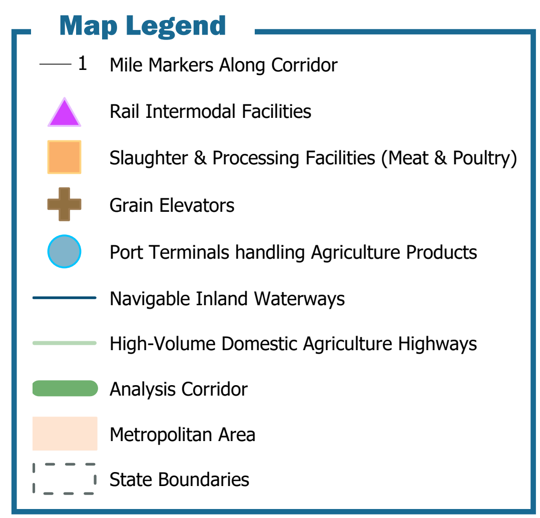
Table 30: Corridor #13 Major Highways

| State | Route | Miles |
|---|---|---|
| Iowa | I-80 | 1 |
| Nebraska | I-80 | 455 |
| Utah | I-80 | 77 |
| Wyoming | I-80 | 405 |

*Source: Volpe Center analysis*

## Commodity Movements

In part due to its length, nearly all commodity groups move in high volumes along this corridor, totaling about 7.4 billion ton-miles of agricultural commodities moved each year (Figure 53). Agricultural volumes travel in significantly larger volumes through Nebraska than in other parts of the corridor, and volumes are higher in the West-East direction. Near the route's 575th mile on Nebraska's western edge, Interstate-70 merges with I-80 to create the higher volumes on the corridor. The confluence of



several north-south routes with the corridor in Nebraska help create larger volumes on the corridor—especially US-83, Nebraska Route-47, and US-183, each of which are part of the HDAH and help connect Nebraska grain and livestock farmers with the corridor. Corn (1.1 billion ton-miles), soybeans (170 million ton-miles), livestock (124 million ton-miles), and processed meats (259 million ton-miles) travel eastward across Nebraska toward processing facilities near Omaha. Dairy (2 billion ton-miles), fruits (306 million ton-miles), and vegetables (1.6 billion ton-miles) travel along the entirety of the corridor, most of which is also traveling eastbound. Meat commodities are by far the largest agricultural commodity traveling westward along the corridor (830 million ton-miles), indicating Midwestern-produced meats are moving toward the West Coast for either consumption or export via the northern west coast ports.

## Corridor Conditions and Performance

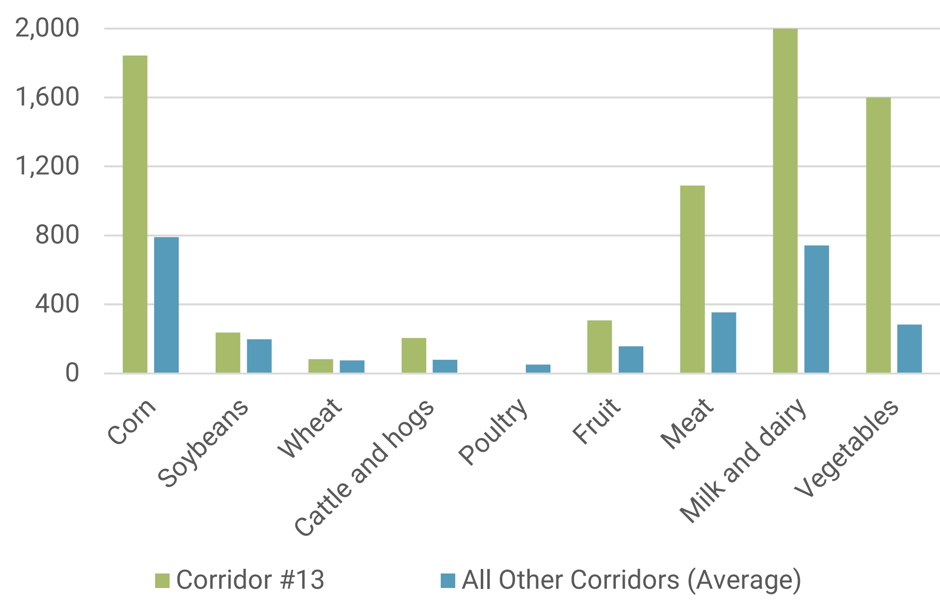
There are fluctuations in travel time and reliability across the corridor, but overall the corridor experiences minimal congestion. Salt Lake City and Omaha are the points along the corridor with the highest AADT and the highest TTI values. However, a 10-mile stretch southeast of Omaha near Gretna, Nebraska has significant spikes in TTTR, creating issues with travel time reliability for trucks. The corridor is in primarily good condition, with almost 75% of the pavement in "good" condition and almost 24% in "fair" condition. There are six bridges in "poor" condition, comprising 1.6% of all bridges along the corridor.

Table 31: Corridor #13 Key Commodities

| Key Commodities | Tonnage | Market Value | Truck Units |
|---|---|---|---|
| Corn | 23.39 M | $2.32 B | 1.52 M |
| Meat | 3.64 M | $14.24 B | 158 K |
| Vegetables | 2.67 M | $2.08 B | 128 K |
| Livestock | 2.56 M | $5.63 B | 166 K |
| Fruit | 0.45 M | $0.40 B | 21 K |

*Source: Volpe Center analysis of 2018 IHS Markit Transearch data*

Figure 53: Millions of Ton-Miles Moved Per Commodity for Corridor #13 Versus Average of All Other Analysis Corridors




Corridor #13 moves higher-than-average volumes of nearly all studied commodities compared to the other 16 analysis corridors.

*Source: Volpe Center analysis of 2018 IHS Markit Transearch data*

Corridor #14

# Portland, OR, to Salt Lake City, UT

Figure 54: Context Map of Corridor #14


*Source: Volpe Center analysis*

Salt Lake City, UT is an important intermodal freight location, and connects the previous Corridor #13 to this corridor, #14 (Figure 54). This corridor consists of 763 miles of I-84 that connects Portland, OR, to Salt Lake City by way of Boise, ID. Many goods that arrive in Salt Lake City from the Midwest may switch to rail at Salt Lake City to reach the Port of Seattle/Tacoma or the Port of Oakland, but significant highway freight continues on from Salt Lake City along this corridor to reach the Port of Portland for export. This corridor also runs along the Columbia River, providing access to river ports along the Columbia for goods to switch from trucks to barge transportation.

## Commodity Movements

Overall, this corridor moves about 3.86 billion ton-miles of agricultural goods annually. Corn (607 million ton-miles), dairy (1.4 billion ton-miles), and vegetables (937 million ton-miles) move in high quantities in each direction throughout the length of the corridor,

Table 32: Corridor #14 Major Highways

| State | Route | Miles |
|---|---|---|
| Idaho | I-84 | 276 |
| Oregon | I-84 | 370 |
| Utah | I-84 | 117 |

*Source: Volpe Center analysis*

moving toward processing and distribution centers on the West Coast or toward central processing hubs such as Salt Lake City, Denver, or Omaha (see Corridor #13). On the routes western edge, which travels along the Columbia River for nearly 150 miles, wheat grown primarily in Washington and Oregon travel in vast quantities—about 400 million ton-miles annually. Several grain elevators provide multimodal connections between this route and river barges traveling down the Columbia toward the Port of Portland (see Figure 55), where much of this product is likely prepared for export. Fruit, primarily traveling eastbound on the corridor through Oregon and Idaho (approx. 167 million ton-miles), and processed meats traveling westbound (158 million ton-miles) have a heavy presence on the corridor.

## Corridor Conditions and Performance

This corridor experiences a wide range of travel time reliability, with the two biggest areas of congestion near Boise, ID, and near Salt Lake City, UT. The corridor as a whole averages .243 truck-related fatalities per 100 million vehicle miles traveled (all vehicles), about 50% above the national average. Overall, condition of the corridor is good, with just over 80% of the pavement in "good "condition and 30% of bridges in "good" condition. The "fair" and "poor" pavement is concentrated along the middle of the corridor, outside of Boise, indicating that infrastructure in that area in particular could pose the greatest mobility challenge along this corridor.

Table 33: Corridor #14 Key Commodities

| Key Commodities | Tonnage | Market Value | Truck Units |
|---|---|---|---|
| Dairy | 10.64 M | $4.26 B | 664 K |
| Vegetables | 7.02 M | $5.19 B | 339 K |
| Wheat | 3.70 M | $0.63 B | 240 K |

*Source: Volpe Center analysis of 2018 IHS Markit Transearch data*

Figure 55: Grain Elevator Along the Columbia River Between Oregon and Washington - Corridor #14 Carries Higher Volumes of Wheat Than Any Other Analysis Corridor

*Credit: Esteban Martinena Guerrero via 123rf.com*

# Corridor #15

## Stockton, CA, to Los Angeles, CA

This corridor contains 334 miles of California State Route 99 (SR-99) and Interstate 5 (I-5) and provides additional access to the State's agricultural-producing Central Valley (Figure 56). As opposed to the parallel route of I-5 (see Corridor #1), this corridor runs through the directly through heart of one of the most agriculturally productive regions in the West and provides direct access between farms and pasturelands with local processing facilities and major centers of international trade in the Los Angeles Metropolitan Area.

### Commodity Movements

Comparatively short by mileage, this corridor carries just under 3 billion ton-miles of agricultural goods by truck each year, underscoring the Central Valley's productivity. Vegetables (280 million ton-miles), fruits (181 million ton-miles), dairy (1.51 billion ton-miles), and processed meats (166 million ton-miles) produced in the Central Valley travel through the corridor, primarily southbound. Many of these products are processed in the valley, though some are likely prepared for export and processed

Table 34: Corridor #15 Major Highways

| State | Route | Miles |
|---|---|---|
| California | I-5 | 67 |
| | SR-99 | 236 |
| | Others | 31 |

*Source: Volpe Center analysis*

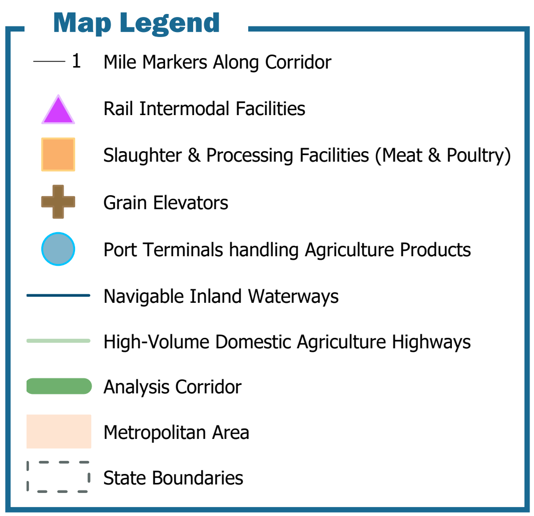



Figure 56: Context Map of Corridor #15


*Source: Volpe Center analysis*

at facilities in Southern California. Several rail intermodal facilities exist at both end points of the corridor, which may be used to transport agricultural commodities grown in California eastward for consumption in the rest of the country. Northbound, dairy products (579 million ton-miles) and corn (313 million ton-miles) also move in large quantities.

## Corridor Conditions and Performance

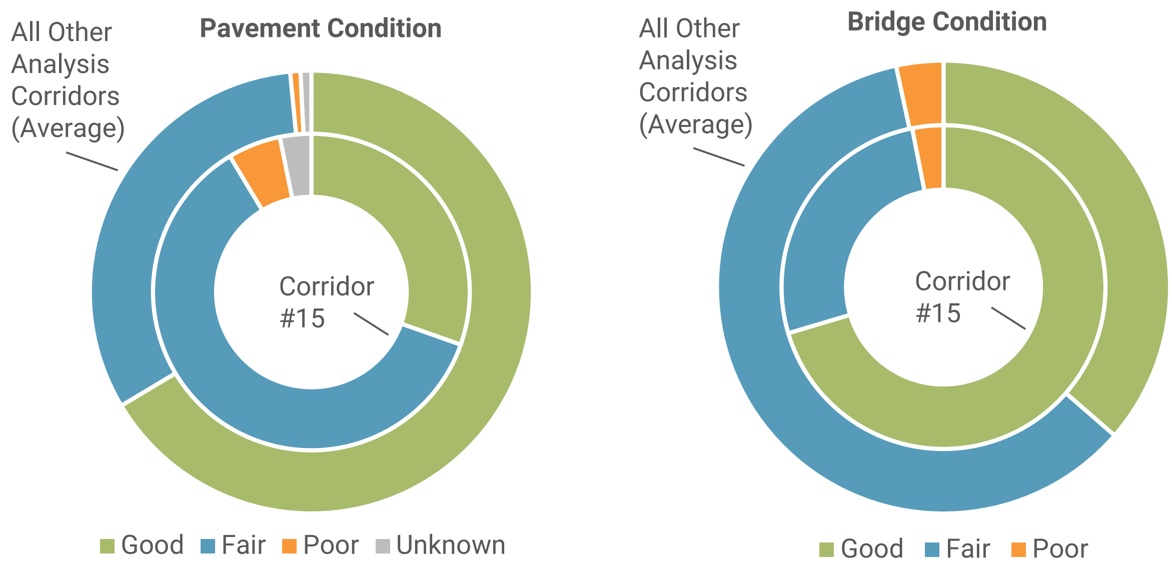
The corridor tends to remain reliable between the major urbanized areas on the corridor, though significant spikes in unreliability are seen in each of the four major metropolitan areas on the route—Stockton, Fresno, Bakersfield, and Los Angeles—as well as near the confluence of I-5 and SR-99, south of Bakersfield. Pavement condition is rated to be in "fair" condition along the vast majority of the route, and approximately 5% is rated as "poor" condition, most of which falls in or nearby the major cities. Notably, bridge condition tends to improve as one travels southward on the corridor, particularly in and around the Los Angeles metropolitan area (Figure 57). Just 2% of bridges are rated "poor condition," most of which lie on the northern half of the corridor.

Table 35: Corridor #15 Key Commodities

| Key Commodities | Tonnage | Market Value | Truck Units |
|---|---|---|---|
| Vegetables | 3.72 M | $3.97 B | 177 K |

*Source: Volpe Center analysis of 2018 IHS Markit Transearch data*

Figure 57: Pavement and Bridge Condition of Corridor #15 Versus the Average of all Other Analysis Corridors



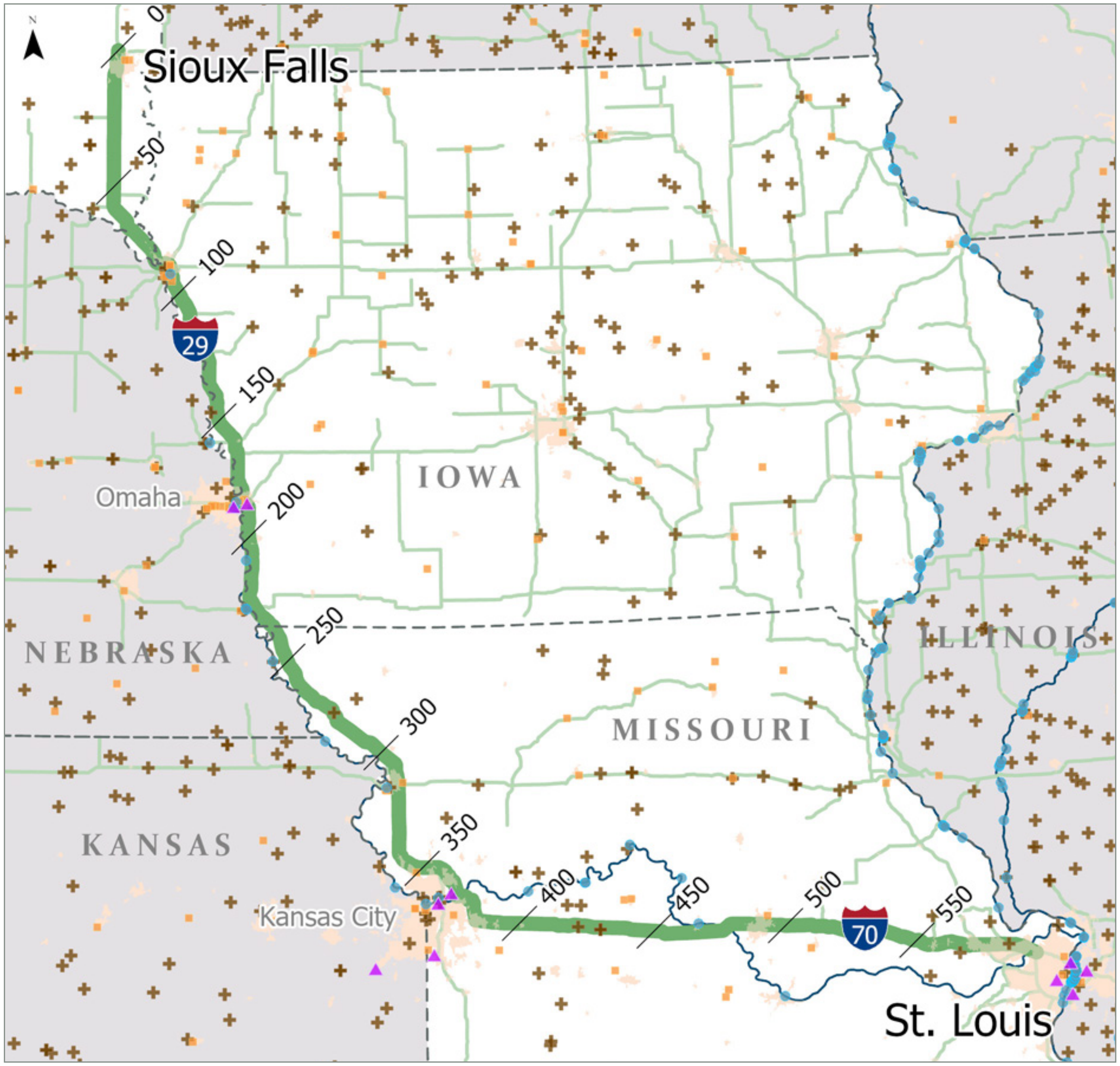

While this corridor contains significantly more "poorly" and "fair" rated miles of pavement, a far greater percentage of bridges on the corridor are rated in "good" condition.

*Source: Volpe Center analysis of 2018 HPMS data*

# Corridor #16

## Sioux Falls, SD, to St. Louis, MO

Figure 58: Context Map of Corridor #16




Source: Volpe Center analysis

This corridor contains 595 miles of Interstate connecting the agricultural producers in upper Midwest with rail and inland waterway intermodal transfer facilities in the Great Plains and along the Missouri and Mississippi Rivers (Figure 58). The route contains two

Table 36: Corridor #16 Major Highways

| State | Route | Miles |
|---|---|---|
| Iowa | I-29 | 152 |
| Missouri | I-29 | 110 |
| | I-70 | 217 |
| | Others | 32 |
| South Dakota | I-29 | 84 |

*Source: Volpe Center analysis*

**Map Legend**

- 1 Mile Markers Along Corridor
- Rail Intermodal Facilities
- Slaughter & Processing Facilities (Meat & Poultry)
- Grain Elevators
- Port Terminals handling Agriculture Products
- Navigable Inland Waterways
- High-Volume Domestic Agriculture Highways
- Analysis Corridor
- Metropolitan Area
- State Boundaries

distinct segments, with Interstate-29 (I-29) travelling parallel to the Missouri River between South Dakota and Kansas City, MO, and Interstate-70 connecting Kansas City and St. Louis.

## Commodity Movements

This corridor carries just under 5 billion ton-miles of agricultural goods each year. Corn (2.12 billion ton-miles), soybeans (776 million ton-miles), livestock (260 million ton-miles), meat (631 million ton-miles), vegetables (253 million ton-miles) and dairy (646 million ton-miles) all move in high volumes on this corridor. Corn and soybeans produced in Iowa, Nebraska, and the Dakotas move along I-29 on their way to or from one of the dozens of grain elevators clustered along the route. A large drop-off in grain truck traffic south of Omaha, NE, suggests that grains are either being trucked east-west along I-80 (see corridors #3 and #13), or being loaded onto river barges down the Missouri and Mississippi Rivers. Hogs are also transported in high quantities along the route, likely destined for slaughterhouses and other processing facilities in an around Omaha. Soybeans produced in southeastern Nebraska tend to move toward Kansas City, suggesting that they are moving toward western ports via rail or loaded onto river barges and exported via the Mississippi River system.

Between Kansas City and St. Louis, soybeans are produced and transported in much larger quantities, much of which travels to river ports along the Mississippi River and is likely destined for export. Meat, vegetables, and milk are also produced in large quantities in Missouri, and travel in high quantities on eastbound I-70 toward processing facilities in the St. Louis region or beyond.

Table 37: Corridor #16 Key Commodities

| Key Commodities | Tonnage | Market Value | Truck Units |
|---|---|---|---|
| Corn | 38.40 M | $3.81 B | 2.49 M |
| Soybean | 11.78 M | $4.06 B | 764 K |
| Meat | 4.95 M | $19.48 B | 215 K |
| Livestock | 4.66 M | $10.26 B | 302 K |

*Source: Volpe Center analysis of 2018 IHS Markit Transearch data*

## Corridor Conditions and Performance

While travel times throughout the entire 600-mile corridor are quite reliable for trucks, significant delays are common in both the Kansas City and St. Louis metropolitan areas. Travel times are particularly unpredictable in Kansas City near the I-29 and I-70 connection. The I-70 section of the corridor sees significantly more overall traffic compared to the I-29 segments. Pavement condition on I-70 also tends to be rated higher than that of I-29, though less than 0.2% of the pavement along the entire corridor is rated in “poor” condition. Eleven total bridges on the corridor are rated in “poor” condition, most of which lie on I-29 between Omaha and Kansas City—an important segment of the corridor for transporting soybeans.

# Corridor #17

## Wilmington, DE, to Norfolk, VA

An important route for transporting poultry through the Delmarva Peninsula, this corridor is 236 miles of US-13, traveling from Wilmington, DE, to Norfolk, VA (Figure 59). The Delmarva Peninsula has one of the highest concentrations of poultry producers in the United States, and this corridor provides the peninsula with connections to both the Port of Wilmington and the Port of Norfolk, which are both important hubs for exports. Although this is a relatively short corridor compared to the others, this corridor is vital for poultry transportation in the peninsula and provides connections to other routes on the HDAH.

### Commodity Movements

Each year, approximately 457 million ton-miles of agricultural products are trucked through this corridor. Corn (132 million ton-miles), poultry (108 million ton-miles), and processed meat (99 million ton-miles) comprise the majority of the agricultural freight movements along the corridor, with about two-thirds of these goods moving northbound. This peninsula contains a large amount of poultry farms. Many of

Table 38: Corridor #17 Major Highways

| State | Route | Miles |
|---|---|---|
| Delaware | DE-1 | 37 |
| | US-13 | 56 |
| Maryland | US-13 | 42 |
| Virginia | US-13 | 92 |
| | Others | 9 |

*Source: Volpe Center analysis*

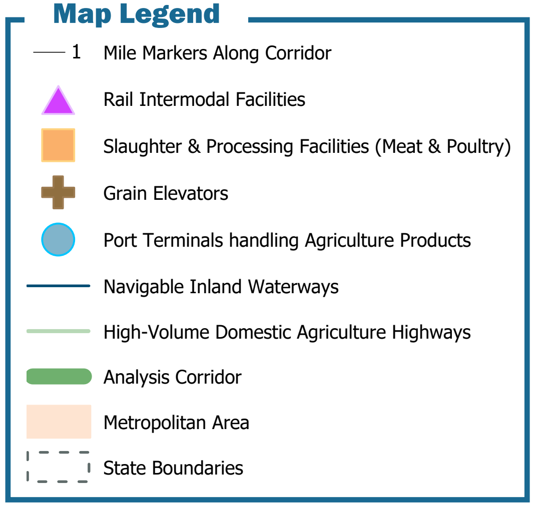
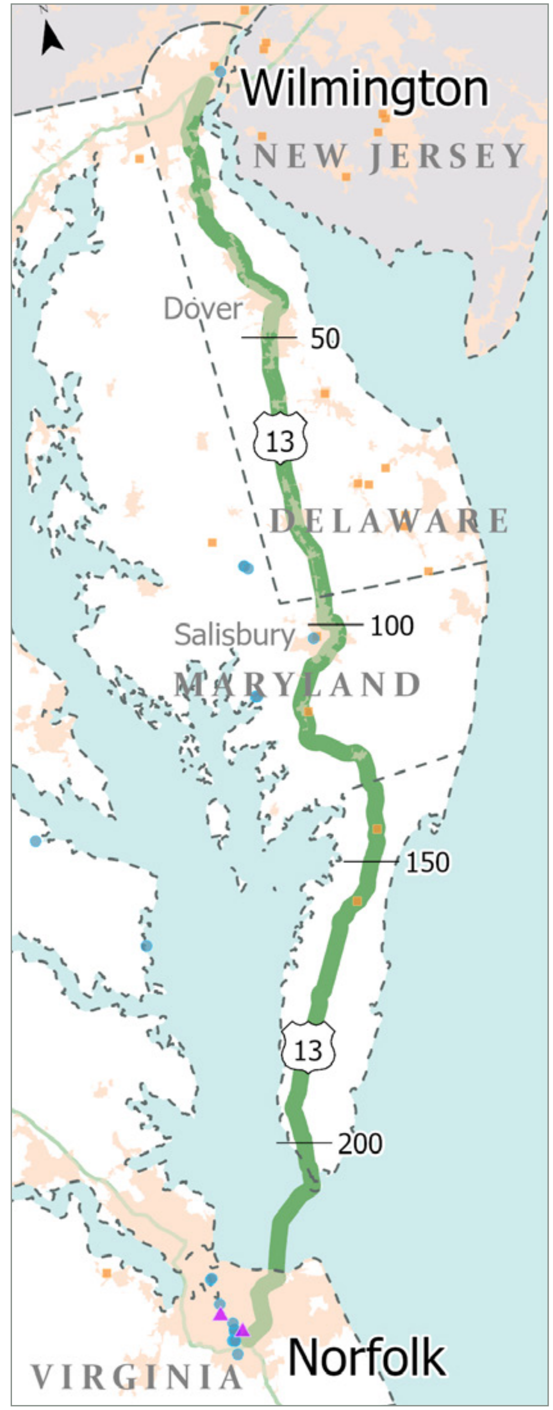



Figure 59: Context Map of Corridor #17




*Source: Volpe Center analysis*

the animals produced in Delaware and Southern Maryland are trucked to nearby slaughterhouses and processing facilities scattered throughout the peninsula. Other commodities traveling along the corridor include corn (132 million ton-miles), soybeans (55 million ton-miles), and wheat 26 million ton-miles), all traveling in both directions between Salisbury and Norfolk. Large, deep-water ports on both terminuses of the corridor are potential interim destinations for these products, where they continue traveling to either international or domestic destinations. At least some of the volumes continue beyond these ports, either being trucked to other regions, or potentially switching to rail via intermodal lifts.

## Corridor Conditions and Performance

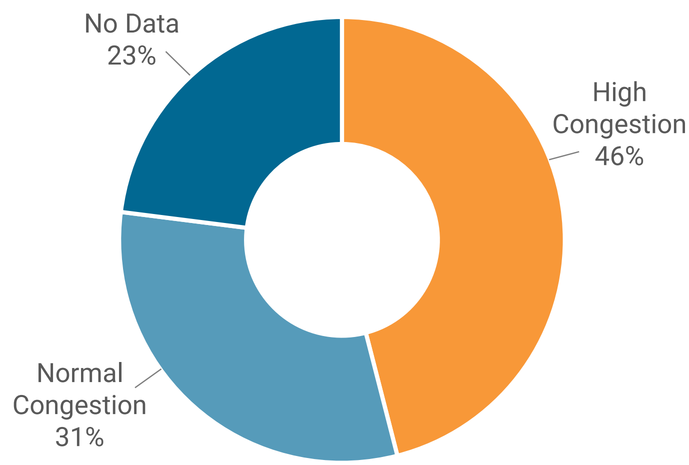
This corridor experiences varying amounts of congestion, with the stretch between Dover and Salisbury having particularly high TTI and TTTR, with an additional peak in TTI near Norfolk (Figure 60). Over 98% of the pavement along the corridor is in either "good" or "fair" condition, and there are no bridges along the corridor in "poor" condition. The congestion issues are likely the larger mobility challenge on this corridor, and not the condition of the infrastructure itself.

Table 39: Corridor #17 Key Commodities

| Key Commodities | Tonnage | Market Value | Truck Units |
|---|---|---|---|
| Poultry | 1.81 M | $5.04 B | 118 K |

*Source: Volpe Center analysis of 2018 IHS Markit Transearch data*

Figure 60: Corridor #17 Congestion Levels Based on Roadway Mileage




46% or more of Corridor 17 experiences High Congestion.

*Source: Volpe Center analysis of 2018 NPMRDS data*

# SECTION 5

## Future Conditions and Investment Scenarios

# Future Conditions and Investment Scenarios

This section describes how planned highway freight projects at the State level may affect future performance of the highway network. It uses the Federal Highway Administration's (FHWA) Highway Economic Requirements System (HERS) model to evaluate the costs and benefits of alternative investment scenarios, and to analyze the impact of planned projects. While it is difficult to predict with great precision how any future highway network will perform, this section provides modeled estimates to illustrate the value of future conditions analysis. The overall goal is to provide information to stakeholders and decision-makers on the expected future conditions of the highway network and to describe the potential benefits of future investments.

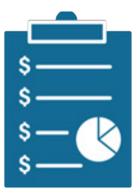
The section is organized in three parts:

1. State Freight Plan (SFP) Projects
2. Estimating the Impacts of SFP Projects
3. Alternative Investment Scenarios

### Estimated Impact - State Freight Plan Projects (2016-2020)

**$17B**

Funding programmed in State Freight Plan Projects from NHFP



**24%**

Percent of projects located on highways that are part of the HDAH

**$540M**

Estimated annual truck operating cost savings

### Key Findings

The projects that State DOTs include in their SFPs will have a significant impact on freight performance.

Nearly $17 billion of National Highway Freight Program (NHFP) and other funding sources were programmed in SFP projects between Fiscal Years 2016-2020. Twenty-four percent of these SFP projects were planned for highways that are part of the High-Volume Domestic Agriculture Highways (HDAH).

The HERS model suggests that projects of this type and at this $17 billion level of investment can produce societal benefits in excess of costs, with a benefit-cost ratio greater than 2, relative to a baseline in which these investments are not made. Included among these estimated benefits are nearly $540 million per year in truck operating cost savings. With at least a portion of these savings likely to be passed on to shippers due to the competitive nature of the industry, these impacts could positively impact profitability for the agricultural sector.

The modeling results also find that the cost-effectiveness of increased highway freight investment would decline only slightly even if investment levels were doubled or quadrupled from the levels in the State Freight Plans, suggesting that many worthy projects could be funded if investment levels increase.

## State Freight Plan Projects

Transportation infrastructure projects typically have long lead times for planning, and ultimately yield fixed infrastructure with lifespans measured in decades. As a result, State DOTs must consider both current and future highway freight infrastructure needs when making investments in the system. From a freight perspective, a State DOT must consider the dynamic nature of its most important supply chains, including the agriculture industry, when assessing current and future needs. Other considerations include the potential changes in product volumes and production patterns, as well as changes in the overall transportation landscape, such as fuel prices and congestion levels.

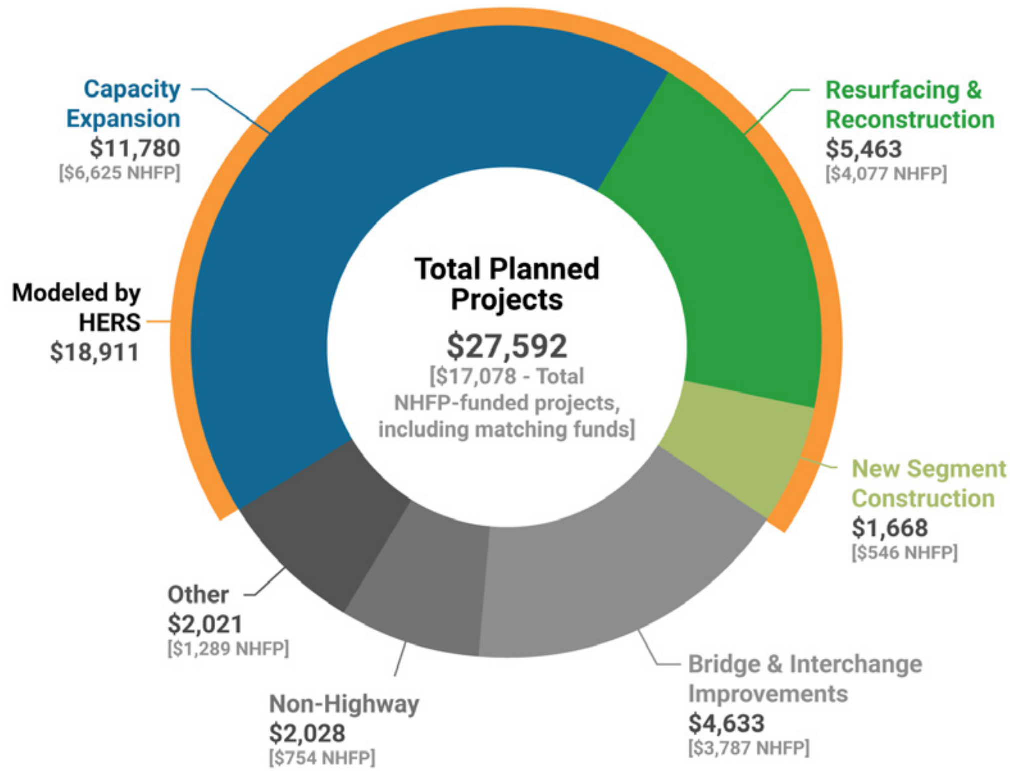
The passage of the 2015 *Fixing America's Surface Transportation* (FAST) Act established for the first time a freight-specific funding source within the larger Federal-Aid Highway Program. The NHFP requires each State (plus the District of Columbia and Puerto Rico) to develop an SFP before it is able to access its funding allocation from this program. SFPs are required to define critical rural and urban freight corridors and system trends within the State; major bottlenecks and other issues; and a freight investment plan describing what projects the State plans to funds using the NHFP.

These plans are the most consistent source to date describing how each State prioritizes freight investments. Planned projects included in the SFPs can provide an estimate of the improvements expected on U.S. highways, including on the HDAH. Not every project that will affect highway condition and performance is included in SFPs, but for the purposes of this project, the analysis presumes that States have included the most important freight projects.

For this analysis, projects listed in SFPs were aggregated, georeferenced, and assigned additional characteristics such as functional class and project type.[7] Appendix C: Methodology includes more information about this study's approach to aggregating SFP project lists. Together, these projects account for just over $27 billion in planned

7 These planned projects reflect the State Freight Plans published as of December 2019. State DOTs may modify these plans or projects at any time.

Figure 61: State Freight Plan Investments, 2016-2020, by Project Type and HERS Modeling Capability (Millions $)




*Note: NHFP figures listed include total project costs of NHFP-funded projects, which are made up of NHFP dollars and State matching funds. Appendix C includes information on the methodology.*
*Source: Volpe Center analysis of 51 State Freight Plans as published in December 2019*

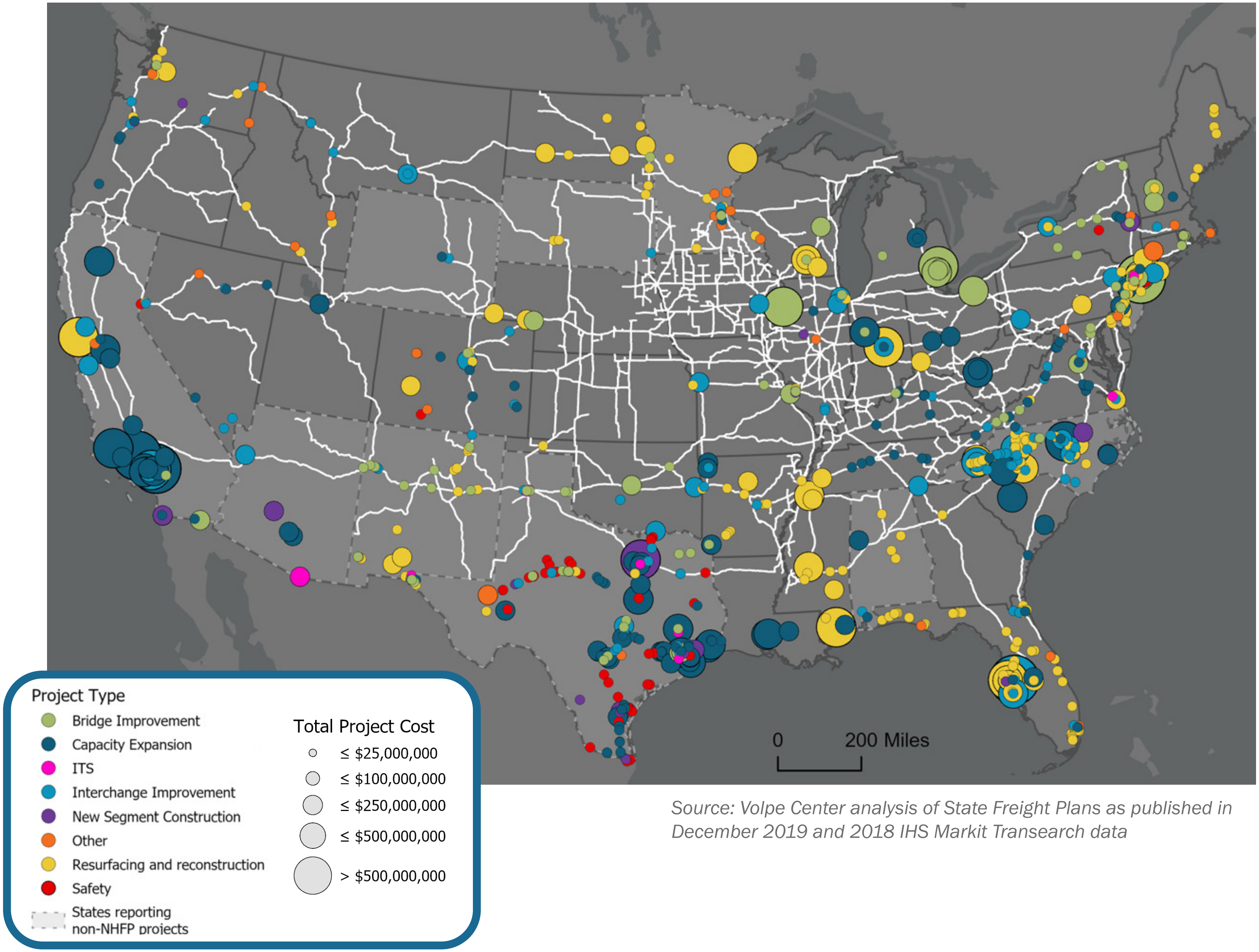
spending (some using NHFP funds while some projects use other sources of funding). However, certain project types cannot be analyzed in the HERS model (such as bridge improvements, truck parking, and some types of safety improvements). Appendix C: Methodology includes more detail on project types. When restricting the analysis to project types that are covered by the HERS model, the resulting total is $18.9 billion in highway infrastructure improvements for the period between fiscal years 2016 and 2020 (Figure 61). This dataset was used to estimate how this level of planned investment would affect highways overall (Figure 62), as well as the HDAH (Figure 63).

Notably, 24% of all SFP projects by dollar value are on the HDAH, and thus are assumed to directly benefit agriculture highway freight performance. Projects not on the HDAH may also benefit agricultural highway freight performance because, although the HDAH represents 80% of agriculture freight movements for the commodities selected for study in this report, all highways support agricultural freight.

The SFP projects on the HDAH tend to be reconstruction/resurfacing (26%), capacity expansion (24%), and interchange improvements (34%), although other categories are also represented. While several of the projects are in areas with demonstrated reliability and congestion challenges, closer analysis at a corridor or statewide level would be needed to understand the specific impacts that these projects are expected to have on the overall network and is beyond the scope of this report.

*Credits: (clockwise) Tyler Olson, Henadzi Pechan, and Valmedia Creatives via 123rf.com*

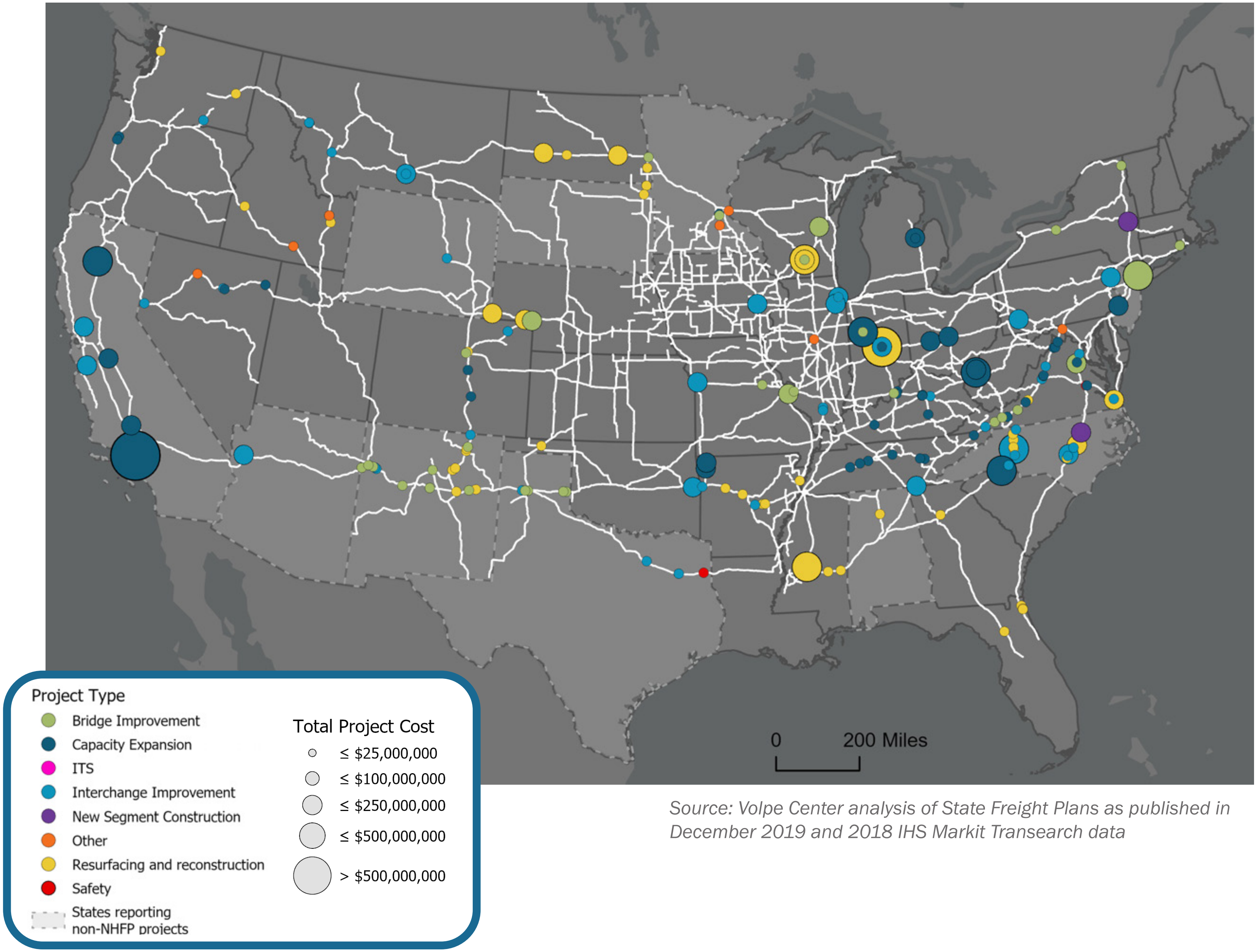
Figure 62: State Freight Plan Projects by Type and Cost, Fiscal Years 2016-2020




*Source: Volpe Center analysis of State Freight Plans as published in December 2019 and 2018 IHS Markit Transearch data*

States with dashed borders indicate that State reports additional funding sources beyond their NHFP and matching funds in their State Freight Plan's constrained program.

Figure 63: State Freight Plan Projects Affecting the High-Volume Domestic Agriculture Highways by Type and Cost, Fiscal Years 2016-2020




States with dashed borders indicate that State reports additional funding sources beyond their NHFP and matching funds in their State Freight Plan's constrained program.

*Source: Volpe Center analysis of State Freight Plans as published in December 2019 and 2018 IHS Markit Transearch data*

## Estimating the Impacts of State Freight Plan Projects

HERS is a model of the U.S. highway system used to forecast the impacts of different investment scenarios. The project team used HERS to estimate the aggregate impacts of the SFP projects.

Rather than developing a project-by-project estimate, the HERS model is able to estimate the aggregate impacts of a national package of highway investment that is equal to the sum of the SFP projects. The HERS model estimates should be considered illustrative of the overall magnitude of the potential impacts these planned projects will have on the highway network. The model output does not reflect the impacts of the SFP projects specifically, or their allocation across particular States and highway facilities. See Appendix C for a detailed methodology of the HERS modeling approach.

### Why Not Model at the Project Level?

**While a number of tools are available to estimate these types of impacts at the project-specific level, rather than as a national total, there are many challenges to this approach:**

- Project level analysis **requires detailed information on the nature of the programmed improvements**, but this level of detail is typically not available from the SFPs. In many cases the project team had to make inferences about the nature of the project from only a title or short description, and the full scope of work is not listed.
- **Even projects with adequately detailed descriptions were not generally accompanied by the data needed for analysis**, such as current traffic volumes, speeds, pavement condition, and roadway configuration. Compiling this information via queries of the Highway Performance Monitoring System (HPMS) and other databases, across hundreds of projects, was not feasible within the resource constraints of the current research effort.
- **Many project types are difficult to model quantitatively** in project-level Benefit-Cost Analysis (BCA) models such as Cal-B/C because they require more sophisticated microsimulation of traffic impacts (e.g., for interchange or intersection re-configurations). See Figure 61.
- In other cases, **project impacts are largely indirect and inherently difficult to model**. For example, expanded truck parking may reduce illegal truck parking along highway ramps, improving security and safety. However, modeling these impacts with any sort of quantitative precision would be very challenging.

## Modeling Results

The HERS model estimates benefits of highway investments across multiple categories, including safety improvements, reduced travel time and vehicle operating costs, and avoided emissions (Table 40). These impacts are converted to monetary equivalents using parameters in the model, such as the value of travel time savings. HERS estimates the incremental benefits of the SFP projects – that is, the benefits that would accrue, relative to a baseline in which these projects are not funded – to be $40.2 billion over a 5-year period, compared to $18.9 billion in incremental project costs. Incremental costs are defined as the additional project capital costs. This implies a benefit-cost ratio of 2.13 for these projects, again relative to the baseline.

With this level of incremental investment, HERS expects 18,705 lane-miles of road would be improved, and 1,171 lane-miles would be added. Roadway surface condition would improve slightly, from an average of 110.6 to an average of 109.3 on the International Roughness Index (IRI) scale. Average speeds on the highway network are estimated to rise by 0.02 mph nationally, with delay falling by 0.01 hours per 1,000 vehicle miles traveled (VMT). These seemingly small changes, when multiplied across the entire Nation's highways, would yield travel time savings valued at over $1 billion per year. Safety benefits likewise show a modest improvement of $0.10 per 1,000 VMT, but this adds up to about $267 million per year in safety benefits, when monetized at U.S. DOT's standard values of avoided injury.

Looking specifically at the impacts on trucks, overall truck operating costs are reduced by an estimated $1.00 per 1,000 VMT. When combined with truck travel time savings, this yields an estimated national total of $540 million per year in trucking cost savings. This is likely a conservative estimate, because the benefits for trucks are likely higher on the freight-specific projects selected by the States, rather than the more general impacts calculated by the model. These benefits would accrue to all trucks, not only trucks carrying agricultural freight. However, agriculture will certainly benefit as the largest component of highway freight.

**Table 40: HERS Model Predicted Benefits of State Freight Plan (SFP) Investment**

| | |
|---|---|
| Total Incremental Spending (5-Year Period) | $18.9 billion |
| Estimated Incremental Benefits (5-Year Period) | $40.2 billion |
| Benefit-Cost Ratio (Overall) | 4.81 |
| Benefit-Cost Ratio of Incremental Spending | 2.13 |
| Lane-miles Improved | 18,705 |
| Lane-miles Added | 1,171 |
| Roadway Surface Improvement (Reduction in Average IRI) | 1.3 |
| Speed Improvement (Average, mph) | 0.02 |
| Delay Reduced (Hours per 1000 VMT) | 0.01 |
| Truck Operating Cost Savings, $/1000 VMT | $1.00 |

*Source: Volpe Center analysis using HERS model and State Freight Plans*

**The $18.9 billion investment level in the State Freight Plans is likely to be highly cost-effective.**

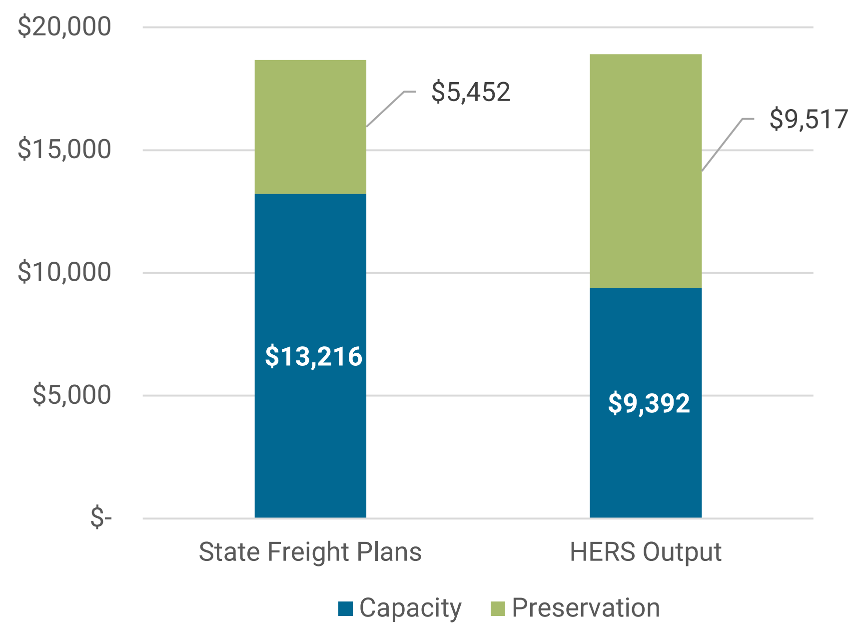
While projects programmed into State Freight Plans represent a small share of a State's overall highway spending, these projects provide significant impacts and benefits to the highway network. These include safety benefits, improved pavement quality, avoided delays and reduction of operating costs. Although the HERS model is not designed to capture the impacts of the specific State-selected projects, the results also suggest that the $18.9 billion investment level in the State Freight Plans is likely to be highly cost-effective. For every dollar invested into the highway network by a State DOT, users of the system on average realize more than $2 worth of safety benefits, vehicle operating cost savings, and other benefits.

## Insights on Project Selection

To shed light on State-level decision-making and project selection, the project team ran the HERS model with the total level of investment from the SFP projects ($18.9B over 5 years—see Appendix C). The project team compared SFP projects against a scenario in which the same amount of money was invested, but unconstrained by project type or functional class. This allows the composition of projects by project type and functional class to be compared between the SFP projects and a HERS-calculated optimum, based on projects with the highest benefit-cost ratio. As a further refinement, the project team ran the model with the funding split by functional class to roughly match that of the SFP projects. That split is roughly $17.6 billion on HPMS classes 1-3 (Interstates; other freeways and expressways, and principal arterials), and $1.3 billion on lower functional classes (arterials and collectors). For the analysis by project type, projects were classified as "capacity expansion" (such as construction of additional lane-miles or geometric improvements) or "preservation" (such as rebuilding or resurfacing a roadway).

The results of the HERS modeling found that the SFP projects allocate 1.92 times more funding to Interstate projects, as opposed to non-Interstate projects, than the HERS model's allocation, which is based on maximizing projects' estimated cost-effectiveness. SFP projects are also more oriented toward capacity expansion, spending 1.4 times greater in this category than the model's calculated optimum, versus 0.6

Figure 64: Comparison of State Freight Plans and HERS Outputs by Project Type ($ millions)

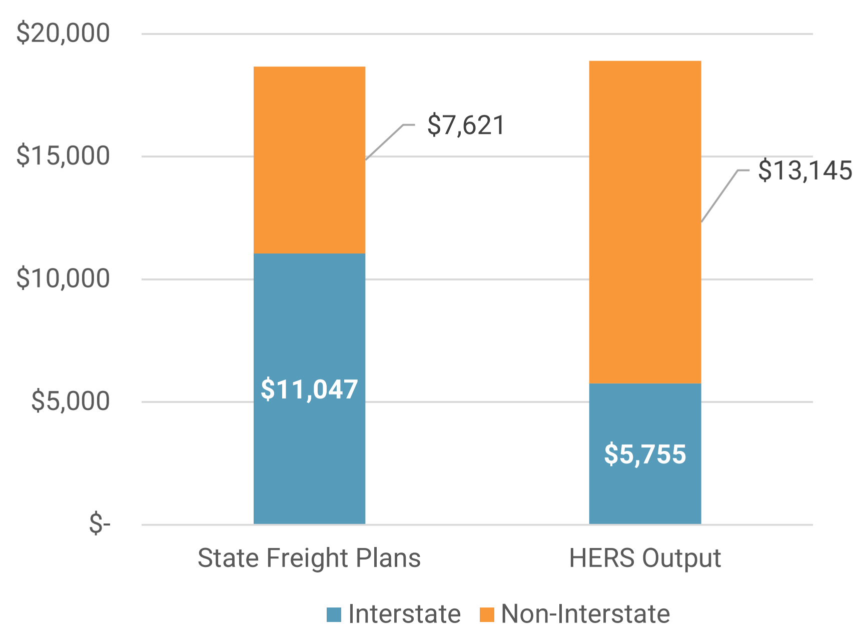



*Source: Volpe Center analysis using HERS Model and State Freight Plans*

### Potential Implications for Highway Freight Programming

- **States may wish to analyze their freight project selections using benefit-cost tools to ensure an optimal mix between capacity and preservation projects, and among highway functional classes.**
- **A greater emphasis on non-Interstate projects and on roadway preservation projects rather than new capacity may yield greater overall returns on investment.** This is based on national-level HERS modeling results across all current SFPs, and is not necessarily applicable to any given State or corridor. This overall finding is consistent with stakeholder input about the importance of good pavement conditions and the role that smaller, local roads play in facilitating agricultural freight movements.

Figure 65: Comparison of State Freight Plans to HERS Output by Functional Class ($ Millions)




*Source: Volpe Center analysis using HERS Model and State Freight Plans*

times the model's allocation for preservation projects. Overall, the SFPs spend 2.5 times more than the HERS model's estimated optimal mix on *capacity expansion on Interstates*, and only 27% of the HERS allocation on *preservation projects for lower functional classes*. Similar ratios apply if comparing the State-planned freight project spending against a breakdown of overall highway investment, such as the "Sustain" scenario in the most recent *Conditions and Performance Report* (FHWA, 2019).

There are many reasons why this pattern could emerge, and may simply reflect an analysis of the most promising freight projects at the State level. There are also limitations to the HERS model, such as the inability to estimate benefits for certain project types. However, the relative lack of attention to lower functional classes and to road condition is consistent with stakeholder concerns about local roads that are critical for agricultural freight, and that poor road and bridge conditions can be a limitation on freight movements. The focus on Interstates and capacity projects may be associated with data-availability or institutional factors such as:

- Limited data availability on lower-volume roads;
- Lack of analytical capability for quantifying the impacts of preservation projects; and
- Less political support for routine preservation projects relative to higher-profile expansion projects.

It is important to note that this was the first time that State DOTs were required to prepare SFPs, so these initial plans may not entirely reflect State DOT's overall approach. Network designations and funding eligibility could also play a role in how State DOTs select Federally funded projects, and contribute to differences between overall spending patterns and funding allocations in the SFPs.

## Alternative Scenarios: Highway Freight Performance with Enhanced Investment

If current levels of investment in the highway freight system are highly cost-effective, would additional funding provide similar benefits? The HERS model was also used to explore what the impact of additional freight-related funding might be on the highway network. Specifically, two scenarios were tested:

- Highway freight investments at twice the current level of modeled spending, i.e., $37.8 billion over a 5-year period
- Highway freight investments at four times the current level of modeled spending, i.e., $75.6 billion over a 5-year period

HERS found that these theoretical increased funding amounts were similarly cost-effective, as they would produce societal benefits in excess of costs, albeit at a slightly decreasing rate due to diminishing returns (Table 41). That is, even if investment via SFPs were raised to two or four times the current level, the model is still able to identify highway projects that are cost-effective, with incremental benefits exceeding the incremental costs by a factor of 2.0 or more.

In the case where the highway freight investments are doubled, the incremental benefits of the investments over the 5-year period are estimated to be $78.3 billion, compared to $37.82 billion in project costs. This implies a benefit-cost ratio (BCR) of 2.07 for the incremental funding, and overall BCR of 4.64. The model also estimates that doubling their freight-project spending can lead to improvement of 35,878 lane-miles of road, and the addition of 2,438 lane-miles. Roadway surface condition would improve by 2.5 IRI as an overall national average and average speeds on the highway network are estimated to rise by 0.05 mph nationally, and delay reduced by 0.02 hours per 1,000 VMT. Looking specifically at the impacts on trucks, truck operating costs would be reduced by $1.80 per 1,000 VMT. These are partially

Table 41: HERS Model Predicted Outcomes of Several Levels of Highway Investment

| | State Freight Plan Projects | 2x State Freight Plan Level | 4x State Freight Plan Level |
|---|---|---|---|
| Total Spending (5-Year Period) | $18.9 billion | $37.8 billion | $75.6 billion |
| Estimated Benefits (5-Year Period) | $40.2 billion | $78.3 billion | $151.1 billion |
| Overall Benefit-Cost Ratio | 4.81 | 4.64 | 4.35 |
| Benefit-Cost Ratio for Incremental Spending | 2.13 | 2.07 | 2.0 |
| Lane-miles Improved | 18,705 | 35,878 | 76,011 |
| Lane-miles Added | 1,171 | 2,438 | 4,778 |
| Roadway Surface Improvement (Reduction in Average IRI) | 1.3 | 2.5 | 5.2 |
| Speed Improvement (Average, mph) | 0.02 | 0.05 | 0.10 |
| Delay Reduced (Hours per 1,000 VMT) | 0.01 | 0.02 | 0.05 |
| Truck Operating Cost Savings, $/1,000 VMT | $1.00 | $1.80 | $3.80 |

*Source: Volpe Center analysis using HERS Model and State Freight Plans*

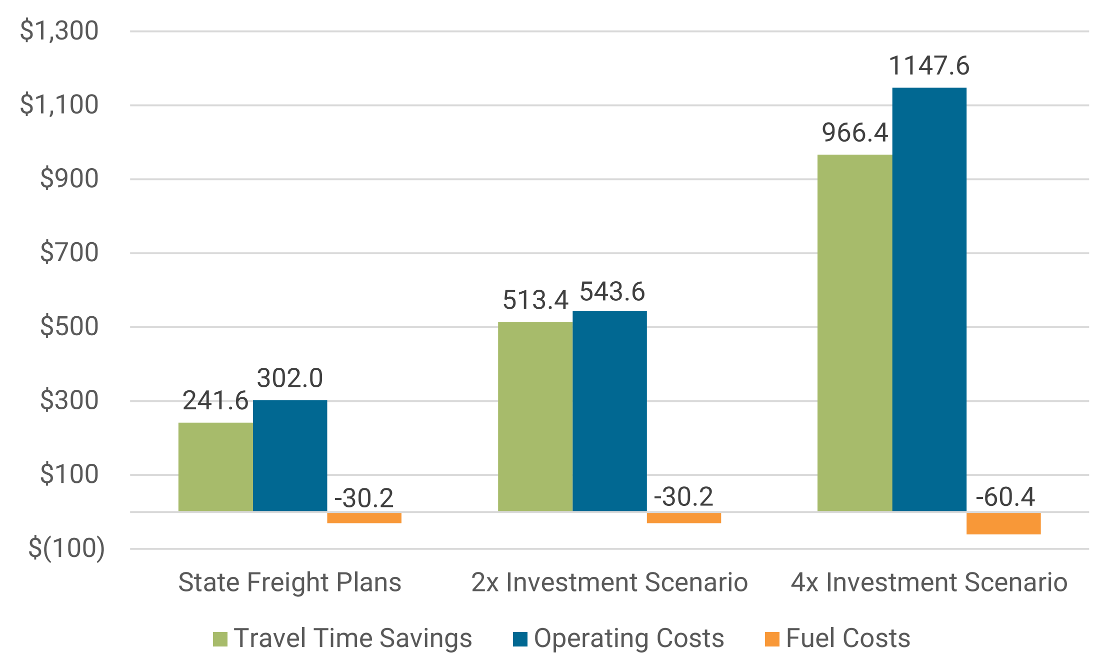
offset by a slight increase in fuel costs, likely due to increased speeds, but the overall effect is positive.

In the second alternative case, highway freight investments would be four times the level of the current SFPs. The incremental benefits of investments are estimated at $151.11 billion, compared to $75.64 billion in project costs. This results in a BCR of 2.0 for the incremental spending, and an overall BCR of 4.35. These BCRs are smaller than the first case due to diminishing returns on investment. The model also estimates that quadrupling their freight-project spending would lead to improvement of 76,011 lane-miles of road, and the addition of 4,778 lane-miles. Roadway surface condition would improve by 5.2 IRI as an overall national average and average speeds on the highway network are estimated to rise by 0.10 mph nationally, and delay reduced by 0.048 hours per 1,000 VMT. Looking specifically at the impacts on trucks, truck operating costs would be reduced by $3.80 per 1,000 VMT.

Across both investment scenarios the HERS model estimates a significant number of projects are funded which provide significant benefits to the highway network (projects with benefit/cost ratios > 2.0). This indicates that additional funding for the highway network—even at large magnitude increases—would create value in excess of the cost. For instance, even modest reductions in delay and improvements to IRI can generate significant truck operating costs savings when generated across the network; these savings have slightly diminishing returns but continue to provide significant value, even if current funding levels were to be quadrupled. There is no way to accurately model what proportion of these benefits would accrue to the agriculture industry. However, because approximately one-quarter of the SFP projects are on the HDAH, and because the agriculture industry is the single largest component of freight travel on U.S. highways, it is reasonable to expect that increased investment in highway freight projects would improve the HDAH.

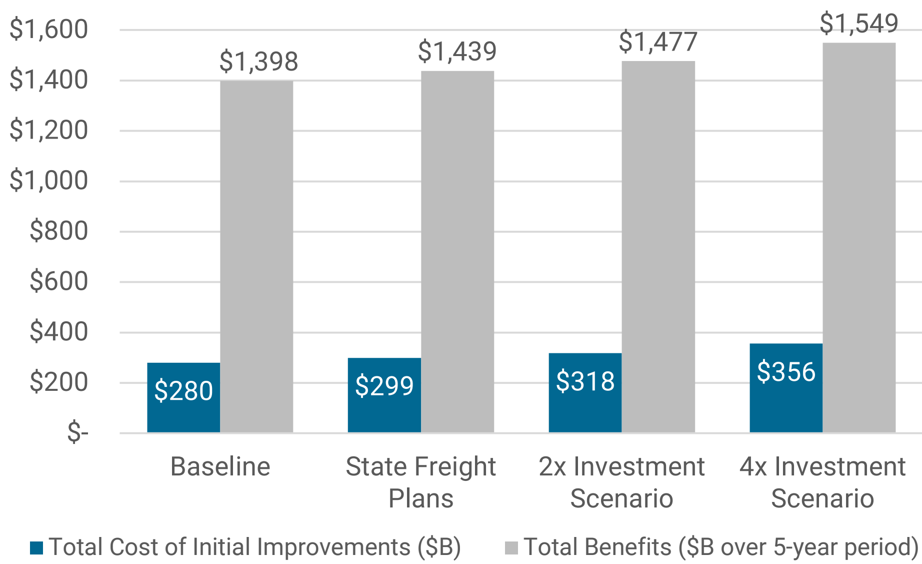
**Additional funding for the highway freight network - even at fairly large magnitude increases - would create value in excess of the cost.**

Figure 66: Annual Truck Cost Savings for Alternative Investment Level Scenarios




*Source: Volpe Center analysis using HERS Model and State Freight Plans*

Figure 67: Benefits and Costs (in Billion $)




*Source: Volpe Center analysis using HERS Model and State Freight Plans*

Figure 68: Average BCR over a 5-Year Modeling Period


*Source: Volpe Center analysis using HERS Model and State Freight Plans*

# SECTION 6

## Notable Practices Case Studies

# Notable Practices Case Studies

Credit: vitpho via 123rf.com

State DOTs, regional planning agencies, and their local partners have developed innovative approaches to filling freight data gaps, engaging freight stakeholders, and analyzing the performance of the highway freight system. This section provides case studies of notable practices in freight planning and analysis (Table 42), which demonstrate a range of innovations agencies are using to improve highway networks and multimodal connections in their jurisdictions.

Many of the practices highlighted in these case studies apply to highway freight generally. However, each case study also includes a description of the potential impacts that are specific to agricultural freight.

Table 42: Freight Planning and Analysis Case Studies

| | Freight Planning and Analysis Topic | Agency |
|---|---|---|
| 1 | Cross-Department Coordination for Improved Agricultural Freight Infrastructure | Missouri Department of Transportation |
| 2 | Advanced Freight Networks and Data Systems | Washington State Department of Transportation |
| 3 | State Grant Programs to Enhance Multimodal Freight Connectivity | Iowa Department of Transportation and others |
| 4 | Prioritizing Freight Projects with Data-Driven Methods and Tools | Iowa Department of Transportation |
| 5 | Collaborative Freight Project Identification and Prioritization | St. Louis Regional Freightway |
| 6 | State Freight Advisory Committees | Texas Department of Transportation |

Source: Volpe Center

1 - Case Study

# Cross-Department Coordination for Improved Agricultural Freight Infrastructure

## Overview

The Missouri DOT (MoDOT) works closely with the Missouri Department of Agriculture (MDA) on a number of transportation planning initiatives to enhance the State's rural transportation network. In matters of freight planning, the two agencies work side by side to plan for and deliver infrastructure that supports the State's large agricultural economy.

The two agencies coordinate on a variety of initiatives, and a 2019 effort to prioritize rural bridges for investment is a particularly notable example of this partnership. Working with MDA to incorporate perspectives and needs from the agriculture industry and local communities, MoDOT was able to prioritize many rural bridges important to rural and agricultural economies for investment over a 4-year period.

**Implementing Agency**

Missouri Department of Transportation

**Focus Area**

Prioritization | Freight Planning

**Local Contact**

Eric Curtit, AICP

Transportation Planning Director,
Missouri Department of Transportation

Eric.Curtit@modot.mo.gov

573-526-1374

## Notable Practice Highlights

- *Missouri's Departments of Transportation and Agriculture coordinate closely to improve rural freight infrastructure.*
- *The agencies work together to share stakeholder insights, data, and other relevant information to enhance freight and transportation planning.*
- *Together, these agencies prioritized and programmed more than $450 million for bridge projects in FY2020-2023, many of which are located in vital rural transportation corridors serving the agriculture industry.*

# Implementation Approach

MoDOT and MDA coordinate and share information regularly on freight programs and studies related to agriculture. Some examples of this coordination include:

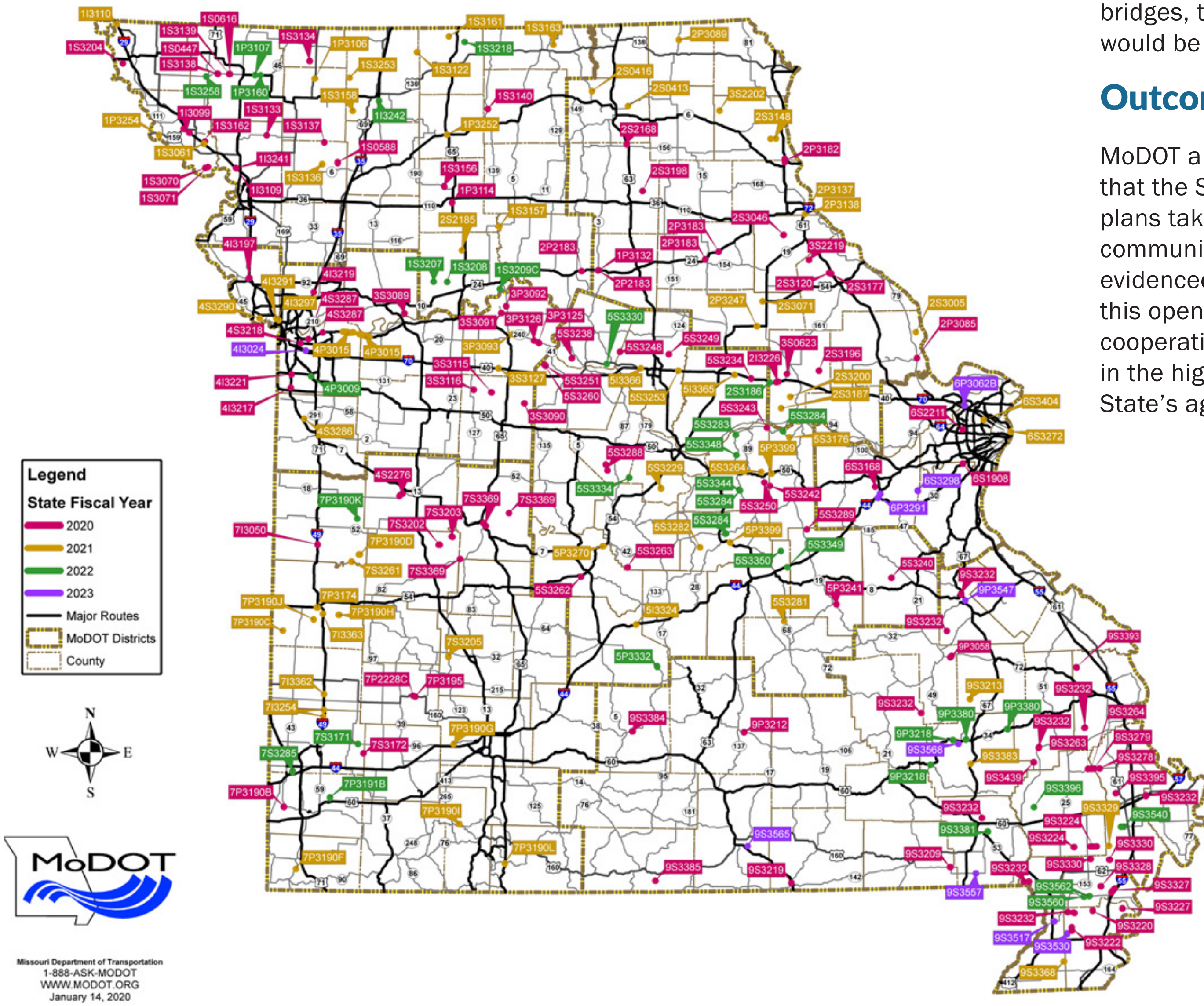
- **Inventorying Agricultural Processing Facilities:** MDA tracks the locations of agricultural grain elevators and other processing locations and shares this information with MoDOT; when MDA learns about a new grain elevator or development, MDA passes the information to MoDOT to inform freight planning and analysis.
- **Coordination on Corridor Analyses:** MoDOT periodically conducts corridor-level studies on key transportation routes throughout the State to identify strategies for improving roadway performance. Particularly in rural highway corridors carrying large volumes of agricultural commodities, MDA actively assists MoDOT in these analyses by sharing data and passing along agricultural stakeholder insights relevant to the corridor.
- **Inland Waterways Planning:** Inland waterway ports and barge operations are an important multimodal connection for both the agricultural shipping industry and the Missouri economy. MDA assists MoDOT in developing strategies to strengthen the connections between the highway network and inland waterways by sharing insights and concerns of agricultural stakeholders.

The Focus on Bridges program is perhaps the most notable example of cooperation between MDA and MoDOT to improve rural infrastructure important to agricultural freight. As of 2019, the State has 10,384 bridges, of which more than 900 are rated in poor condition, 1,131 are weight-restricted, and 413 are both weight-restricted and in poor condition. MoDOT worked with MDA to identify the rural bridges where investment and upgrades will make the largest difference to local transportation and freight operations. The agencies prioritized bridges that were just one lane or weight restricted, especially those in areas with high traffic volumes. MDA and MoDOT also worked together to prioritize certain bridges with lower traffic volumes, which are vital to local needs and network connectivity. For instance, a rural community served by one principal roadway that includes a bridge might be prioritized higher than other bridges with greater traffic volumes based on the critical access nature of that route.

MoDOT significantly prioritized bridge investment under the Focus on Bridges program. More than 260 high-priority bridges are programmed for more than $450 million of investment and upgrades between fiscal years 2020 and 2023 (Figure 69). The program includes $50 million of State General Fund revenues, a $301 million State bond program, and Federal grant funding from both the U.S. DOT Infrastructure for Rebuilding America (INFRA) discretionary grant program and the U.S. DOT Competitive Highway Bridge Program funding.

With the help of MDA, a significant number of these bridge projects are located in high-priority rural areas. In August 2019, U.S. DOT's Competitive Highway Bridge Program awarded MoDOT $20.8 million to replace more than 40 rural bridges that are in poor

Figure 69: Bridges in the State of Missouri Slated for Investment Between 2020 and 2023 Under the Focus on Bridges Program




*Source: Missouri Infrastructure Investment - Focus on Bridges, Progress Report for July 2020*

condition, weight-restricted, supported by timber pile, or one-lane wide but carry two-way traffic. Without the replacement of these bridges, the State projected that at least half would be closed within 8 years.

## Outcomes and Results

MoDOT and MDA's partnership helps ensure that the State's infrastructure investment plans take the needs of rural and agricultural communities into consideration. As evidenced by the Focus on Bridges program, this open channel of communication and cooperation creates tangible improvements in the highway infrastructure supporting the State's agricultural supply chains.

# Advanced Freight Networks and Data Systems

## Overview

The Washington State Department of Transportation (WSDOT) developed its [statewide *Freight and Goods Transportation System*] (FGTS) to identify and designate freight corridors based on freight tonnage and their important to freight movement. The FGTS network provides comprehensive freight data to the different regions and municipalities in the State and create freight corridor classification criteria to support various transportation planning processes and inform freight investment decisions.

WSDOT has maintained the FGTS statewide freight network since 1995. The National Highway Freight Network (NHFN) includes 1,079 miles of highway in Washington while WSDOT's 2019 update of the FGTS includes 22,155 miles of corridors, providing an expanded network for truck freight in the State with several different corridor classifications. The FGTS framework includes two different types of freight network designation: (1) tonnage-based classification system ranging from high to low tonnage corridors; and (2) truck freight economic corridor designation by taking into account freight tonnage, freight system resiliency, and first/last mile connectivity to freight intensive land uses such as agricultural facilities. Designation of these corridors—particularly when mapped and compared to supply chains of important major industries in the Washington, including agriculture—informs investment decisions on the freight highway system for both WSDOT and State decision-makers.

**Implementing Agency**
Washington State Department of Transportation

**Focus Area**
Freight Data | Proritization

**Local Contact**
Wenjuan Zhao
Multimodal Freight Systems Planning Engineer, Washington State Department of Transportation
Wenjuan.Zhao@wsdot.wa.gov
360-705-6990

## Implementation Approach

The FGTS includes data on truck, waterway, and rail corridors, and WSDOT works collaboratively with local and regional governments to update the FGTS biennially. WSDOT collects truck volume and vehicle classification data on State highways through more than 4,000 truck traffic counters.[8] The agency then converts these counts into tonnage estimates based on each vehicle types average weight and count on the roadway.[9] County governments collect local data and submit it to FGTS via the County Road Administration Board's (CRAB) Roads Mobility Database. Local governments also provide additional data to governments also provide additional data to WSDOT about local conditions, including truck volumes and tonnage on local roadways as available.

WSDOT works with local partners to collect data and update freight network designation, which is classified into five categories based on annual freight tonnage moved. Building upon FGTS tonnage, WSDOT in 2014 expanded the FGTS framework and incorporated a new designation, *Truck Freight Economic Corridors*, which are the routes major statewide industries use most often to move goods by truck through the State. WSDOT defines three components of Truck Freight Economic Corridors:

- High Volume Corridors, which carry more than 4 million tons of freight annually;
- Alternative Freight Routes, which serve as alternates to cross-State High Volume Corridors during severe weather or other disruptions to increase freight system resiliency; and
- First- and last-mile connector routes—those roadways connecting high volume freight corridors with freight-intensive land uses such as agricultural facilities.

After each update, the State's Freight Mobility Strategic Investment Board (FMSIB) officially adopts the designated strategic freight corridors, which is a subset of the FGTS system and meets certain tonnage threshold. FMSIB uses this designation to evaluate freight project eligibility for the FMSIB grant program and inform its investment decisions.

WSDOT prioritizes its National Highway Freight Program (NHFP) funds—the major highway freight funding sources administered by the Federal Government. Additionally, the State tracks and reports freight performance trends for the FGTS network, such as freight traffic volume and tonnage shipped, and is considering additional performance measures to evaluation system congestion and reliability.

### Notable Practice Highlights

- ***WSDOT combines data from State, county, and local truck counts to create an expanded multimodal freight network, called the Freight and Goods Transportation System (FGTS).***
- ***Including local insights in the development of FGTS enhances the network's accuracy.***
- ***WSDOT updates FGTS biennially with the latest freight volumes, tonnage, and flow data.***
- ***With each update, WSDOT aims to build additional functionality into the dataset, expanding its usefulness to state and local decision-making.***

## Outcomes and Results

WSDOT uses the FGTS to support freight planning efforts, including analyzing

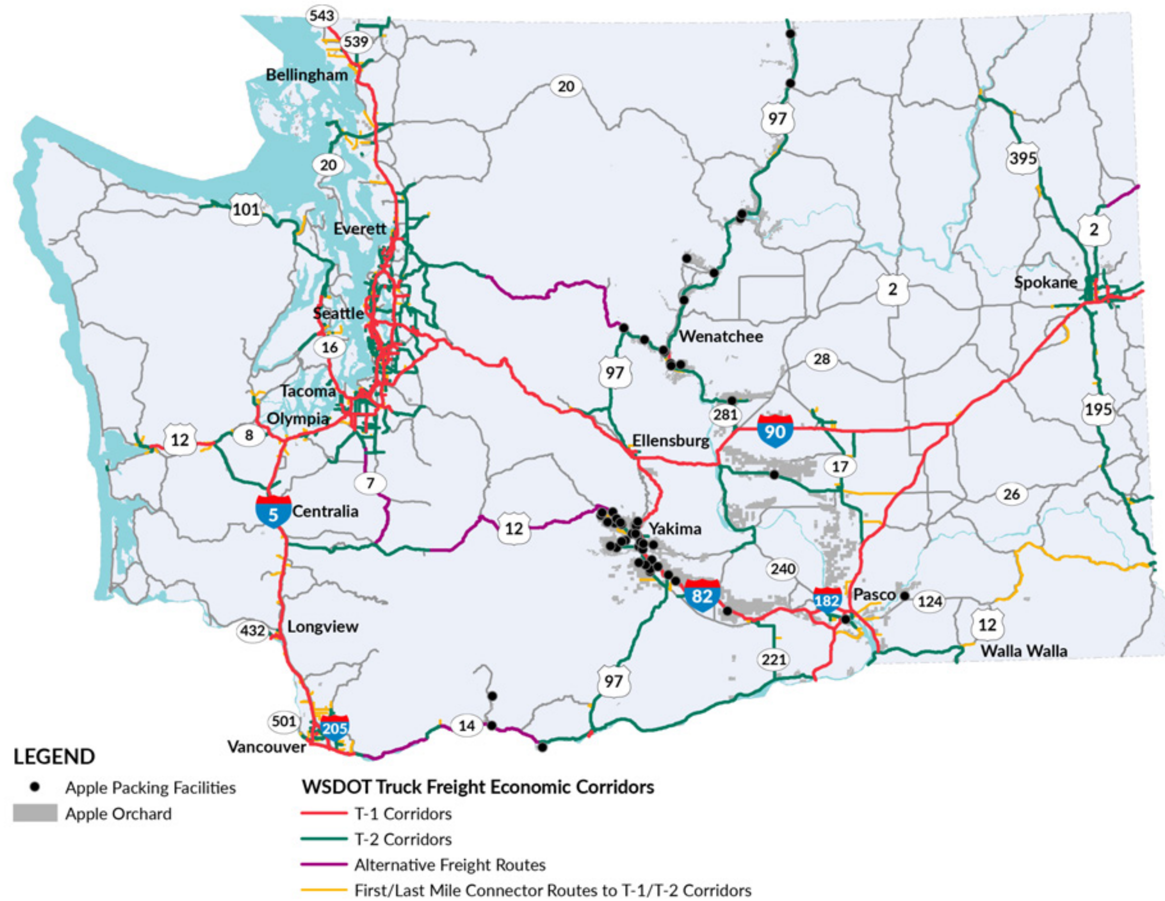
8 While WSDOT operated a total of 4,071 truck counters in the State, the agency reports that 46% of them record truck traffic, while the remaining 54% record total traffic (trucks plus passenger vehicles); for those counters which only record total traffic, truck volumes are estimated as a percent of total traffic using truck percentage counts from previous years.

9 The average weights are based on the truck weight data collected from weigh-in-motion sites in Washington State. For more information, see FGTS technical documentation.

transportation supply chains for major industries in the Washington economy, including agriculture. Using FGTS, WSDOT analyzes the proximity of production zones, relevant processing centers, and key export locations such as the Ports of Seattle-Tacoma and Port of Portland in relation to Truck Freight Economic Corridors. In this way, WSDOT and its local partners gain insight into how the transportation system aligns with key commodities' production areas. The [WSDOT Freight Mobility Plan](https://wsdot.wa.gov/) describes this type of supply chain analysis for several key agriculture exports, tracing the typical routes and modes of travel each commodity utilizes as they move through the process of harvesting, processing, and exporting as well as for consumption throughout the State. Such analysis enables WSDOT to better understand how freight corridors are being used by industry, and identify needs and opportunities for improving these corridors. The Freight System Plan illustrates this analysis and key conclusions for several agricultural commodities including apples (Figure 70), potatoes, milk, and wheat, as well as other key industries like aerospace.

Additionally, WSDOT provides FGTS data to its Metropolitan Planning Organizations, county, and local governments to aid their transportation and freight planning processes. This helps to enhance and standardize freight data and availability across partner organizations, and provides a consistent source of information across the state.

Figure 70: Apple Supply Chain in Relation to WSDOT's 2017 Truck Freight Economic Corridors




*Source: 2017 Washington State Freight System Plan*

# State Grant Programs To Enhance Multimodal Freight Connectivity

## Overview

Many agricultural freight trips are multimodal, including transfers from truck to rail or barge, but funding multimodal infrastructure can be a challenge. State DOTs often have relatively little information about multimodal facilities (typically, privately owned) and their surrounding infrastructure needs. However, agricultural freight shippers often describe delays associated with these locations. To help address this issue, some State DOTs have created local grant programs that use National Highway Freight Program funds apportioned to the State to fund local infrastructure or improvements to multimodal facilities. Iowa DOT's *Linking Iowa's Freight Transportation Systems* (LIFTS) program is a particularly notable example.

The NHFP allows States to use up to 10% of their apportioned funding to finance non-traditional highway and multimodal investments. LIFTS grants enable local agencies and private sector partners to access funds to make improvements to their local freight infrastructure that might otherwise go unfunded. Traditional highway projects such as resurfacing, adding lanes, and restriping are not eligible for LIFTS grants. Those projects are considered through the Value, Condition, and Performance (VCAP) scoring prioritization process and funded with the remaining 90% of Iowa's NHFP funds (see p.104)—ensures the LIFTS grants' focus remains on local and multimodal freight infrastructure projects.

The intent of LIFTS is to improve the multimodal freight connections in the Iowa transportation system and to provide additional transportation options for moving goods throughout the State. As a secondary benefit of the LIFTS program, Iowa DOT is able to learn more about local freight infrastructure needs and identify trends that inform statewide freight planning and project development.

**Implementing Agency**
Iowa Department of Transportation and others

**Focus Area**
Local Freight Infrastructure | Funding

**Local Contact**
Laura Hutzell
Rail Development Manager,
Iowa Department of Transportation
Laura.Hutzell@iowadot.us
515-239-1066

### Notable Practice Highlights

- *Iowa DOT programmed $7.5 million between fiscal years 2016-2019 to improve multimodal connections, construct transloading facilities and rail access points, and improve other freight infrastructure.*
- *LIFTS competitive grant program for local agencies and private sector partners, using National Highway Freight Program funds targets projects that are often ineligible for other funding sources.*
- *Iowa DOT learns more about local freight needs through the grant application process, helping identify trends across the State.*
- *Similar programs in other States provide grants for local highways, multimodal facilities, and target freight performance improvements on local and rural highways.*

*Credit: vitpho via 123rf.com*

## Implementation Approach

Iowa DOT developed the LIFTS grant program in 2016, originally funding it with State Infrastructure Bank funds. After receiving several strong applications in the first year, the agency continued offering the program, annually using a portion of its National Highway Freight Program funds. State DOTs may use up to 10% of their apportioned NHFP funding on non-highway freight investments, including intermodal projects, deployment of truck intelligent transportation systems, freight rail improvements, and projects that "directly impact freight network performance." Iowa DOT uses this 10% to fund the LIFTS program.

Iowa DOT defines eligible applicants for LIFTS to include any "transportation provider, transportation user, city, county, or any other entity with an interest in a freight transportation improvement." The agency strongly encourages joint applications between public and private entities or between two private entities. If a public entity is involved in a project, up to 80% of projects costs are eligible for LIFTS funding; applications from only private sector entities may be funded for up to 50% of the project costs. Funds may be used on private facilities and infrastructure, though these applicants must clearly describe how the investment will positively affect the public and overall freight transportation system.

Projects submitted for consideration are evaluated by Iowa DOT based on five factors:

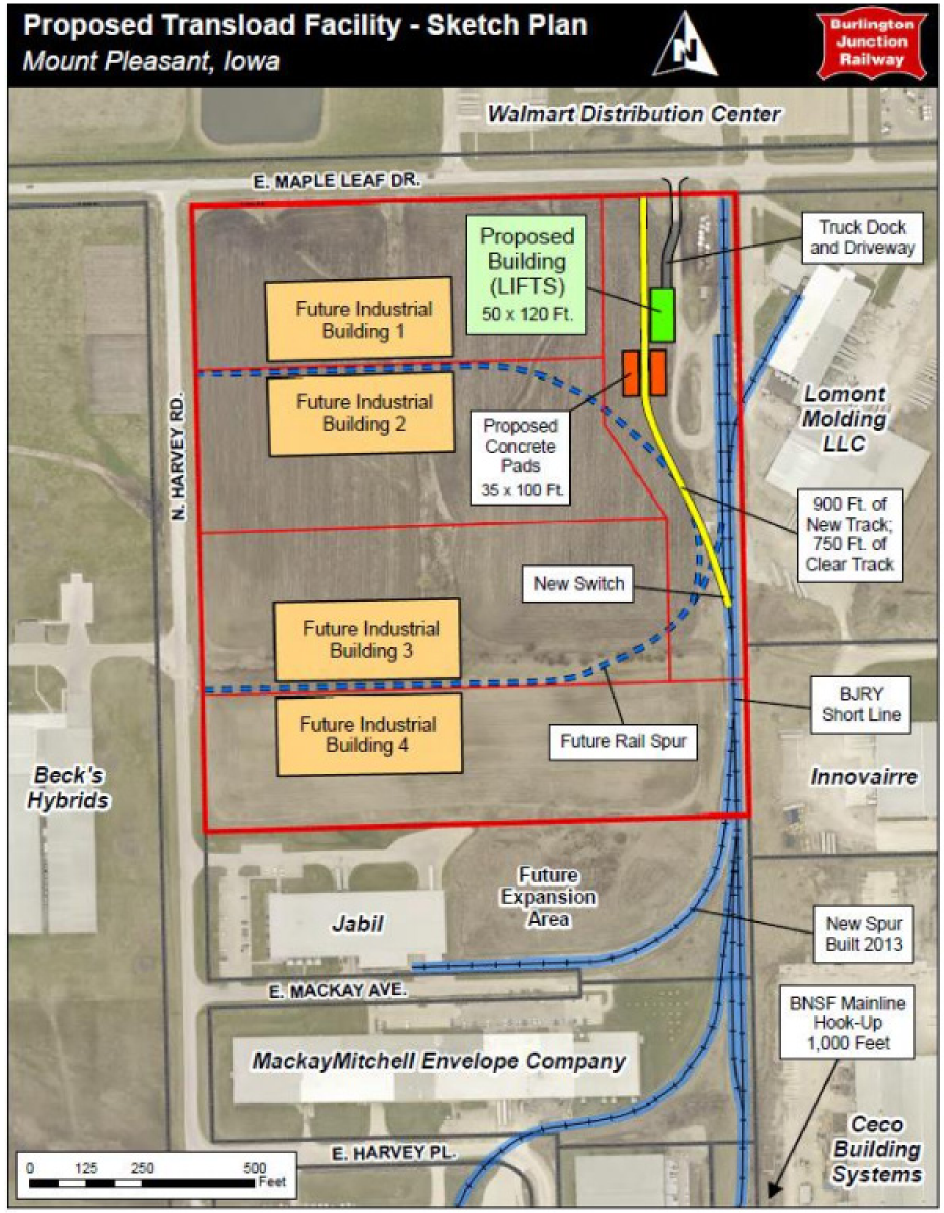
- **Freight Mobility Benefits (25%):** eliminates an impediment to freight mobility, and improves efficiency, reliability, or resiliency of the freight network
- **Economic Benefits (25%):** potential to create or retain jobs, or cost savings to shippers and consumers
- **Public Benefits (20%):** project benefits to other users of the transportation system, including safety, quality of life, or environmental benefits
- **Project Readiness (20%):** evaluation of how prepared the project is to begin and expected project timeline
- **Innovative Approach (10%):** use of new technology, construction methods, or other creative project approaches

## Outcomes and Results

LIFTS grants invested more than $7.5 million in multimodal freight infrastructure between fiscal years 2016-2020. Applications regularly exceed available funding by several million dollars, showing a sustained demand for the grant funds.

Successful applicants so far have used LIFTS grants to construct and preserve sections of rail tracks, and to develop new storage facilities.

Figure 71: Proposed Site Plan of the Burlington Junction Railway's Transloading Facility, Awarded a LIFTS Grant in 2019




Source: Iowa DOT LIFTS awards announcement

These local infrastructure investments have a strong potential to make impacts in the movement of agricultural goods. For example, in 2019 LIFTS awarded funding to the City of Mt. Pleasant in southeastern Iowa to construct a transloading facility connecting the highway network with the Burlington Junction Railway. This project creates a new local truck to rail connection for shippers (Figure 71). Transloading facilities allow bulk freight such as grains to transfer from truck to rail more efficiently, which can result in a lower cost transportation option for longer distance trips.

## Additional State Led Freight Programs

Iowa DOT is not alone in using NHFP funds to create local infrastructure grant programs. While each has its own goals, selection criteria, and funding structures, several State DOTs have recognized the need to fund freight infrastructure at the local levels. Additional examples include:

**Caltrans Trade Corridor Enhancement Program:** Caltrans funds projects designed to move freight more efficiently on corridors with high volumes of freight to enhance the State's economy and support trade. The program's grants fund projects which increase the use of on-dock rail, improve safety by eliminating at-grade rail crossings, reduce impacts to surrounding communities, reduce border wait times, and increase rail capacity with double tracking, as well as other multimodal freight enhancements. The program provides access to $515 million Federal funds and $300 million annually in State funds are available through the grants.

**Minnesota DOT's Highway Freight Program:** This grant program aims to meet the needs of the State's freight transportation system at a more local level with the goal of improving safety, mobility, and first and last mile connections. Unlike Iowa's program, this grant allows for improvements on local roads and highways. Intermodal projects are also eligible.

**Illinois DOT's Competitive Freight Grant Program:** A State program providing up to $225 million dollars over 4 years (fiscal years 2019-22) to local departments of transportation to help implement the strategies and recommendations in the Illinois State Freight Plan in their area. In particular, the State lists projects aimed at reducing truck bottlenecks, improving freight-related safety on the highway, increasing intermodal accessibility to freight corridors, and using technology to enhance efficiency as priorities.

# Prioritizing Freight Projects with Data-Driven Methods and Tools

## Overview

The Iowa Department of Transportation (Iowa DOT) prioritizes statewide highway freight funds using a data-driven process and relatively simple, agency-developed tool. The *Value, Condition, and Performance* (VCAP) *matrix* combines multiple existing freight datasets and models to identify and prioritize areas of the highway network with freight mobility challenges for improvement. Additionally, the process of using the VCAP matrix allows a range of stakeholders to provide input on which projects should be funded based on their local priorities, helping to build consensus for a program of highway freight projects.

Iowa is an intensely agricultural State, so general freight planning is, in effect, also agricultural freight planning. While the VCAP prioritization process does not explicitly include considerations for agricultural freight, the VCAP matrix method is flexible enough that industry-specific data and considerations could be added if desired.

**Implementing Agency**
Iowa Department of Transportation

**Focus Area**
Prioritization | Freight Bottlenecks

**Local Contact**
Samuel Hiscocks
Freight Planning Coordinator,
Iowa Department of Transportation
Samuel.Hiscocks@iowadot.us
515-239-1004

## Notable Practice Highlights

- *Developed a matrix-based tool to measure expected performance and condition benefits of prospective highway freight projects.*
- *Local governments and stakeholders help to determine an initial list of projects for scoring in the matrix tool by completing an annual freight survey.*
- *Iowa DOT uses the matrix's data-driven outputs to prioritize highway freight investments under the National Highway Freight Program.*

# Implementation Approach

The VCAP process starts with identifying locations with freight mobility issues across the State to populate an initial list of potential projects. Iowa DOT identifies bottleneck locations with frequent congestion using both INRIX's Bottleneck Ranking tool and the results of Iowa DOT freight mobility issue surveys to populate a list of candidate locations. Candidate locations must have at least a 30% share of truck traffic or more than 5,000 total trucks per day. Iowa DOT's Freight Advisory Council, Iowa DOT district offices, Metropolitan Planning Organizations (MPOs), and Regional Planning Affiliations (RPAs) are also asked to suggest potential projects based on their knowledge of specific industry needs and local contexts.

After the initial bottlenecks list is created, each project is then evaluated in the VCAP matrix tool (Figure 72). The individual datasets and models described below are used to characterize each project's potential to impact and value to the overall freight system and the highway's current condition and performance:

- **Value:** Leveraging data from the *Iowa Travel Analysis Model* (iTRAM), each project is given a rating based on the expected value it provides toward improving the efficiency of the overall network;
- **Condition:** Based on data from Iowa DOT's *Infrastructure Condition Evaluation* (ICE) *tool*, each project is given a rating based on a composite of seven different physical condition and traffic ratings; and
- **Performance:** Using INRIX's Bottlenecks Ranking tool and data describing annual occurenes of congestion, each project is given a score.

Projects are scored and ranked in each of the three categories, and an overall VCAP score is calculated based on the average of of three subcomponents. The final VCAP score is used to prioritize the overall program of improvements. Truck traffic counts provided by Iowa DOT traffic data are used to break any ties that occur. The prioritized program of freight improvements is then included in the 5 year constrained investment list included in both the Iowa State Freight Plan and the Statewide Transportation Improvement Program (STIP).

# Outcomes and Results

Iowa DOT's first State Freight Plan was released in 2017 and includes a robust overview of the highway network from a freight transportation standpoint. VCAP was used to both identify highway bottlenecks and to develop a fiscally-constrained freight investment plan describing how Iowa will invest its $13-to-$15 million in annual NHFP funding.

District-by-district maps of the VCAP priority projects were developed and used to conduct further stakeholder analysis at the local level. Iowa DOT asked local officials, industry leaders, and members of the public to provide comments on the prioritized projects for their area, leading to additional nuance and understanding for Iowa DOT while implementing the work. This process also helped explain to local stakeholders why Iowa DOT decided to fund certain projects over others and helped create local and regional consensus on the State's planned NHFP-funded investments to improve the freight network.

## Figure 72: Example VCAP matrix

| | | Value | | Condition | | Performance | | | Tie | |
|---|---|---|---|---|---|---|---|---|---|---|
| Map ID | Location | iTRAM | "v" rank | ICE | "c" rank | INRIX | "p" rank | Average ranking | Truck volume | Priority rank |
| 48 | I-80/29 N/S through Council Bluffs | 60.79 | 32 | 52.82 | 2 | 374 | 16 | 16.67 | 13579 | 1* |
| 47 | U.S.151 N/S @ Maquoketa Dr | 53.29 | 38 | 57.36 | 6 | 1040 | 6 | 16.67 | 2115 | 2 |
| 87 | I-74 @ Mississippi River | 90.95 | 23 | 65.53 | 23 | 706 | 9 | 18.33 | 2908 | 3* |
| 57 | I-35/80 N/S, E/W@ Iowa 141 | 49.26 | 43 | 61.17 | 13 | 2036 | 2 | 19.33 | 12761 | 4 |
| 76 | I-380 N/S through Cedar Rapids | 76.37 | 26 | 55.34 | 4 | 123 | 33 | 21.00 | 7226 | 5 |
| 5 | U.S. 30 E/W through Missouri Valley | 21.80 | 58 | 54.31 | 3 | 1563 | 4 | 21.67 | 993 | 6 |
| 79 | I-380 N/S @ I-80/exit 0 and I-80 E/W @ I-380/exit 239 | 146.63 | 10 | 73.35 | 47 | 250 | 24 | 27.00 | 11161 | 7* |
| 15 | I-35 N/S @ U.S. 20/exit 142 and U.S. 20 E/W @ I-35/exit 153 | 114.43 | 17 | 73.91 | 51 | 420 | 14 | 27.33 | 5559 | 8 |
| 55 | I-35/80 N/S @ Douglas Ave | 52.83 | 41 | 59.84 | 11 | 116 | 34 | 28.67 | 12884 | 9 |
| 66 | Iowa 160 E/W @ I-35 and I-35 N/S @ Iowa 160/exit 90 | 108.67 | 18 | 69.29 | 36 | 114 | 35 | 29.67 | 8331 | 10 |
| 11 | U.S. 30 E/W @ U.S. 59/Iowa 141 | 60.33 | 33 | 70.81 | 41 | 387 | 15 | 29.67 | 1377 | 11 |
| 84 | U.S. 61 N/S @ I-80/exit 123 and I-80 E @ U.S. 61/Brady St/exit 295 | 53.65 | 36 | 69.57 | 37 | 368 | 17 | 30.00 | 11230 | 12 |
| 51 | I-80/I-35/I-235 N/S,E/W @ southwest mixmaster | 92.24 | 22 | 73.83 | 50 | 365 | 18 | 30.00 | 6870 | 13 |
| 71 | I-380/U.S. 218 N/S from San Marnan Dr to W Ninth St | 12.87 | 61 | 66.45 | 27 | 1764 | 3 | 30.33 | 2799 | 14 |
| 46 | U.S. 20 E/W@ Iowa 946 | 55.22 | 35 | 58.80 | 8 | 79 | 48 | 30.33 | 2212 | 15 |
| 27 | Iowa 14 N/S from Marshalltown north city limits to Iowa 330 | 11.10 | 63 | 62.08 | 17 | 576 | 12 | 30.67 | 542 | 16 |
| 17 | I-35 N/S @ U.S. 30/exit 111 and U.S. 30 E/W @ I-35/exit 151 | 131.58 | 13 | 77.55 | 61 | 336 | 19 | 31.00 | 7633 | 17 |

* These three high priority locations are included in the freight investment plan in section 9.3, Freight investment plan.

*Source: Iowa DOT Freight Advisory Committee documentation*

# Collaborative Freight Project Identification and Prioritization

## Overview

The St. Louis Regional Freightway (the Freightway) has established a record of fostering strong, results-oriented stakeholder collaboration to prioritize regional freight investments. Working with local industry leaders, elected officials, shipping companies, the Illinois and Missouri economic development agencies, and others, the agency prioritizes and deliver regional freight investments to optimize the efficiency of the St. Louis Metropolitan Area's freight-based economy. The stakeholder engagement model utilized by the Freightway has resulted in significant infrastructure investment—sometimes in unexpected places—and attracted additional State, local, and Federal investment in regional infrastructure.

The Freightway was formed in 2015 as a regional freight district and comprehensive authority for freight operations and opportunities within the eight counties in Illinois and Missouri that comprise the St. Louis metropolitan area. An enterprise of Bi-State Development, a regional economic development corporation, the Freightway's mission is to help the St. Louis region enhance its freight economy through stakeholder collaboration and identifying priority upgrades for regional freight infrastructure.

The region's success in prioritizing and investing in freight is particularly notable for the agricultural freight industry. The St. Louis region is an important regional hub for agricultural commodities, particularly grains and oilseeds trucked from farms across the Midwest and transferred to river barges or railways, many bound for export. This region has the highest level of barge handling capacity for grain anywhere along the Mississippi River.

**Implementing Agency**
St. Louis Regional Freightway

**Focus Area**
Stakeholder Collaboration | Prioritization

**Local Contact**
Mary C. Lamie, P.E.
Executive Director, St. Louis Regional Freightway
MCLamie@TheFreightway.com
314-982-1562

## Notable Practice Highlights

- ***Industry and transportation agency partnership to identify and communicate most important regional freight investment needs.***
- ***Created a list of 20 high-priority freight projects, which has a strong impact on project selection, programming, and grant success.***
- ***Developed collaborative relationships and regional consensus that enables the region to speak with one voice about the importance of freight investments to economic competitiveness.***

# Implementation Approach

One of the Freightway's first efforts as an organization was to develop a prioritized list of freight roads, bridges, and other multimodal infrastructure that most needed investment to enhance the region's freight competitiveness (Figure 73). The agency interviewed local industry leaders, freight carriers, and other private entities in the region, asking them to identify which infrastructure improvements would most directly help them improve their business operations. Ultimately, the Freightway's Freight Development and Needs Analysis Committee, comprised of public and private freight stakeholders representing the region and two States (Missouri and Illinois), developed criteria to analyze prospective projects' ability to lower freight transportation costs and optimize the freight network. The committee uses these criteria to narrow the initial list of 120 projects identified by stakeholders to 20 high-priority projects annually.

The Freightway develops and shares fact sheets to communicate anticipated project outcomes for each of the 20 high-priority projects. These outcomes include benefits to the regional economy, gains in supply chain efficiency, and enhancing the competitiveness of local industries that depend on freight. The fact sheets also describe the way each project satisfies the vetting criteria, possible funding sources and associated match requirements, a proposed project schedule, and testimonials from industry users detailing why the project is necessary. The Freightway shares the fact sheets with the Missouri and Illinois Departments of Transportation, local, regional, and State elected officials, and other stakeholders to foster a greater understanding of freight's contributions to economic development and inform project selection and programming.

Helping the leaders of regional industry communicate their needs to transportation decision-makers fosters a collective awareness of which specific projects would benefit the region's economic competitiveness, and informs a unified vision of the St. Louis region's future economic goals and opportunities related to freight.

# Outcomes and Results

Ultimately, the Freightway was able to develop and build consensus—uniting local and regional governments, Class I railroads, port and barge industries, shippers and other stakeholders in regional freight—around the 20 high-priority projects. Decision-makers from both Illinois and Missouri supported the regional infrastructure priority list on the strength of its unanimous regional approval. The list helped decision-makers understand the regional and national importance of the high-priority projects.

More than $1 billion of public and private funding is being invested in the region's multimodal freight infrastructure. For example, both Missouri and Illinois DOT's multi-year programs include over $500 million for the replacement of the four-lane Chain of Rocks Bridge over the Mississippi River with one that can accommodate six lanes and reconstruct more than 10 miles of Interstate 270. Additionally, the Terminal

Railroad Association (TRRA) of St. Louis is investing $222 million—along with a $21.5 million Federal Railroad Administration Consolidated Rail Infrastructure and Safety Improvements grant—to replace the 129-year old Merchant's Bridge. Spanning the Mississippi River and used by six Class I railroads and Amtrak, the bridge is critical to maintaining the region's economic competitiveness. The Freightway made replacing the bridge its top infrastructure priority, given estimates that the bridge would be out of service in less than 10 years without action. Six additional infrastructure projects in the region collectively received nearly $18.7 million in funding in 2018 through an Illinois DOT statewide program that funds local freight mobility projects, the Illinois Competitive Freight Program.

The Freightway is also forging partnerships with coastal ports to move more goods along the Mississippi River from the Gulf of Mexico to the Midwest using containers on barges and to create a new rail connection to the Port of Savannah. These initiatives seek to meet projected increased freight demand, reduce roadway congestion, and reduce the number of fatal roadway crashes involving trucks. Because the highways in and around the St. Louis region are critical to moving and exporting Midwestern grain, these partnerships and initiatives may provide significant benefits to the agricultural freight industry. The efforts should reduce trucking congestion on routes, as well as expand regional options for exporting agricultural commodities.

Figure 73: Photo of St. Louis and the Mississippi River Showing River, Port, and Rail Freight Activity

*Credit: The St. Louis Regional Freightway*

Finally, the Freightway plans to help encourage regional approaches to collecting and analyzing freight data to better identify supply chain bottlenecks and opportunities to mitigate them. These activities are expected to help the St. Louis Metropolitan Area continue to enhance and expand its role as a freight leader.

# State Freight Advisory Committees

## Overview

At least 35 State Departments of Transportation (State DOTs) convene *Freight Advisory Committees* (FACs). These These groups consist of public and private freight stakeholders, who help their respective State DOTs identify freight needs and prioritize freight projects. FAC members leverage their experience managing local or regional transportation systems or private sector freight shippers, carriers, and consumers. This combination of public and private sector freight knowledge is important for understanding which investments are likely to have the most significant impact on freight performance.

While many States primarily engage their FACs during the development of their State Freight Plan, others ask committee members to take a larger role in the freight planning and project delivery processes. The Texas Department of Transportation (TxDOT) is one such agency (Figure 74). The Texas Freight Advisory Committee (TxFAC) not only provides input during the development of the 2018 Texas Freight Mobility Plan, but members of TxFAC also serve as implementation liaisons for the plan, helping to put specific strategies into action. In this way, TxDOT has made members of TxFAC champions of the plan, helping to broaden and expand partnerships. TxDOT attributes the success of these partnerships to continued and meaningful coordination with both the private industry and their public sector partners.

**Implementing Agency**
Texas Department of Transportation

**Focus Area**
Stakeholder Engagement | Freight Planning

**Local Contact**
Sherry Pifer
Branch Manager, Texas Department of Transportation Freight and International Trade Section
Sherry.Pifer@txdot.gov
512-936-0928

## Notable Practice Highlights

- *Texas DOT hosts a Freight Advisory Committee (FAC) of public and private freight practitioners who advise the agency on freight needs throughout the State.*
- *Examples of FAC roles include advising regional planning initiatives and helping inform statewide freight design guidelines via practical experience.*
- *The FAC brings a wealth of "on-the-ground" freight perspectives that are not captured in common statewide freight data sets and analyses.*
- *TxDOT staff foster the development of the committee by making a conscious effort to involve committee members in decision-making and inviting them to participate in a variety of meetings and events.*

# Implementation Approach

Twenty-four representatives from major trucking companies, rail providers, port authorities, county and regional freight officials, and others from the state's freight industry make up TxFAC's membership. Agricultural interests are included in the committee's roster, including the Texas Farm Bureau.

TxFAC's involvement in the freight planning process is unique relative to other State advisory bodies in that it plays a role in each step of the process. From setting statewide freight goals and strategies, to prioritizing projects, and implementing strategic goals and initiatives, this advisory committee plays a role. During the group's first meeting with TxDOT in 2013, TxFAC worked to determine its own mission, goals, and objectives, including its charge to advise TxDOT on freight issues, projects, priorities, and to help champion freight as an important driver of the Texas economy. Involving members of TxFAC in the development of this founding document helped to create a sense of shared responsibility among the membership. It also set an expectation that the advisory group would be key players in freight decision-making in the State of Texas.

TxDOT also involves TxFAC members in the implementation of the Texas Freight Mobility Plan, asking TxFAC members to serve as liaisons to each of the plan implementation efforts, allowing them to apply their specific knowledge of the freight industry in an advisory role. Examples of these implementation activities include:

- **Developing Freight Infrastructure Design Considerations.** This forthcoming report will assess the current design practices for infrastructure components on the Texas Multimodal Freight Network in relation to freight vehicles. The report will help TxDOT understand whether it should update statewide road and bridge design standard to better accommodate modern freight flows, and to prepare the State for near-term and future technological innovations in goods movements.
- **Completing a Statewide Truck Parking Study.** This study identifies truck parking needs with practical, innovative, and cost-effective strategies developed in coordination with the private sector. These facilities are key for a variety of reasons, including helping truckers meet Federal Hours of Service requirements and reducing fatigue-related crashes. TxDOT staff plans to directly engage TxFAC and other private sector stakeholders to implement the recommendations of the Truck Parking Study.
- **Conducting a Permian Basin Regional Freight and Energy Sector Transportation Plan.** This regional plan, still under development at the time of this report, is an example of

Figure 74: The Texas Freight Advisory Committee Logo

*Credit: Texas Department of Transportation*

an industry-specific freight study. The plan will examine freight activities, opportunities, challenges, and strategies in the energy-rich western Texas region. The large increase in shale production in the Basin has led to a substantial increase in truck volumes in the State. This plan will describe strategies that TxDOT and its local transportation agency partners plan to undertake to ensure the efficient movement of goods through the region.

TxFAC members appointed to serve as liaisons to these efforts reviewed the analysis and draft reports to provide technical feedback and 'on-the-ground' perspectives in each report topic area. Additionally, TxFAC representatives advising each project were able to provide local credibility and connections to additional stakeholders, allowing the work products to better reflect the realities of freight transportation in localities throughout the State.

TxDOT's freight staff engages TxFAC throughout the year about ongoing policy and freight planning matters. Staff convene TxFAC two to four times per year to provide updates on current and upcoming freight initiatives at the State level, and to gather TxFAC feedback to these initiatives. TxDOT staff travelling across the State for freight studies, committee meetings, and other official action alert individual TxFAC members that they will be in the area and often invite them to take part in meetings. This regular interaction helps to foster a strong relationship among the group, and to keep an open line of communication among the State DOT and their local government and private sector partners.

## Outcomes and Results

The relationships TxDOT has forged through TxFAC continue to make an impact on freight project prioritization and decision-making. From TxFAC's members, the State DOT is able to draw valuable observations from the expertise and insights of daily users of the highway freight network that it otherwise might miss. The human and business perspectives brought by its members help TxFAC advise statewide freight planners and create a deeper understanding of the State's freight network. TxDOT believes that its State Freight Plan implementation efforts are of higher quality because of these insights and committee participation.

Through consistent partnership and interaction with TxFAC membership, TxDOT has created a group of private sector and local champions for its freight initiatives. Individual members of the group are knowledgeable about the State DOT's freight goals and decision-making process, and are able to help inform their professional networks and peers about these efforts, helping to build a greater understanding at local and regional levels of freight's role in the transportation system and State economy.

# SECTION 7

# Challenges, Opportunities, and Potential Strategies

# Challenges, Opportunities, and Potential Strategies

Agricultural highway freight is a complex system, influenced by many different factors and stakeholders. As discussed in Section 2, a high-performing highway freight system is a critical part of the economic competitiveness of the agriculture industry. In order to maintain or improve the agricultural highway freight system, many different types of stakeholders, from State DOTs to Federal agencies to private shippers and carriers, must identify existing challenges and opportunities, and act upon them, which often may require working together.

This section synthesizes findings from the research and analysis presented in this report. It outlines several topics that the project team identifies as challenges or opportunities for agricultural highway freight movement, and suggests potential strategies to address them, drawn from case studies, research, and stakeholder feedback.

## The challenges and opportunities discussed in this section include:

**Agricultural Freight Data**

1. Improving Data on Agricultural Freight Movements
2. Understanding and Communicating Seasonal Effects on Demand and Performance
3. Improving and Standardizing Freight Data and Analysis Tools

**Freight Planning and Analysis**

4. Enhancing Corridor Analyses to Identify Agricultural Freight Performance Challenges
5. Accessing Local and Industry Knowledge to Inform Infrastructure Planning
6. Analyzing Performance in the Context of National and International Supply Chains
7. Identifying Redundant Routes to Avoid Disruptions

**Project Identification and Prioritization**

8. Addressing County and Local Infrastructure Condition
9. Optimizing Highway Investment Decision-Making to Benefit Freight Supply Chains
10. Cooperating Across Jurisdictions in Planning and Project Development

Credit: *vitpho via 123rf.com*

## Agricultural Highway Freight Stakeholders and Key Roles

### State DOTs and Local Transportation Agencies

- Plan, build, operate, and maintain major highways
- Program Federal, State, and local funds
- Engage agriculture shippers and carriers in freight planning and project identification
- Cooperate and communicate with each other and other modal stakeholders to address performance of agricultural supply chain

### Federal Agencies

- Support State DOTs and local transportation agencies by administering Federal funding, and providing technical assistance
- Provide research, data, and guidance on agricultural freight planning and analysis methods

### Agriculture Shippers and Carriers

- Participate in highway planning and decision-making processes at Federal, State, and local levels
- Collect and share data about agricultural freight movements to inform infrastructure planning and research
- Contribute to a body of knowledge on agricultural freight practices, issues, and opportunities

# Agricultural Freight Data

Section 4 and Appendix B of this report present detailed data on agricultural highway freight commodity movements and the performance of selected analysis corridors. The project team combined multiple datasets in a novel way to illustrate how highway performance may affect the movement of agricultural commodities at locations along these major corridors. These illustrations may provide transportation agencies with insights help them make improvements in the future. With the exception of the Transearch database, all data sources used in this report are available to State and Federal transportation agencies through existing programs and agreements. Transearch data are proprietary and licenses can be purchased for a fee.

However, the analysis was limited in several ways, including a lack of certain types of data, granularity of data, or challenges in combining datasets needed to analyze agricultural highway freight. Similarly, stakeholders interviewed as part of this research universally identified data challenges as a top issue.

Freight data issues are particularly challenging for State DOTs and local transportation agencies, which often rely on data and modeling to identify performance challenges and prioritize projects competing for limited resources. If freight data or understanding of freight issues is lacking, this may disadvantage freight projects. Freight data issues may not be easily solved because of concerns about sharing proprietary data, or the cost and effort needed to improve data collection or standardization.

The challenges and opportunities discussed in this section include:

1. Improving Data on Agricultural Freight Movements
2. Understanding and Communicating Seasonal Effects on Demand and Performance
3. Improving and Standardizing Freight Data and Analysis Tools

*Credit: vitpho via 123rf.com*

## 1 Improving data on agricultural freight movements

Data describing movements of agriculture freight commodities for lower functional classification roads (e.g., local roads, collectors, rural arterials) are not typically available. Agricultural commodity data are also not granular enough to support local-scale analysis. The most consistently published, highest quality sources report at the county level, with movements modeled based on county-to-county flows, making it impossible to use these sources for county-scale analyses.

Condition and performance data are also not consistently available for all highways necessary to the agriculture industry. For example, the National Performance Management Research Data Set (NPMRDS) dataset covers only the National Highway System (NHS). Lower functional class roadway segments—some of which appear in the High-Volume Domestic Agriculture Highways (HDAH)—are not included in NPMRDS. However, congestion and reliability data may be available from data providers for some non-NHS routes.

Ideally, transportation planners would be able to follow agricultural commodity flow data through a full multimodal journey, but data about intermodal transfers, rail movements, and processing centers are not available in a way that enables this.

These data limitations make it difficult for transportation agencies to identify agricultural highway freight patterns for intra-county movements or for non-NHS highways. If commodities are processed or transferred to another mode within the same county in which they are produced, they do not appear in Transearch or other county-level commodity movement datasets. As a result, key highways used to transport commodities over shorter distances may not be identified in freight planning processes. The lack of performance data for non-NHS routes may lead transportation agencies to overlook important performance challenges that affect agricultural freight. Although stakeholders often mention intermodal transfers as particular pain points, a lack of available data on the performance of these critical junctions makes it difficult to incorporate into freight planning.

## 1 Improving data on agricultural freight movements (continued)

### Strategies:

- State DOTs, local transportation agencies, agricultural shippers and carriers could work together to pilot new ways of collecting and sharing data to capture the full journey from farm to market, with a particular emphasis on the initial journey from the farm to elevators, storage, or other aggregation points.
- If there are concerns about sharing proprietary data with public agencies, Federal agencies, State DOTs, and agricultural shippers and carriers could explore establishing a secure data commons,[10] which would provide access to data for planning and research purposes, but protect these data from unauthorized disclosure or public release.
- State DOTs and local transportation agencies could explore supplementing NPMRDS data with additional data for non-NHS routes or installing equipment to measure truck volumes on farm-to-market routes or highway linkages to intermodal transfer locations.
- Federal agencies can support State and local efforts to improve agricultural freight data with research and technical assistance, and also work to improve national datasets.

10 U.S. DOT Secure Data Commons is an example of this type of system.

## 2 Understanding and communicating seasonal effects on demand and performance

Demand for agricultural freight transportation is seasonal, with the highest volumes for individual commodities often occurring at harvest time or periods of particularly high consumer demand. Agricultural shippers describe peak periods of several weeks for some commodities, during which the majority of a harvest may be shipped. Data about shipments of some agricultural commodities are published on a weekly or monthly basis by USDA and others. However, these data are typically summarized at a State or regional level and not translated into seasonal highway commodity flows.

In addition, many highway planning practices are based primarily on passenger travel patterns, which exhibit less seasonal variation than agricultural freight. State DOTs and local transportation agencies tend to analyze highway performance in terms of annual averages (i.e., average annual daily traffic, average delay). Planning to meet passenger travel demand often considers peak daily commuting periods. However, State DOTs interviewed for this research typically do not plan for seasonal peaks in agricultural freight demand. One reason for this is that commodity flow data about the seasonality of agricultural truck trips are typically not available in formats suitable for transportation planning.

### Strategies:

- Shippers and carriers can work to make information about seasonal peaks in agricultural freight demand more available to State DOTs and local transportation agencies. Working to provide forecasts of expected harvest volumes, likely transportation routes, and peak seasonal timeframes can help inform infrastructure planning and project prioritization.
- Federal and State DOTs and local transportation agencies can work with shippers and carriers to communicate their data needs in order to better consider the seasonal natural of agricultural freight demand in freight planning and modeling.
- Federal agencies can work to improve seasonal data about agricultural freight by coordinating data improvement efforts, promoting notable practices, and providing technical assistance.

## 3 Improving and standardizing freight data and analysis tools

Freight planning methods, data, and tools vary from State to State. One of the U.S. transportation system's greatest strengths is that State DOTs innovate and create customized approaches that meet their needs. However, because agricultural freight is multimodal, and because so much freight crosses State boundaries, this variation can be limiting for national and multi-State analyses.

In many cases, the most important link in an agricultural supply chain may not be in the State where the products are grown, but in neighboring or distant States. However, because State DOTs have varying funding, geospatial network standards, and access to detailed freight data, it is difficult to analyze freight across State boundaries. The more that freight data and analysis methods can be standardized, the more likely that these barriers can be reduced and that freight highway infrastructure projects of the greatest significance can be identified and prioritized.

### Strategies:

- Federal agencies can continue to improve national freight and highway performance datasets with a goal of supporting State and local freight planning.
- Federal agencies could also consider working with State DOTs to encourage greater consistency in how State data are reported and aggregated, such as HPMS highway condition and use data, geospatial network features, and the location and details of planned freight projects.
- State DOTs and local transportation agencies can form bi- or multi-State corridor partnerships that work to standardize freight data and analysis tools across jurisdictions (see *Collaborative Freight Project Identification and Prioritization* case study in Section 6).
- Agriculture shippers could work with data providers to improve the accuracy of agricultural freight data and routing modeling to be more consistent across the country.

# Freight Planning and Analysis

Freight is a relatively new component of transportation planning, and practices continually evolve and improve. Some State DOTs have had freight plans and analysis capabilities for decades, while others completed their first State Freight Plan within the last 5 years. This report highlights several notable practices in freight planning that State DOTs employ, which may be useful as precedents for others to learn from or adopt.

Using a corridor analysis approach that combines agricultural commodity flow data with performance and condition information is one approach to gaining greater insights into agriculture-specific performance and investment priorities. However, data analysis alone may not be sufficient to identify all needs. Engaging local and industry experts in the planning process can also provide valuable insights (both qualitative and quantitative). Furthermore, a better understanding of the national and international multimodal supply chains of agriculture products would help infrastructure planners address pain points in the complex multimodal networks that many agricultural commodities rely on.

Robust freight planning should consider not only current conditions, but a range of possible futures, including possible disruptive events, such as extreme weather, labor disruptions, or shifts in demand for alternate modes. Investing in redundant or alternate freight corridors could make supply chains more resilient to disruptions, ensuring food can continue to reach consumers even during trying times.

The challenges and opportunities discussed in this section include:

4. Enhancing Corridor Analyses to Identify Agricultural Freight Performance Challenges
5. Accessing Local and Industry Knowledge to Inform Infrastructure Planning
6. Analyzing Performance in the Context of National and International Supply Chains
7. Identifying Redundant Routes to Avoid Disruptions

*Credit: vitpho via 123rf.com*

## 4 Enhancing corridor analyses to identify agricultural freight performance challenges

Key to highway freight planning is analyzing agricultural freight movements along highway corridors, the condition of infrastructure, and the performance of corridors. By taking an industry-specific view of how agricultural freight (or even individual commodities) use a corridor, policymakers can gain enhanced understanding to formulate better plans and investment strategies.

This report demonstrates a methodology for identifying corridors important to agricultural freight and analyzing the performance of those corridors in terms of congestion, reliability, and safety, using national datasets. This methodology could be adapted for use at a State or regional scale using the same datasets, or supplemented with local and industry data. In this way, State DOTs and local agencies may be able to better identify performance problem areas that affect agricultural freight, or specific commodities, and projects to address them.

### Strategies:

- State DOTs and local transportation agencies can analyze corridor performance from the perspective of agricultural freight, or individual agriculture commodities
- Shippers and carriers can support corridor analyses by participating in advisory committees and providing local or regional data
- Federal agencies could continue or expand access to national datasets used in corridor analyses and provide technical assistance.

## 5 Accessing local and industry knowledge to inform infrastructure planning

The people who often know the most about what is and is not working in a freight supply chain are those at the local level, either in State DOT district offices, local governments, or shippers and carriers on the ground in a community or region. As described in this report, commodity flow and highway performance datasets provide great insights to inform freight planning, but they do not paint a complete picture.

Local agriculture industry stakeholders can provide information about freight demand, routes, and pain points that may not be available in national or regional datasets. Similarly, local governments and transportation agencies understand best the condition and performance of local roads and bridges. Ensuring that freight infrastructure planning practices incorporate these local and industry voices can help bridge data gaps and identify projects which will have a significant impact on local and regional agriculture highway freight networks (see *State Freight Advisory Committees* case-study in Section 6). One challenge is assessing the adequacy of driver support systems such as truck parking areas, rest rooms and showers, along key routes. State DOTs have taken great strides in making information about parking available. However, including carriers and drivers in corridor planning efforts can provide information about the challenges drivers face and the investments that are most needed.

### Strategies:

- State DOTs and local transportation agencies can include local agriculture industry stakeholders in advisory committees, task forces, corridor studies, and other freight planning efforts.
- Shippers and carriers can supplement State and national datasets with information about the impacts of highway performance issues on their operations and the support systems drivers need to keep agriculture freight moving efficiently and safely.
- Federal agencies can research and highlight effective practices for incorporating local data into freight planning.

# 6 Analyzing performance in the context of national and international supply chains

This report focuses on domestic agricultural highway freight transportation. However, because the market for agriculture is global, and many agricultural freight trips are multimodal, this limited scope cannot capture the full scale of agricultural freight transportation. It is also necessary to consider that many agricultural products are processed prior to consumption or export, but tracking the numerous products that incorporate agricultural commodities is beyond the scope of this study.

To gain a more complete understanding of agricultural freight performance and infrastructure needs, a multimodal approach that considers the full supply chain would be beneficial. Some State DOTs have developed supply chain maps for key agricultural commodities in their State. Efforts to expand these analyses at a multi-State or national scale, and incorporating important processed commodities could provide a more complete picture of where infrastructure investments will have the greatest impact.

## Strategies:

- Federal agencies could work with State DOTs, shippers, carriers, exporters, and agriculture shippers and processers to develop more complete maps of agriculture supply chains for key commodities at a multi-State or national scale.
- Federal agencies could support research and data analysis into agriculture supply chains that would provide useful transportation planning value to State DOTs and local transportation agencies.
- State DOTs and local transportation agencies could participate in efforts to improve information about agriculture supply chains, providing data and local knowledge.
- Agriculture shippers, carriers, and exporters would play a role in helping identify how agriculture commodities move across multiple modes, where they are stored and processed, and which processed products are most commonly developed from them.

## 7 Identifying redundant routes to avoid disruptions

Disruptions to freight transportation systems have economic and societal consequences. If farmers cannot deliver their products to market in a timely and cost-efficient manner, not only do profits suffer, but consumers may experience higher prices or shortages. Disruptions may take many forms, such as major events like the flooding in many Midwestern States in 2019 (which destroyed crops), and the Covid-19 public health emergency in 2020 (which disrupted supply chains), and more routine events like bridge closures and major highway construction.

To ensure that important commodities such as agriculture can continue to move during times of disruption, freight planning should consider not only the current dominant freight flows, but also redundant or alternate routes, which will result in a more resilient freight network. Some States which commonly experience extreme weather events are already including network resiliency in their State Freight Plans (see *Advanced Freight Networks and Data Systems* case-study in Section 6).

### Strategies:

- State DOTs and local transportation agencies can identify redundant or alternate routes that might be needed to keep agricultural freight moving during times of disruption and consider these impacts in project prioritization processes.
- State DOTs and local transportation agencies can work with carriers to explore the potential of new rail or waterway connections that could increase destinations accessible by non-highway modes during emergencies.
- Agriculture shippers and carriers might provide insights into how commodities were moved during past disruptions, and the performance of alternate routes or modes for the industry.
- Federal agencies can encourage and support the use of scenario planning to identify potential disruptions and possible industry responses, which may inform freight planning and project development activities.

# Project Identification and Prioritization

Ultimately, to maintain and improve the performance of highways for agricultural freight, projects must be identified, programmed, and constructed. State DOTs and local transportation agencies face many competing interests when deciding which projects to pursue. Every industry relies on highways for freight transportation, and transportation agencies must balance freight needs with the needs of passengers, working within significant funding constraints. There are always urgent needs to be addressed and usually not enough resources to advance all worthy projects.

State DOTs and local transportation agencies use a variety of methods to balance competing stakeholder needs with funding eligibility criteria and State and local laws to determine which projects they will pursue. However, because all highways are connected, and because agricultural freight travels throughout the country, all project decisions are likely affect freight performance just as they affect impact passenger travel. Optimizing highway project investments to best balance the needs of all stakeholders is difficult.

Another barrier is that many States divide jurisdiction over highways, funding, and responsibility for developing projects and programming funds. Jurisdiction is split between the State DOT and numerous local governments based on functional classification or other factors. Because agricultural freight relies on major and minor highways in both rural and urban areas, many State and local agencies must coordinate to meet the needs of agriculture shippers. This system creates a complicated landscape, where shippers may not understand which agency has authority over which roads, or is responsible for planning and developing projects. The potential geographic mismatch of shippers and State DOTs and local transportation agencies should also be considered. For example, it is not uncommon for shippers to be located in a different county or State than the agency responsible for the section of highway that most affects their shipments.

The challenges and opportunities discussed in this section include:

8. Addressing County and Local Infrastructure Condition
9. Optimizing Highway Investment Decision-Making to Benefit Freight Supply Chains
10. Cooperating Across Jurisdictions in Planning and Project Development

*Credit: vitpho via 123rf.com*

## 8 Addressing county and local infrastructure condition

Agriculture industry stakeholders often stress that the condition of rural roads and bridges is a challenge for the industry. Anecdotes describe bridge closures and weight restrictions generating long detours and hampering transportation of farm products to markets. In most States, the maintenance and repair of local roads, collectors, and some arterials is the responsibility of county governments and local municipalities. State funding formulas may not recognize the important role these facilities play in providing farm to market transportation. Although data are not consistently available to enable a direct comparison, lower volume rural roads may suffer from a lack of investment to modernize them in ways that account for today's farming and freight practices. Some States have invested significant time and resources into studying and improving their rural freight networks (see *Cross-Department Coordination for Improved Agricultural Freight Infrastructure* case study in Section 6), but the challenge remains in most States.

The National Highway Freight Program (NHFP) provides a dedicated funding source to State DOTs for projects that address freight needs. Some States have used flexibility in the NHFP to fund worthy projects at the local level, or to fund improvements to intermodal connections, or highway facilities that are not part of the system the State DOT is responsible for (sometimes called "off system" facilities). Many county and local roads are not eligible for NHFP funds because of project eligibility requirements which require that they be part of the National Highway Freight Network, or because State-level rules designate local governments as responsible for this infrastructure and expect local funding to pay for their maintenance.

### Strategies:

- ▶ Local transportation agencies could document the rehabilitation and modernization needs of roads and bridges in their jurisdictions that support agricultural freight and communicate their importance to funding decision-makers.
- ▶ Agricultural freight shippers can help communicate the impacts of bridge closures, poor roadway conditions, obsolete designs, or inadequate roadway capacity on their operations and shipping costs, to transportation agencies.
- ▶ State DOTs can consider using flexibility in Federal and State funding to support rehabilitation and modernization of "off system" highways that serve important functions in the supply chains for agricultural commodities.
- ▶ Federal agencies can help clarify eligibility of Federal funds to support infrastructure planning and investment in local and rural highways and bridges that provide access to agricultural areas.

## 9 Optimizing highway investment decision-making to benefit freight supply chains

Highway Economic Requirements System (HERS)[11]modeling presented in this report suggests that the State Freight Plans (as of December 2019) collectively would yield benefits – including avoided crashes, travel time savings, and vehicle operating cost savings – that exceed the costs of the investments by a ratio of greater than 2:1. Benefits to trucking specifically were estimated at $540 million per year. Findings from the HERS analysis also suggested that the then-current set of State Freight Plans may over-invest in projects that enhance capacity (particularly for Interstates) as compared with rehabilitating or improving the condition of highways (particularly for non-Interstates). However, the complexity of the highway system makes this difficult to say with certainty, as the HERS model does not capture network effects and is unable to model some project types (e.g., interchanges, intelligent transportation systems).

Additional research and modeling to identify optimal project types for network-scale freight investment could help State DOTs and local transportation agencies target more efficient projects from a freight performance perspective. However, agricultural freight needs would still need to be balanced with needs of other highway users.

Benefits-cost analysis (BCA) is a powerful tool for informing project selection and other investment decisions. For State DOTs, BCA can be employed to ensure that scarce highway funding is targeted to the projects that will yield the greatest return on investment in terms of improved safety, reduced delay, and other benefits. However, BCA is typically resource-intensive, requiring detailed data on traffic volumes, travel speeds, safety outcomes, and other input parameters, along with modeling techniques to forecast project-level impacts on these variables against a baseline. Staffing and expertise is also required to develop appropriate monetization factors and to run and interpret the BCA model. Most State DOTs do not routinely employ BCA as a standard part of project prioritization, in part due to the resource demands noted above, and in part because of a preference for other prioritization methods (Federal Highway Administration (FHWA), 2016).

Freight-related projects may present additional challenges for BCA, as fully quantifying their impacts can require data on freight flows that are proprietary or difficult to obtain. Travel time reliability benefits, which are a key impact for many freight-related projects, can also be more difficult to quantify and monetize, although there is much ongoing research in this area. Agricultural freight impacts, in particular, may be influenced by strong but short-lived seasonal peaks that are not represented in the available data, such that BCA would tend to underestimate those benefits. Some States lean on local knowledge of freight systems to make targeted improvements to the network (see *State Grant Programs to Enhance*

11 Appendix C includes more details about the HERS model.

# 9 Optimizing highway investment decision making to benefit freight supply chains (continued)

*Multimodal Freight Connectivity* and *Prioritizing Freight Projects with Data-Driven Methods and Tools* case studies in Section 6), but the challenges of quantifying agriculture- or other industry-specific benefits across the entire system remain.

This report represents a first step in addressing data gaps that affect the ability to include agricultural freight impacts in BCA, by providing information on agricultural product flows in major corridors alongside reliability and other performance information. Additional research and data collection on topics such as seasonal peaks, perishability, and reliability benefits would help state DOTs expand their BCAs to include impacts on agricultural freight.

## Strategies:

- State DOTs and local transportation agencies can consider training staff in the use of modeling tools and BCA to inform project prioritization in State Freight Plans, and to optimize their investment mix across project types and functional classes. In some cases, this may mean greater investment in pavement preservation over capacity expansion, or non-Interstate projects over Interstate projects.

- Federal agencies could research potential enhancements to BCA modeling capabilities related to freight projects, including accounting for seasonal peaks in agricultural freight demand, and methods for incorporating agricultural commodity flow data into BCA.

- Federal agencies could work with State DOTs to improve the project details included in State Freight Plans, Statewide Transportation Improvement Programs, and other transportation planning and programming documents, to enable more accurate modeling of the benefits of highway freight projects.

- Federal agencies and State DOTs could work together to assess the relevance of various BCA techniques to freight planning and project prioritization, as well as identify technical assistance needed to better employ BCA.Agricultural freight does not stop

## 10 Cooperating across jurisdictions in planning and project development

at State or municipal boundaries, but funding and decision-making authority usually does. When transportation agencies work together to analyze freight movements, share data, and develop joint priorities, they can more clearly communicate needs and focus on the projects of greatest significance. Increased cooperation in project identification and prioritization, in a region, or along a corridor, can help improve performance for commodities that travel through multiple jurisdictions, like agricultural freight often does (see *Collaborative Freight Project Identification and Prioritization* case study in Section 6). The analysis presented in this report could provide a starting point for State, multi-State, or regional freight corridor analyses or freight plans with an agriculture focus.

### Strategies:

- State DOTs and local transportation agencies, with agriculture shippers, carriers, and processors can form regional or corridor-level coalitions, task forces, or associations to focus on agricultural freight needs, then identify priority infrastructure projects that will most benefit agricultural supply chains.
- Metropolitan planning organizations, particularly those that include areas of more than one State, may be uniquely well-suited to organize regional freight planning efforts.
- Federal agencies may support cross-jurisdictional planning efforts by serving as a convener or organizer and providing case-study examples of successful planning efforts in other regions.[12]

12 The FHWA Megaregion Workshops and Regional Models of Cooperation initiative provide examples of cross-jurisdictional planning by State DOTs and metropolitan planning organizations.

# SECTION 8

## Conclusion

# Conclusion

The efficient movement of agricultural commodities is vital to the continued health, prosperity, and economy of the United States. The valuable role of highways in supporting agriculture was clear in the early 20th century and was a driving force behind the creation of what became a national effort to build roads that connect farmers to markets. Highways are even more integral to agriculture today. Agriculture represents the largest share of freight movements on our Nation's highways and the agriculture industry relies on the efficient movement of agricultural commodities that our excellent highway system provides. Highways play a role in almost all agricultural freight trips and often serve the critical first and last miles of multimodal trips, which may also include rail and waterways. The highway mode accounts for the majority of ton-miles traveled by agricultural commodities.

The condition and performance of highway infrastructure affect the agriculture industry in many ways. Congestion causes delay and adds costs to truck trips. Longer trips result in higher wage and fuel costs. The condition of infrastructure is important as well; poor pavement condition increases wear and tear on trucks and raises overall operating costs for carriers. These costs are typically passed along to shippers and may increase food costs for consumers. The Nation's transportation system has historically been a competitive advantage for the U.S. agriculture industry. However, competition from foreign producers, fueled in part by increased investment in transportation systems in those countries, has poorly positioned U.S. agriculture to absorb higher transportation costs. Maintaining the highways and other modes that support U.S. agriculture is critical for keeping costs low and staying competitive internationally.

Agriculture shippers and carriers use highways throughout the country to meet their transportation needs, but some highways carry much higher volumes of agricultural freight than others. The analysis of agricultural commodity flows in this report reveals that 80% of domestic agricultural commodities travel on as little as 17% of the highway mileage. These "High-Volume Domestic Agriculture Highways" are of particular value to U.S. farmers and the agriculture industry. This report also uses novel analysis techniques to examine the performance of selected high-volume corridors, showing how highway condition and performance overlap with agricultural commodity movements. This research provides a potential starting point for State and regional-scale analyses focused on domestic agricultural freight, and gives a sense for where improvements to highway performance may have the greatest impacts on the agriculture industry. The report also provides a methodology State Departments of Transportation and local transportation agencies can use as a starting point for detailed, agriculture-specific corridor analyses of their own.

Highway freight planning is still a relatively young discipline in the United States, but State Departments of Transportation are increasingly investing in detailed freight plans and programming funds for highway freight projects. This report analyzes the projects included in State Freight Plans as of December 2019. Findings show State Departments of Transportation planned to invest nearly $28 billion in highway freight infrastructure projects between 2016 and 2020. 24% of these projects are located on the highways carrying the highest volumes of agricultural freight. Using the Federal Highway Administration's Highway Economic Requirements System (HERS) model, the project team estimated that these types of projects would generate $540 million in annual truck operating cost savings. HERS modeling at investment levels two or four times the level planned in the State Freight Plans estimates that benefit-cost ratios would decline only slightly, suggesting many worthy projects that could benefit freight transportation exist if funding were to increase. While the benefits estimated by the HERS modeling would apply to all freight, domestic agricultural freight would likely experience strong benefits, because agriculture is the largest user of highway freight.

This report demonstrates the potential for industry-specific freight analysis to help identify worthwhile projects and to inform freight planning. As State Departments of Transportation and local transportation agencies move forward with updated freight plans, corridor studies, and project development, this report can support an increased emphasis on agricultural freight. The report provides six case-study examples from State Departments of Transportation and regional freight planning organizations that have developed notable practices in freight planning and programming that benefit agricultural freight. These examples may provide models for others to consider or adapt to their own context.

As the U.S. population continues to grow and our economy continues to evolve, freight volumes are also forecasted to grow by nearly 25% over the next 20 years. Continued investment in highways supporting the movement of agricultural freight during this period of growth will be critical. Also critical will be improving information about how agricultural highway freight interfaces with rail and inland waterway modes. This report provides a piece of a larger puzzle toward understanding the complex multimodal system that moves agricultural commodities across the country. Partnerships are the most solid answer for continuing to build this understanding and best positioning the Nation to meet the challenge of rising highway freight volumes, without sacrificing performance. Agricultural freight shippers and carriers can work with State Departments of Transportation, local transportation agencies, and Federal agency partners to improve data access, understand supply chains, identify redundant routes, and find projects that will have the biggest impact on performance.

*Credit: Tyler Olson via 123rf.com*

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