TECHNICAL MEMO: ITTS BOTTLENECKS FINDINGS AND METHODOLOGY

ITTS Regional Bottlenecks Assessment for Goods Movement

(Client Ref: CPCS-ITTS 2019-02)

Prepared for:

Institute for Trade and Transportation Studies

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ITTS Regional Bottlenecks Assessment for Goods Movement (Work Order 2)

As part of a five-year Master Contract for ITTS on freight research, data, planning and engagement, the CPCS Team is assessing truck bottlenecks across the Southeast Region and developing a GIS planning tool for information sharing and to facilitate multi-state collaboration.

Technical Memo 1

This Technical Memo documents the findings of the ITTS regional bottlenecks assessment across the Southeast Region and the methodologies used.

Acknowledgements

The CPCS Team acknowledges and is thankful for the input of ITTS member states consulted through interviews, as well as the guidance and input of the ITTS Regional Bottlenecks Study Steering Committee and the Technical Advisory Committee.

Opinions and limitations

Unless otherwise indicated, the opinions herein are those of the authors and do not necessarily reflect the views of ITTS or any other member states consulted in the development of this memo.

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Acronyms / Abbreviations

Acronym	Definition
AADT	Average Annual Daily Traffic
ALDOT	Alabama Department of Transportation
AM	Morning
ARDOT	Arkansas Department of Transportation
ATCMTD	Advanced Transportation and Congestion Management Technologies Deployment Program
ATRI	American Transportation Research Institute
AV	Automated Vehicle
BNSF	Burlington-Norfolk Santa-Fe
BTI	Buffer Time Index
CCS	Continuous Count Station
CMV	Commercial Motor Vehicle
CoSS	Corridors of Statewide Significance
CSX	CSX Transportation
CV	Connected Vehicle
DHL	DHL Express
DOT	Department of Transportation
DTDPM	Daily Total Delay Per Mile
EPA	Environmental Protection Agency
EVE	Evaluation of Roadway Efficiency
FAF	Freight Analysis Framework
FAST	Fixing America's Surface Transportation Act
FDOT	Florida Department of Transportation
FHWA	Federal Highway Administration
GDOT	Georgia Department of Transportation
GIS	Geographic Information Systems
GPS	Global Positioning System
HERO	Highway Emergency Response Operator
HPMS	Highway Performance Management System
INRIX	INRIX, Inc.
ITS	Information Technology System
ITTS	Institute for Trade and Transportation Studies
KCS	Kansas City Southern
KYTC	Kentucky Transportation Cabinet
LA DOTD	Louisiana Department of Transportation and Development
LOS	Level of Service

LOTTR	Level of Travel Time Reliability
MDOT	Mississippi Department of Transportation
MoDOT	Missouri Department of Transportation
MOVES	Motor Vehicle Emission Simulator
MPH	Miles Per Hour
MPO	Metropolitan Planning Organization
NCDOT	North Carolina Department of Transportation
NCHRP	National Cooperative Highway Research Program
NHS	National Highway System
NPMRDS	National Performance Management Research Data Set
NS	Norfolk Southern
PM	Afternoon
PTI	Planning Time Index
RITIS	Regional Integrated Transportation Information System
SCDOT	South Carolina Department of Transportation
STRAHNET	Strategic Highway Network
TAC	Technical Advisory Committee
TCI	Texas Congestion Index
TDOT	Tennessee Department of Transportation
TMC	Traffic Message Channel
TPIMS	Truck Parking Information Management System
TSMO	Transportation System Management and Operations
TTI	Texas A&M Transportation Institute
TTI	Travel Time Index
TTTR	Truck Travel Time Reliability
TxDOT	Texas Department of Transportation
UPRR	Union Pacific Railroad
UPS	United Parcel Service
USDOT	US Department of Transportation
USMCA	US-Mexico-Canada Agreement
V/C	Volume/Capacity
VDOT	Virginia Department of Transportation
VHD/M	Vehicle Hours of Delay per Mile
VHU/M	Vehicle Hours of Unreliability per Mile
VMT	Vehicle-Miles Traveled
WIM	Weigh-in-Motion

Executive Summary

About ITTS:

The Institute for Trade and Transportation Studies (ITTS) is a non-profit state corporation. As a multi-state coalition and pooled fund, the ITTS is funded by the U.S. Department of Transportation Federal Highway Administration (FHWA) and ITTS member state Departments of Transportation. The current ITTS state membership consists of the State DOTs from the following states: Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, Missouri, South Carolina, Texas, and Virginia. The ITTS fosters regional collaboration among its Members and leads freight planning in the Southeast by: providing research and information concerning freight trends and freight planning; developing effective freight planning tools and procedures; and partnering with and nurturing collaborative relationships with relevant organizations and stakeholders.

Purpose of the Study:

ITTS is conducting a regional bottleneck assessment to facilitate goods movement across the Southeast Region. The study covers 2019 bottlenecks in the **Southeast Region**, defined as Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, Missouri, North Carolina, South Carolina, Tennessee, Texas, and Virginia.

The ITTS Regional Bottlenecks Assessment for Goods Movement Study assesses the extent, duration, and severity of truck bottlenecks in the Southeast to facilitate multi-state collaboration on potential recommendations that can be undertaken to reduce top bottlenecks.

Overall Methodology:

The study assessed all truck speed data across the National Highway System (NHS) using NPMRDS 2019 and truck count data from HPMS 2019 data as primary data sources. In coordination with ITTS, the Project Team elected on 2019 was the year of analysis to provide a regional overview of truck bottlenecks without disruptions from the COVID-19 pandemic. The analysis contains two main components: segment-based bottleneck analysis and trip-based bottleneck analysis. The segment-based bottleneck analysis provides a common platform for studying top bottlenecks in the Southeast and the trip-based bottleneck analysis shows how bottlenecks in a certain state affect multi-state economic competitiveness. Both types of analysis exemplify the need for multi-state coordination to address top regional bottlenecks.

The ITTS study calculated the following performance measures: average truck speeds, truck travel time reliability index, truck delay per mile, annual hours of truck delay, and annual cost of truck delay. Congestion was measured in three ways: by state, by interstate, and by roadways aggregated at a county level, while bottlenecks were ranked based on truck delay per mile, total hours of truck delay, and cost of truck delay. For more information on methodology, please see Chapter 3.

ITTS Regional Bottlenecks Findings:

In 2019, the Southeast Region experienced **271 million hours** of total truck delay, amounting to **470 million gallons** in wasted truck fuel and **$18 billion** in direct costs.

All Southeast states experience bottlenecks on the National Highway System. Among the thirteen states, Georgia, Tennessee, and Louisiana experienced the highest average truck delay per mile in 2019 – amounting to over 2,000 average hours of truck delay per mile (Figure 1 and Figure 2).

Figure 1: Southeast States – Average NHS Truck Delay per Mile (Map, 2019)

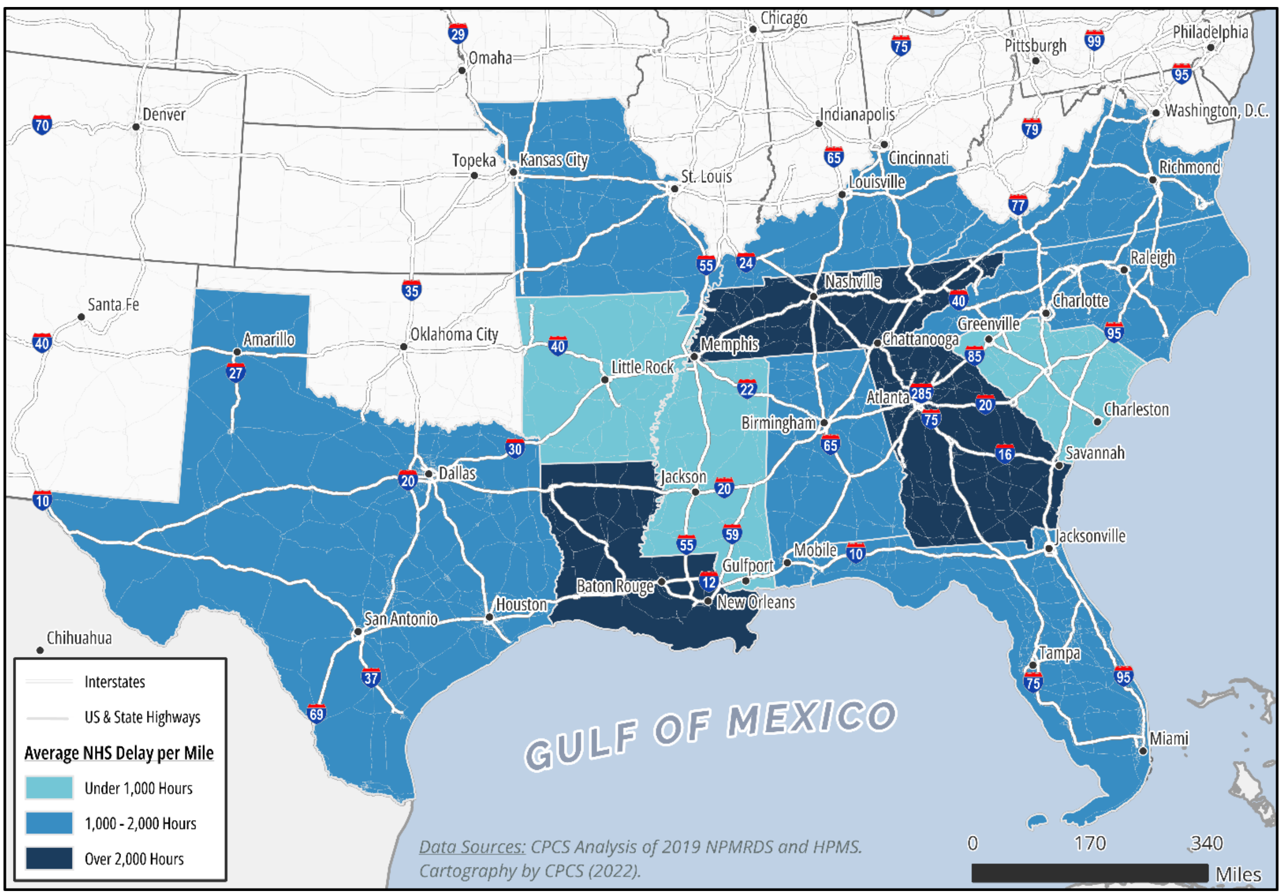


Figure 2: Southeast States – Average NHS Truck Delay per Mile (Table, 2019)

State	Average Annual Daily Traffic Trucks	Truck Delay per Mile (Hours)	Average Truck Travel Time Reliability	Total Truck Delay (Hours)	Cost of Truck Delay (Billions of 2019 Dollars)	Truck Fuel Wasted (Million Gallons)
Georgia	3,874	4,253	1.7	59,922,593.5	$4.0	100.3
Louisiana	1,882	2,209	1.6	13,124,910.0	$0.9	25.3
Tennessee	2,038	2,064	1.7	21,426,687.5	$1.4	42.2
Florida	1,709	1,988	1.9	34,644,055.7	$2.3	65.1
Texas	1,737	1,795	1.7	64,134,756.0	$4.2	101.3
Virginia	1,461	1,454	1.8	13,077,246.3	$0.9	23.4
Missouri	1,735	1,334	1.6	15,089,107.2	$1.0	23.4
Kentucky	1,776	1,279	1.5	8,336,040.0	$0.6	14.2
North Carolina	1,278	1,234	1.7	13,683,305.5	$0.9	24.5
Alabama	1,530	1,082	1.5	9,182,192.8	$0.6	17.1
South Carolina	798	893	1.6	6,179,452.3	$0.4	13.1
Arkansas	1,677	839	1.4	5,540,867.2	$0.4	9.4
Mississippi	1,177	828	1.5	6,359,944.7	$0.4	10.2
Southeast Region	1,825	1,791	1.6	270,701,158.7	$18.0	469.6

Source: CPCS Analysis of 2019 NPMRDS and HPMS Data in the Southeast Region

Freight congestion in the Southeast Region affects economic competitiveness, reduces safety, deteriorates roadway assets more quickly, contributes to air pollution and carbon emissions, and impacts the quality of life for over a third of the U.S. population.

The following pages highlight the top congested interstates, segments by county, and trade lanes.

Top Congested Interstates

The top five congested interstates by truck delay per mile are beltways or auxiliary routes: I-285, I-516, I-610, I-270, and I-670 due to the concentrated congestion levels on these relatively shorter corridors (Figure 3 and Figure 4). When measured by total hours and cost of truck delay, the top five congested interstates are I-75, I-285, I-85, I-10, and I-95 due to both high truck volumes and delay.

Figure 3: Southeast States - Top 20 Congested Interstates by Truck Delay per Mile (Map, 2019)

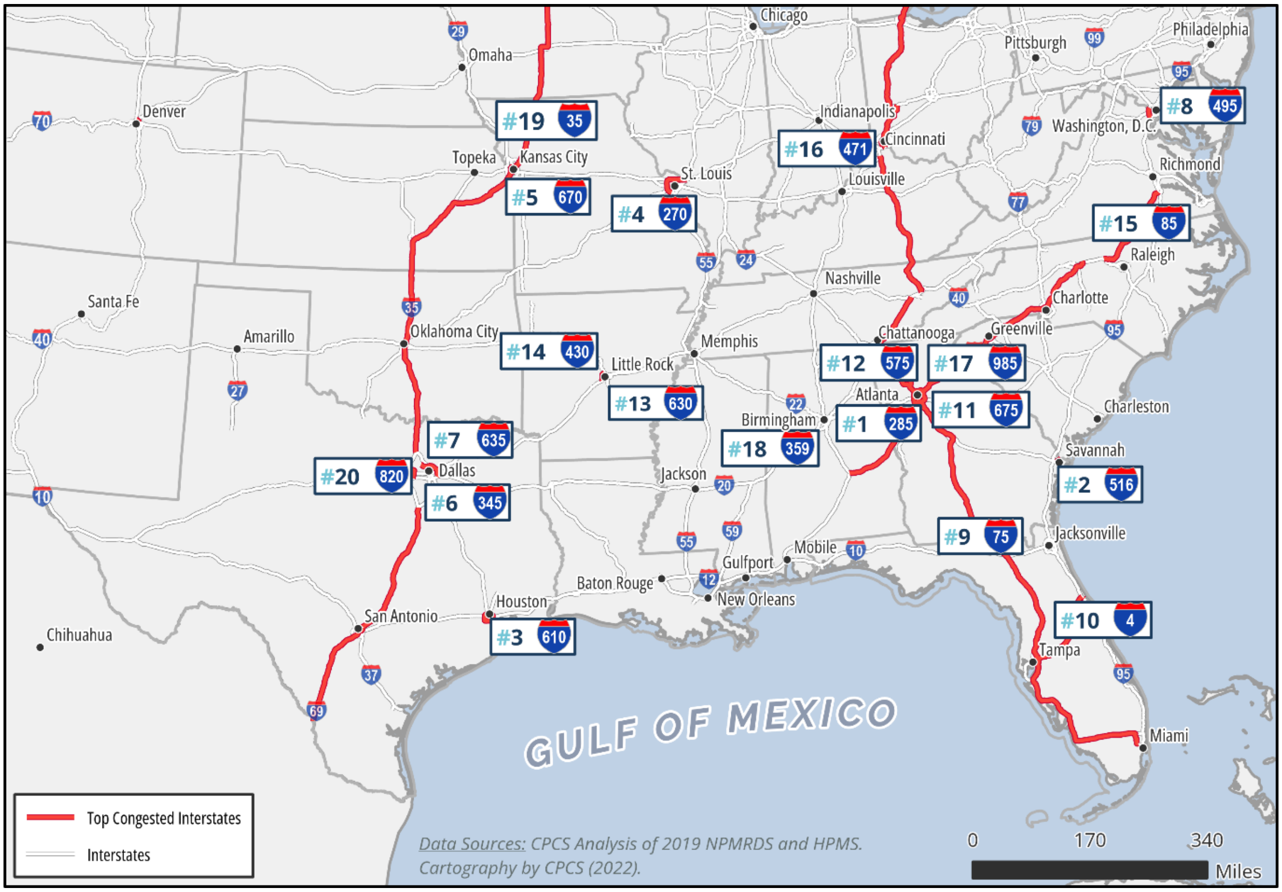


Figure 4: Southeast States - Top 20 Congested Interstates by Truck Delay per Mile (Map, 2019)

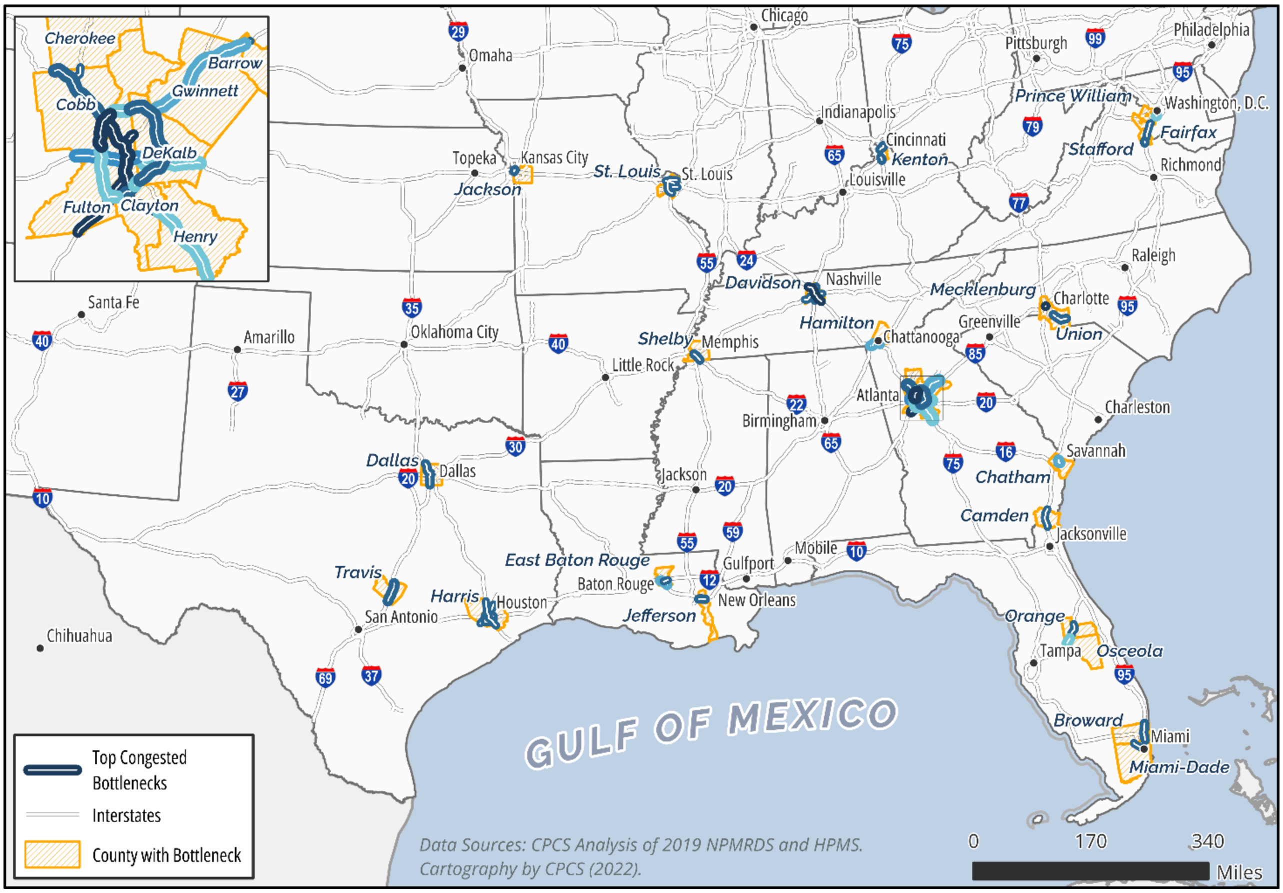
Rank	Interstate	Associated SE States	Truck Delay per Mile (Hours)
1	Interstate-285	GA	82,694
2	Interstate-516	GA	24,538
3	Interstate-610	TX	16,635
4	Interstate-270	MO	14,186
5	Interstate-670	KS, MO	13,527
6	Interstate-345	TX	12,820
7	Interstate-635	TX	11,064
8	Interstate-495	VA	9,636
9	Interstate-75	KY, TN, GA, and FL	8,826
10	Interstate-4	FL	7,999
11	Interstate-675	GA	7,985
12	Interstate-575	GA	7,856
13	Interstate-630	AR	7,391
14	Interstate-430	AR	7,245
15	Interstate-85	VA, NC, SC, GA, and AL	7,150
16	Interstate-471	KY	6,641
17	Interstate-985	GA	5,834
18	Interstate-359	AL	5,451
19	Interstate-35	TX and MO	5,258
20	Interstate-820	TX	5,234

Top Bottleneck Segments by County

The top 50 bottlenecks are distributed across the Southeast and concentrated in Georgia (20), followed by Texas, Virginia, Tennessee, and Missouri each with 5 bottlenecks, Florida (4), Louisiana (3), and Kentucky (1) by truck delay per mile.

The Atlanta metropolitan region sits at the intersection of multiple major Southeast interstates (I-20, I-75, and I-85) and is a major bottleneck location across the Southeast (Figure 5 and Figure 6).

Figure 5: Southeast States – Top 50 Bottleneck Segments by County (Map, 2019)



Note: The interactive map on the ITTS Bottleneck GIS tool allows users to zoom into individual bottlenecks illustrated in the above map.

Figure 6: Southeast States – Top 50 Bottleneck Segments by County (Table, 2019)

Rank	Road	County	State	Delay per Mile (Hours)
1	Interstate-75	Fulton	GA	224,023
2	Interstate-285	Cobb	GA	113,909
3	Interstate-285	Dekalb	GA	106,564
4	Interstate-75	Cobb	GA	99,077
5	Interstate-20	Fulton	GA	77,951
6	Interstate-20	Cobb	GA	69,994
7	Interstate-85	Gwinnett	GA	69,381
8	U.S.-19	Fulton	GA	60,768
9	Interstate-285	Fulton	GA	59,116
10	Interstate-85	Dekalb	GA	55,762
11	Interstate-20	Dekalb	GA	53,235
12	Interstate-75	Henry	GA	51,901
13	Interstate-75	Clayton	GA	49,696
14	Interstate-85	Fulton	GA	33,213
15	Interstate-35	Travis	TX	28,770
16	Interstate-285	Clayton	GA	27,607
17	Interstate-95	Fairfax	VA	25,594
18	Interstate-516	Chatham	GA	24,538
19	Interstate-10	East Baton Rouge	LA	23,369
20	Interstate-24	Hamilton	TN	22,372
21	Interstate-95	Alexandria (City)	VA	22,067
22	Interstate-4	Osceola	FL	21,493
23	Interstate-24	Davidson	TN	21,305
24	U.S.-21	Mecklenburg	NC	20,030
25	Interstate-95	Fredericksburg (City)	VA	19,090
26	Interstate-95	Broward	FL	18,810
27	Interstate-610	Harris	TX	17,762
28	Interstate-35	Dallas	TX	17,603
29	Interstate-75	Kenton	KY	17,386
30	U.S.-74	Union	NC	17,126
31	Interstate-35	Jackson	MO	17,013
32	Interstate-10	Jefferson	LA	16,948
33	U.S.-78	Shelby	TN	16,600
34	Interstate-4	Orange	FL	16,193
35	Interstate-95	Prince William	VA	16,065
36	Interstate-95	Stafford	VA	15,987
37	Interstate-29	Jackson	MO	15,904
38	Interstate-75	Cherokee	GA	15,823
39	Interstate-85	Barrow	GA	15,687
40	Interstate-575	Cobb	GA	15,595
41	U.S.-27	Miami-Dade	FL	15,555
42	Interstate-95	Camden	GA	15,059
43	Interstate-69	Harris	TX	14,913
44	Interstate-70	St Louis	MO	14,874
45	Interstate-65	Davidson	TN	14,611
46	Interstate-64	St Louis (City)	MO	14,371
47	Interstate-270	St Louis	MO	14,281
48	Interstate-40	Davidson	TN	14,270
49	Interstate-45	Harris	TX	13,788
50	Interstate-12	East Baton Rouge	LA	13,738

Top Congested Multi-State Trade Lanes

The study identified top trade lanes based on multi-state commodity flows and consultations. Among these, the top twenty congested trade lanes measured by truck delay per mile are shown in Figure 7 and Figure 8. A cluster of top congested trade lanes in the region have an origin, destination, or intersection in Atlanta, Birmingham, Chattanooga, Greenville, and Nashville.

Figure 7: Southeast States – Top 20 Congested Multi-State Trade Lanes (Map, 2019)

Figure 8: Southeast States – Top 20 Congested Multi-State Trade Lanes (Table, 2019)

Rank	Trade Lane	Delay per Mile (Hours)
1	Chattanooga, TN – Atlanta, GA	49,928
2	Greenville, SC - Atlanta, GA	41,465
3	Nashville, TN - Atlanta, GA	26,763
4	Atlanta, GA -Chattanooga	26,368
5	Charlotte, NC - Atlanta, GA	26,019
6	Atlanta, GA – Greenville, SC	20,411
7	Louisville, KY - Atlanta, GA	17,447
8	Atlanta, GA – Nashville, TN	16,481
9	Birmingham, AL – Atlanta, GA	14,129
10	Atlanta, GA – Charlotte, NC	13,234
11	Nashville, TN – Miami, FL	11,276
12	Atlanta, GA – Louisville, KY	11,264
13	Atlanta, GA – Birmingham, AL	10,547
14	Miami, FL – Nashville, TN	10,393
15	Raleigh, NC – Dallas, TX	7,970
16	Miami, FL – Atlanta, GA	6,716
17	Memphis, TN – Atlanta, GA	6,240
18	Dallas, TX – Raleigh, NC	5,758
19	Louisville, KY – Cincinnati, OH	5,740
20	Atlanta, GA – Miami, FL	5,326

Bottleneck Causes and Strategies:

Peak-period traffic – typically occurring in the late afternoons and early evenings – is the top bottleneck cause in the Southeast, followed by traffic incidents, work zones, and weather.

Southeast states employ a variety of strategies to address top bottlenecks in their states including through policies, partnerships and programs, and projects shown in Figure 9. Many states expressed that collaboration with other states is key to addressing shared bottlenecks across the region from coordinated planning to infrastructure improvement projects, operational improvements, and technology deployments.

Figure 9: Southeast Strategies to Address Bottlenecks

Policies	
	Maintain and improve designated freight networks for freight efficiency and connectivity, and prepare freight system for increasing goods movements and emerging urban delivery patterns.
	Identify locations with existing bottlenecks or at risk of becoming a bottleneck and monitor them for issues or improvement opportunities. • Risk factors include unfavorable infrastructure trends, no recognized route redundancy, a correlation between truck VMT and substandard pavement/bridge ratings on the freight network, O/D trends, etc. • Conduct studies for identified freight highway bottlenecks to identify opportunities for improvement
	Integrate considerations for and prioritize severe congestion locations and efficiency of goods movement in the highway project planning process.
	Define and implement performance measures • To measure and report congestion for the freight network • To track the implementation of projects to reduce congestion

Partnerships and Programs		
	Promote use of freight technologies (e.g., ITS, CV, AV, TPIMS, WIM) proven to increase efficiency and reliability of freight movements	
	Consider cost-effective methods of capacity expansion before building new lane-miles	
	Partner with the private sector to identify opportunities to improve freight flow and reduce congestion (e.g., routing, off-hour delivery times, mode shift, etc.)	
	Work with multi-state partners to make corridor-wide system improvements and share information & best practices	
	Secure funding for congestion reduction construction projects (e.g., Texas Clear Lanes Program, value pricing, P3s)	
Project Types		
	Widen and repave roads, ramps, bridges, and tunnels; **add lanes**; **improve** interchanges, intersections, and access	*Traditional*
	Enhance routing options for trucks in urban areas, last-mile connectors	
	Provide truck-only lanes, key bypass routes, truck climbing lanes	
	Implement proven technology solutions (e.g., ITS applications, dynamic message signs, real time information) to improve mobility and traffic management	
	Other non-traditional capacity improvements to improve congestion (e.g., managed lanes, value pricing, time of day truck restrictions, non-Interstate signal timing)	
	Other innovative designs to improve capacity (e.g., diverging diamond interchanges, super-twos, superstreets, etc.).	*Innovative*

Next Steps:

Technical Memo 1 is the first in a series of three technical memos for this study, documenting the detailed methodology and findings of the bottleneck assessment. Based on the top regional bottlenecks and types of strategies outlined in this document, Technical Memo 2 will present regional needs and potential opportunities/pilot projects to address the top bottlenecks. Technical Memo 3 is a technical manual that will describe the GIS Planning tool development process and guiding steps for updates and maintenance.

1 Introduction

1.1 Background and Objectives

The Institute for Trade and Transportation Studies (ITTS) is conducting a regional bottleneck assessment study to facilitate goods movement across the Southeast Region. The study covers 2019 bottlenecks in the Southeast Region: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, Missouri, North Carolina, South Carolina, Tennessee, Texas, and Virginia.

The ITTS Regional Bottlenecks Assessment for Goods Movement Study assesses the extent, duration, and severity of truck bottlenecks in the Southeast to facilitate multi-state collaboration on potential recommendations that can be undertaken to reduce top bottlenecks.

The regional bottleneck assessment will be integrated into an ITTS GIS Planning Tool. **While each state department of transportation (DOT) identifies top bottlenecks within its state borders, this GIS Planning Tool will illustrate the Southeast regional connections and trip-based bottlenecks encountered on the top long-haul truck trade lanes.**

ITTS GIS Planning Tool

The ITTS GIS Planning Tool will serve as a planning and information-sharing tool for ITTS member state use and will illustrate the Southeast regional connections and trip-based bottlenecks encountered on the top long-haul truck trade lanes. The tool will include an interactive map, table, and statistics with information on top bottlenecks, select origin/destination pairings, performance measures, and foundational network attributes, as well as a data download function.

A segments-based tool will be available for users to explore segment-based results by state, with bottleneck information and performance measure results available for each segment within a selected region. A trips-based tool will allow users to explore bottlenecks on select multi-state trade lanes within the Southeast Region, with bottleneck information and performance measure results available for segments along the route, as well as travel time distribution for each trade lane based on departure time from the origin point.

1.2 Process and Technical Memos

Figure 10 identifies the technical memos that will be produced to document the study results. Technical Memo 1: ITTS Bottlenecks Findings and Methodology has been developed at the culmination of Task 3. This memo is the first in a series of three study technical memos, and it will summarize the findings of the regional bottlenecks assessment task and methodologies used.

Figure 10: Technical Memos

Task	Technical Memo	Timeline
Task 3	1) ITTS Bottlenecks Findings and Methodology	April 2022
Task 4	2) ITTS Bottlenecks Needs and Opportunities	October 2022
Task 5	3) ITTS GIS Planning Tool Manual	November 2022

- **Task 1:** The CPCS Team compiled input and feedback from ITTS member states on study objectives, performance measures, and methodology, as well as on existing bottleneck initiatives, issues, and opportunities in the Southeast, through literature review, consultations, data analysis, and both Steering Committee and Technical Advisory Committee discussions.

- **Task 2:** The CPCS Team designed and structured the ITTS GIS Planning Tool on Plotly, an open-source platform selected by the Steering Committee in consultation with their state agency IT and/or GIS partners. This included developing information architecture, programming specific layers, formatting content, and debugging. In addition to the performance measures calculated in Task 3, additional multimodal freight networks and other data were incorporated into the GIS Planning Tool.

- **Task 3:** The CPCS Team calculated performance measures to assess regional bottlenecks – average truck speed, truck travel time reliability (TTTR), truck delay per mile, annual hours of truck delay, and annual cost of truck delay using 2019 NPMRDS and HPMS data. These measures allow for high-level comparison between states, corridors, and metropolitan areas to inform the identification of top truck bottlenecks in the region. These bottlenecks were subsequently validated with the Study Committee and TAC, bottleneck causes were provided by member states, and the findings of the assessment were then documented in Technical Memo 1.

- **Task 4:** Next, the CPCS Team will facilitate discussions with the committee on regional needs and multi-state mitigation options that apply to bottleneck issues in the Southeast region. This will include both technology-based and non-technology-based multi-state solutions. The CPCS Team will further develop guidelines that describe where solutions typically are most effective. The next steps will also be outlined based on the results of committee discussions on multi-state policy, planning, and potential development grant pursuits. These guidelines and next steps will be documented in Technical Memo 2: ITTS Bottlenecks Needs and Opportunities.

- **Task 5:** The CPCS Team will finalize the ITTS GIS Planning Tool based on refinements requested by the committee. The GIS Planning Tool will be complemented by design charrettes to support users of the tool, as well as detailed documentation of technical steps to support maintenance and updates of the tool by DOTs. These instructions will be included in Technical Memo 3: ITTS GIS Planning Tool Manual. The final GIS Planning Tool launch, along with Study results, will be presented during a dedicated committee presentation, followed by a question-and-answer period.

Technical Memos are internal deliverables to enable timely reviews and feedback between the Project Team and the ITTS Technical Advisory Committee. Technical Memos will be reviewed and revised by the Project Team based on comments from ITTS.

2 ITTS Top Truck Bottlenecks

In 2019, the Southeast Region experienced 271 million hours of total truck delay, amounting to 470 million gallons in wasted fuel and $18 billion in economic costs. Georgia, Tennessee, and Louisiana experienced the highest average truck delay per mile in the region. The top five congested interstates by truck delay per mile are I-285, I-516, I-610, I-270, and I-670 – beltway or auxiliary routes. By total hours and cost of delay, the top five congested interstates are I-75, I-285, I-85, I-10, and I-95 due to both high truck volumes and delay.

The majority of top truck bottlenecks in the region are located in Georgia (20), followed by Texas, Virginia, Tennessee, and Missouri each with 5 bottlenecks, Florida (4), Louisiana (3), North Carolina (2), and Kentucky (1). 18 of the top 50 truck bottlenecks in the Southeast are based in the Atlanta metropolitan region. Fifteen of the top twenty congested truck trade lanes also have an origin or destination in Atlanta. A cluster of top congested trade lanes in the region have an origin, destination, or intersection in Atlanta, Birmingham, Chattanooga, Greenville, or Nashville.

Peak-period traffic is the top bottleneck cause in the Southeast, followed by traffic incidents, work zones, and weather. Congestion starts to accumulate during morning hours before reaching peak congestion during the late afternoons and early evenings. Southeast states employ a variety of strategies to address top bottlenecks in their states including through policies, partnerships and programs, and projects. Many states expressed that collaboration with other states is key to addressing shared bottlenecks across the region from coordinated planning to infrastructure improvement projects, operational improvements, and technology deployments.

2.1 Introduction

The ITTS regional bottleneck assessment study provides an analysis of 2019 bottlenecks in the Southeast Region: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, Missouri, North Carolina, South Carolina, Tennessee, Texas, and Virginia.

This analysis measures truck-based congestion across the entire National Highway System and is based on vehicle probe-based data from 5-minute average travel times included in the National Performance Management Research Data Set (NPMRDS) and truck volumes from the Highway Performance Measurement System (HPMS) – both from 2019. Detailed methodology is documented in Chapter 3 of this Technical Memo.

2.2 Bottleneck Impacts by State

In 2019, the Southeast Region experienced 271 million hours of total truck delay, amounting to 470 million gallons of wasted fuel and $18 billion in direct costs.

Among Southeast states, Georgia, Tennessee, and Louisiana experienced the highest average truck delay per mile along the National Highway System (NHS), as shown in Figure 11.

Figure 11: Southeast States – Average NHS Truck Delay per Mile (2019)

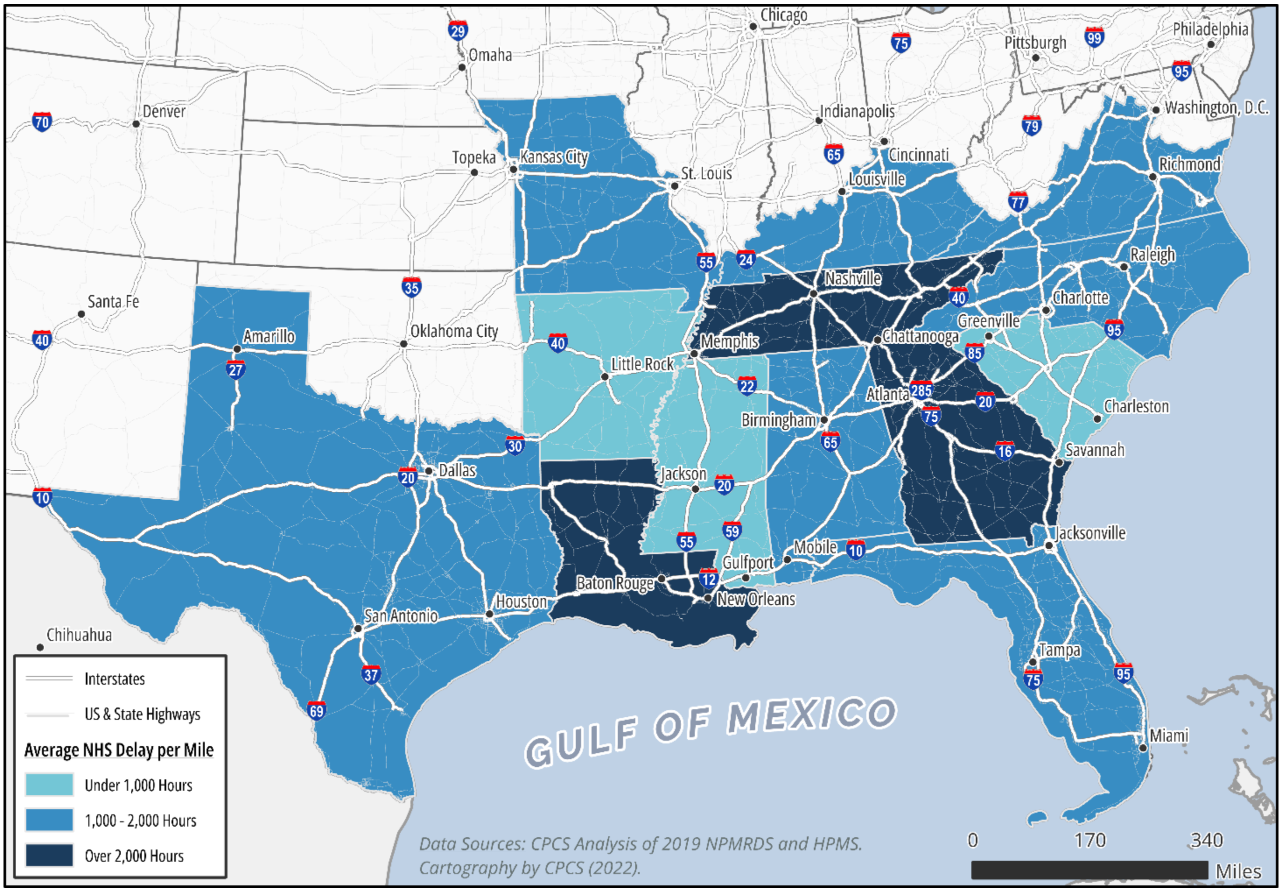


Figure 12 details bottleneck impacts by state for the Southeast Region. Due to high truck traffic volumes in Texas and Georgia – more than two times that of any other state in the region – truck delays in these states cost the most ($4.2 billion and $4.0 billion respectively) and wasted the largest amount of fuel (101.3 million gallons and 100.3 million gallons respectively).

Figure 12: Southeast Bottleneck Impacts by State (2019)

State	Average Annual Daily Traffic Trucks	Truck Delay per Mile (Hours)	Average Truck Travel Time Reliability	Total Truck Delay (Hours)	Cost of Truck Delay (Billions of 2019 Dollars)	Truck Fuel Wasted (Million Gallons)
Georgia	3,874	4,253	1.7	59,922,593.5	$4.0	100.3
Louisiana	1,882	2,209	1.6	13,124,910.0	$0.9	25.3
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Southeast Region	1,825	1,791	1.6	270,701,158.7	$18.0	469.6

Source: CPCS Analysis of 2019 NPMRDS and HPMS Data in the Southeast Region

2.3 Bottlenecks Impacts by Interstate

By truck delay per mile, the top five congested interstates in the Southeast Region are I-285, I-516, I-610, I-270, and I-670. All five interstates are either beltways or auxiliary routes.

1. **I-285** is a beltway encircling Atlanta, GA. In 2019, 10.39 million hours of truck delay wasted 16.6 million gallons of fuel and generated costs of $684.0 million.

2. **I-516**, also located in Georgia, is an auxiliary Interstate Highway in the coastal city of Savannah that has the second-highest truck delay per mile. Truck delays on I-516 in 2019 cost $22.0 million, $1.8 million of which resulted from wasted fuel.

3. **I-610** is a highway beltway around the city of Houston, Texas. A total of 1.4 million hours of truck congestion in 2019 cost $93.9 million and 2.2 million gallons of wasted fuel.

4. **I-270** is a portion of the beltway in Greater St. Louis, stretching 50.59 miles from the junction with I-55 and I-255 in Mehlville, MO to the junction with I-55 and I-70 north of

Troy, IL. In 2019, 0.98 million hours of truck delay led to $64 million in costs and 1.3 million gallons of wasted fuel.

5. **I-670** is an auxiliary route passing through Downtown Kansas City, connecting I-70 in Kansas City, Kansas, and I-70 in Kansas City, Missouri. A total of 0.06 million hours of truck delay in 2019 on I-670 resulted in $4.1 million in costs and 0.1 million gallons of wasted fuel.

Figure 13 illustrates the 20 most congested Southeast interstates and Figure 14 provides a listing of these interstates.

Figure 13: Top Congested Interstates by Truck Delay Per Mile (2019)

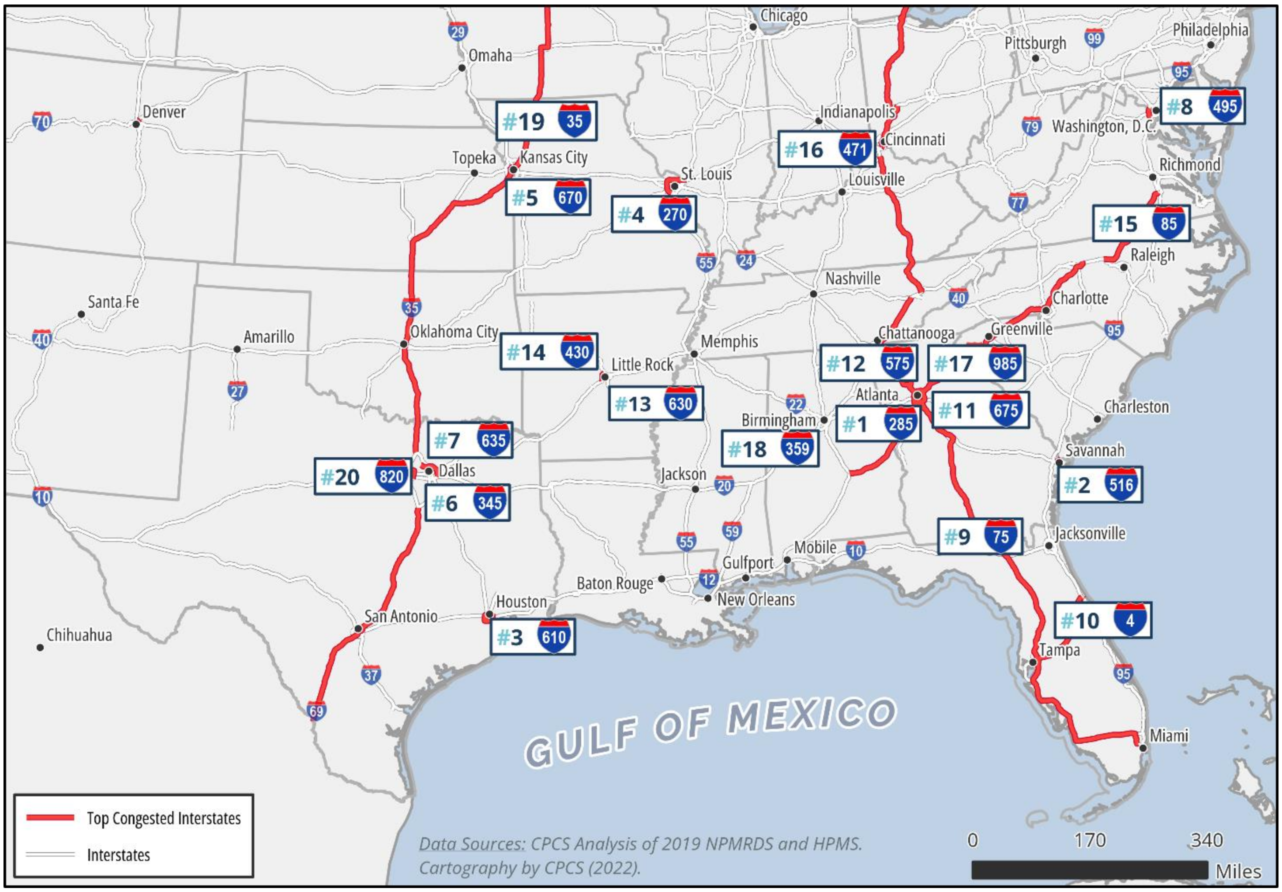


Figure 14: Impact of Bottlenecks by Interstate (ranked by truck delay per mile) (2019)

Rank	Interstate	Average Annual Daily Traffic Trucks	Truck Delay per Mile (Hours)	Average Truck Travel Time Reliability	Total Truck Delay (Hours)	Truck Fuel Wasted (Million Gallons)	Cost of Truck Delay (Millions of 2019 Dollars)
1	Interstate-285 GA	35,021	82,694	2.6	10,375,879	16.6	$684
2	Interstate-516	9,289	24,538	2.2	331,107	0.6	$22
3	Interstate-610	6,148	16,635	2.8	1,427,162	2.2	$94
4	Interstate-270	11,937	14,186	2.2	984,308	1.3	$64
5	Interstate-670	4,988	13,527	2.6	60,815	0.1	$4
6	Interstate-345	3,428	12,820	2.8	30,134	0.05	$2
7	Interstate-635	6,472	11,064	2.4	1,294,135	2.2	$86
8	Interstate-495	4,270	9,636	3.5	423,904	0.7	$28
9	Interstate-75	12,052	8,826	1.3	20,630,672	32.9	$1,360
10	Interstate-4	6,119	7,999	2.1	2,106,314	3.6	$139
11	Interstate-675	16,004	7,985	1.7	159,182	0.2	$10
12	Interstate-575	16,726	7,856	1.7	485,447	0.7	$32
13	Interstate-630	17,989	7,391	2.0	107,843	0.1	$7
14	Interstate-430	14,979	7,245	1.7	179,241	0.2	$12
15	Interstate-85	7,684	7,150	1.3	9,333,196	14.8	$615
16	Interstate-471	6,192	6,641	2.8	70,260	0.1	$5
17	Interstate-985	14,997	5,834	1.4	279,680	0.4	$18
18	Interstate-359	2,707	5,451	2.0	30,055	0.04	$2
19	Interstate-35	7,023	5,258	1.5	7,456,072	11.6	$490
20	Interstate-820	4,491	5,234	1.9	416,162	0.6	$27

Source: CPCS Analysis of 2019 NPMRDS and HPMS Data

By total hours and costs of truck delay, the top bottlenecks are I-75, followed by I-285, I-85, I-10, and I-95 due to high truck traffic and high delay. Figure 15 lists the Southeast interstates with the highest total hours and costs of truck delay.

1. **I-75** is a major north-south Interstate Highway that goes through Kentucky, Tennessee, Georgia, and Florida in the Southeastern Region. The Interstate experienced 21 million hours of total truck delay, wasting 33 million gallons of fuel and costing $1,360 million.

2. **I-285** is a 63.98-mile beltway around Atlanta, GA, and is ranked as the top congested Interstate by truck delay per mile. The 10 million hours of truck delay on the Interstate cost $684 million and wasted 17 million gallons of fuel.

3. **I-85** is an Interstate Highway that traverses through Virginia, North Carolina, South Carolina, Georgia, and Alabama. In 2019, the total truck delay on the 666.1-mile long Interstate accumulated to nine million hours, with 15 million gallons of truck fuel wasted and $615 million in costs.

4. **I-10** is a cross-country Interstate Highway that goes through Texas, Louisiana, Mississippi, Alabama, and Florida in the Southeast. The eight million hours of truck delay on I-10 wasted 13 million gallons of fuel and generated $533 million in costs.

5. **I-95** is a north-south Interstate Highway that traverses through Florida, Georgia, South Carolina, North Carolina, and Virginia in the Southeast. Within the Southeast portion of the corridor, eight million hours of truck delay occurred in 2019, which led to 13 million gallons of wasted fuel and $533 million in costs.

Figure 15: Impacts of Bottlenecks by Interstate (ranked by total truck delay and cost of truck delay) (2019)

Rank	Interstate	Average Annual Daily Traffic Trucks	Truck Delay per Mile (Hours)	Average Truck Travel Time Reliability	Total Truck Delay (Hours)	Truck Fuel Wasted (Million Gallons)	Cost of Truck Delay (Millions of 2019 Dollars)
1	Interstate-75	12,052	8,826	1.3	20,630,672	33	$1,360
2	Interstate-285 GA	35,021	82,694	2.6	10,375,879	17	$684
3	Interstate-85	7,684	7,150	1.3	9,333,196	15	$615
4	Interstate-10	4,439	2,485	1.7	8,093,925	13	$533
5	Interstate-95	5,583	3,702	1.3	8,063,559	13	$533
6	Interstate-20	6,448	2,945	1.2	8,054,315	12	$529
7	Interstate-35	7,023	5,258	1.5	7,456,072	12	$490
8	Interstate-40	5,129	1,583	1.3	4,255,520	6	$278
9	Interstate-45	6,385	4,677	1.7	2,972,579	5	$196
10	Interstate-65	5,845	2,178	1.3	2,673,818	4	$176
11	Interstate-24	6,927	4,576	1.8	2,494,465	4	$165
12	Interstate-69	3,312	3,958	1.4	2,473,004	4	$163
13	Interstate-4	6,119	7,999	2.1	2,106,314	4	$139
14	Interstate-30	6,888	2,766	1.5	2,092,388	3	$137
15	Interstate-64	2,784	1,558	1.5	1,561,735	2	$102
16	Interstate-70	6,944	2,944	2.8	1,476,003	2	$96
17	Interstate-610	6,148	16,635	1.3	1,427,162	2	$94
18	Interstate-635	6,472	11,064	2.4	1,294,135	2	$86
19	Interstate-77	3,667	2,303	1.5	1,116,467	2	$73
20	Interstate-270	11,937	14,186	2.2	984,308	1	$64

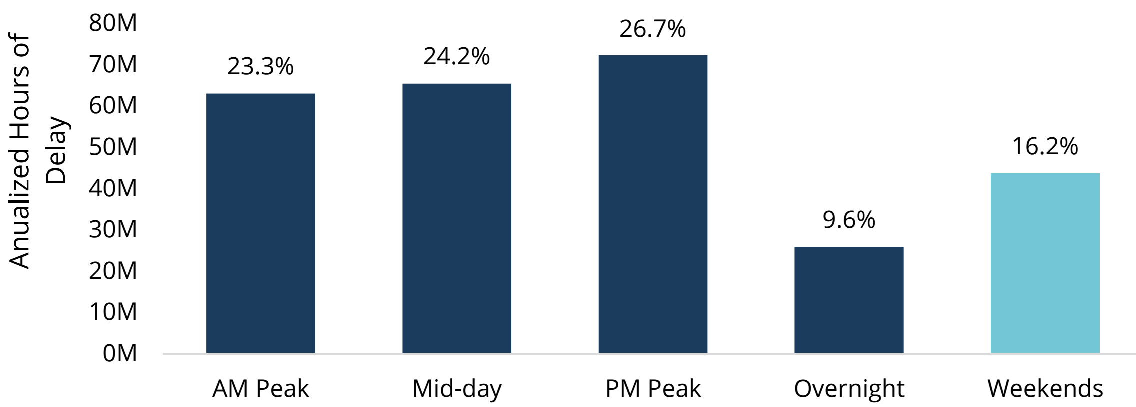
Source: CPCS Analysis of 2019 NPMRDS and HPMS Data. Note: interstate rankings for total truck delay and cost of truck delay are the same.

2.4 Bottlenecks Duration

Congestion on corridors in the Southeast Region builds up throughout the day. Roadways experience accumulated truck delay during morning hours, reach peak congestion during the PM peak hour, and delays decline overnight as traffic volumes decrease.

Figure 16 illustrates these trends, showing annual hours of truck delay by the time of day in the Southeast Region. As shown, 26.7 percent of the total hours of truck delay occurred during the PM peak period in 2019, with only 9.6 percent of total truck delays occurring overnight.

Figure 16: Annual Hours of Truck Delay by Time of Day (2019)



Source: CPCS Analysis of 2019 NPMRDS and HPMS Data

Although daily patterns of congestion are similar throughout Southeast Region, states demonstrate different peak congestion times. As shown in Figure 17, the highest share of daily delay typically occurs during the PM peak period in nine states. Meanwhile, a higher share of truck delay occurs during the mid-day in four states.

Figure 17: The Most Congested Time of Day by State (2019)

Mid-day (% of Annual Duration of Truck Delay)	
Alabama	26.3%
South Carolina	26.1%
Mississippi	25.3%
Kentucky	24.5%

PM Peak (% of Annual Duration of Truck Delay)	
Georgia	30.4%
Texas	27.1%
Virginia	27.1%
Missouri	25.8%
Tennessee	25.7%
North Carolina	25.4%
Arkansas	25.3%
Louisiana	25.0%
Florida	24.9%

Source: CPCS Analysis of 2019 NPMRDS and HPMS Data

2.5 Top Bottlenecks

The top 50 bottlenecks by county are based in nine states: Georgia (20) followed by Texas, Virginia, Tennessee, and Missouri each with 5 bottlenecks, Florida (4), Louisiana (3), North Carolina (2), and Kentucky (1).

- By **truck delay per mile**, the top bottlenecks are based in nine of the states in the Southeastern region, except for Alabama, Arkansas, Mississippi, and South Carolina as shown in Figure 18. Truck delay per mile for these top bottlenecks ranges from 14 to 224 thousand hours per mile. 20 of the top fifty bottlenecks are located in Georgia, 18 of which are located in the Atlanta Metropolitan Area.

- By **total hours of truck delay**, the top bottlenecks are based in eight of the Southeastern states, except for Alabama, Arkansas, Mississippi, Kentucky, and South Carolina, as shown in Figure 19. Annualized hours of truck delay range from 0.5 million to 8.2 million hours of truck delay in 2019.

- By **cost of truck delay**, the top bottlenecks are also based in eight of the Southeastern states, except for Alabama, Arkansas, Mississippi, Kentucky, and South Carolina, as shown in Figure 21. The bottlenecks are similar to those by total hours of truck delay but with different rankings. The cost of truck delay on these corridors varies from $35 million to $541 million.

The various top bottleneck rankings show different results. While some of the roadways appear in both tables, such as I-75 in Fulton and Cobb Counties, I-95 in Fairfax County, I-24 in Davidson County, and I-35 in Dallas County, many segments only make one of the top fifty bottleneck lists. This shows how different bottleneck identification measures can lead to various results. To minimize outlier results, bottlenecks were aggregated by county, and segments under 1 mile were excluded. Top bottlenecks also focus on Southeast interstates and U.S.-highways (functional classes 1-3) due to data quality issues for higher functional class roadways.

Figure 18: Top Bottlenecks by County (ranked by truck delay per mile, excluding <1-mile segments) (Map, 2019)

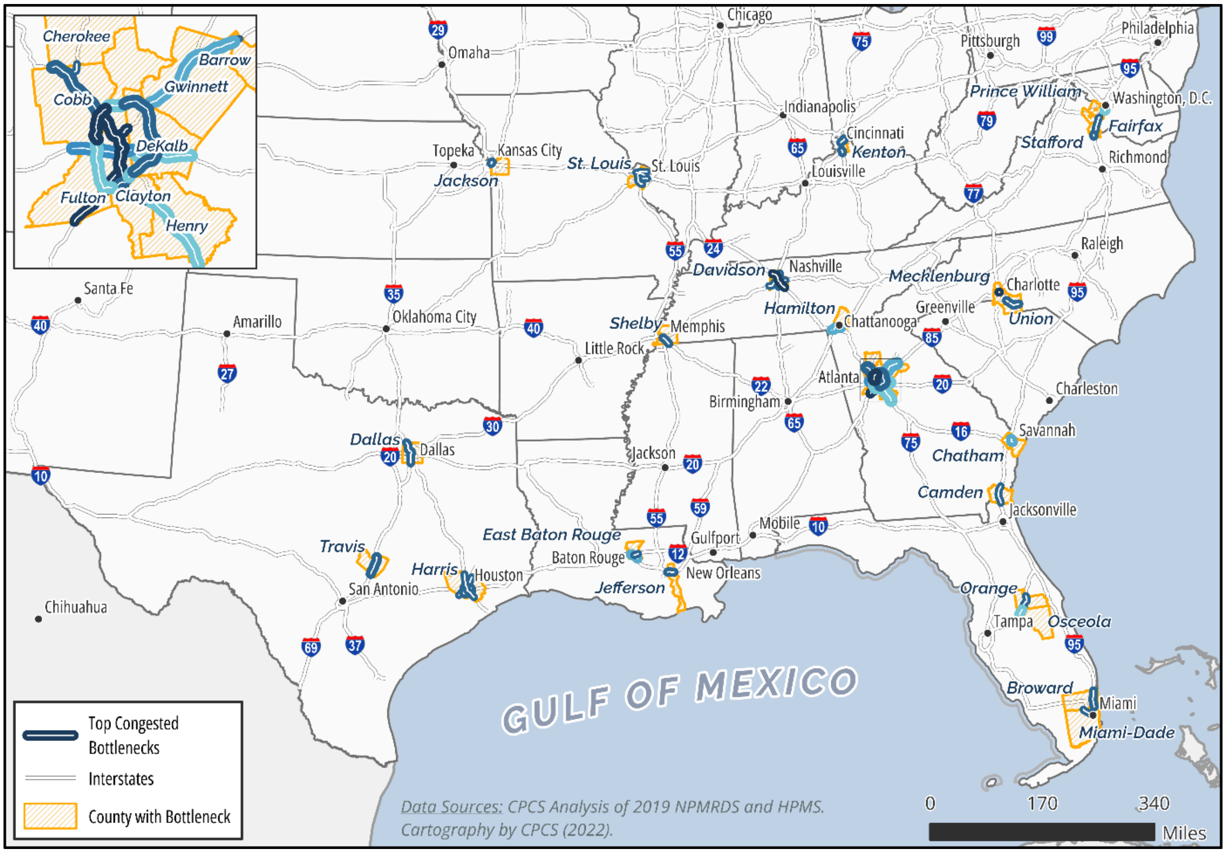


Figure 19: Top Bottlenecks by County (ranked by truck delay per mile, excluding <1-mile segments) (2019)

Rank	Road	County	State	Average Annual Daily Traffic Trucks	Truck Delay per Mile (Hours)
1	Interstate-75	Fulton	GA	70,687	224,023
2	Interstate-285	Cobb	GA	35,118	113,909
3	Interstate-285	Dekalb	GA	36,067	106,564
4	Interstate-75	Cobb	GA	63,196	99,077
5	Interstate-20	Fulton	GA	40,920	77,951
6	Interstate-20	Cobb	GA	36,142	69,994
7	Interstate-85	Gwinnett	GA	34,444	69,381
8	U.S.-19	Fulton	GA	28,744	60,768
9	Interstate-285	Fulton	GA	35,530	59,116
10	Interstate-85	Dekalb	GA	37,447	55,762
11	Interstate-20	Dekalb	GA	38,525	53,235
12	Interstate-75	Henry	GA	40,189	51,901

Rank	Road	County	State	Average Annual Daily Traffic Trucks	Truck Delay per Mile (Hours)
13	Interstate-75	Clayton	GA	42,827	49,696
14	Interstate-85	Fulton	GA	15,674	33,213
15	Interstate-35	Travis	TX	7,078	28,770
16	Interstate-285	Clayton	GA	28,256	27,607
17	Interstate-95	Fairfax	VA	9,023	25,594
18	Interstate-516	Chatham	GA	9,288	24,538
19	Interstate-10	East Baton Rouge	LA	10,580	23,369
20	Interstate-24	Hamilton	TN	13,917	22,372
21	Interstate-95	Alexandria (City)	VA	7,400	22,067
22	Interstate-4	Osceola	FL	7,919	21,493
23	Interstate-24	Davidson	TN	9,301	21,305
24	U.S.-21	Mecklenburg	NC	2,497	20,030
25	Interstate-95	Fredericksburg (City)	VA	10,530	19,090
26	Interstate-95	Broward	FL	13,232	18,810
27	Interstate-610	Harris	TX	6,343	17,762
28	Interstate-35	Dallas	TX	7,491	17,603
29	Interstate-75	Kenton	KY	9,558	17,386
30	U.S.-74	Union	NC	1,962	17,126
31	Interstate-35	Jackson	MO	8,286	17,013
32	Interstate-10	Jefferson	LA	9,244	16,948
33	U.S.-78	Shelby	TN	3,089	16,600
34	Interstate-4	Orange	FL	5,787	16,193
35	Interstate-95	Prince William	VA	7,362	16,065
36	Interstate-95	Stafford	VA	7,167	15,987
37	Interstate-29	Jackson	MO	6,414	15,904
38	Interstate-75	Cherokee	GA	34,245	15,823
39	Interstate-85	Barrow	GA	18,566	15,687
40	Interstate-575	Cobb	GA	19,219	15,595
41	U.S.-27	Miami-Dade	FL	3,498	15,555
42	Interstate-95	Camden	GA	15,965	15,059
43	Interstate-69	Harris	TX	6,470	14,913
44	Interstate-70	St Louis	MO	11,755	14,874
45	Interstate-65	Davidson	TN	9,215	14,611
46	Interstate-64	St Louis (City)	MO	7,626	14,371

Rank	Road	County	State	Average Annual Daily Traffic Trucks	Truck Delay per Mile (Hours)
47	Interstate-270	St Louis	MO	12,004	14,281
48	Interstate-40	Davidson	TN	9,444	14,270
49	Interstate-45	Harris	TX	6,520	13,788
50	Interstate-12	East Baton Rouge	LA	10,921	13,738

Source: CPCS Analysis of 2019 NPMRDS and HPMS Data.

Figure 20: Top Bottlenecks by County (ranked by total truck delay, excluding <1-mile segments) (2019)

Rank	Road	County	State	Average Annual Daily Traffic Trucks	Total Truck Delay (Hours)
1	Interstate-75	Fulton	GA	70,687	20,630,672
2	Interstate-285	Dekalb	GA	36,067	10,375,879
3	Interstate-85	Gwinnett	GA	34,444	9,333,196
4	Interstate-75	Cobb	GA	63,196	8,093,925
5	Interstate-75	Henry	GA	40,189	8,063,559
6	Interstate-285	Fulton	GA	35,530	8,054,315
7	Interstate-45	Harris	TX	6,520	7,456,072
8	Interstate-69	Harris	TX	6,470	4,255,520
9	U.S.-19	Fulton	GA	28,744	2,972,579
10	Interstate-20	Fulton	GA	40,920	2,673,818
11	Interstate-20	Dekalb	GA	38,525	2,494,465
12	Interstate-285	Cobb	GA	35,118	2,473,004
13	Interstate-35	Travis	TX	7,078	2,106,314
14	Interstate-10	Harris	TX	8,497	2,092,388
15	Interstate-85	Fulton	GA	15,674	1,561,735
16	Interstate-95	Fairfax	VA	9,023	1,476,003
17	Interstate-35	Dallas	TX	7,491	1,427,162
18	Interstate-610	Harris	TX	6,343	1,294,135
19	Interstate-95	Broward	FL	13,232	1,116,467
20	Interstate-635	Dallas	TX	6,546	984,308
21	Interstate-75	Clayton	GA	42,827	20,630,672
22	Interstate-24	Davidson	TN	9,301	10,375,879
23	Interstate-10	Hudspeth	TX	4,665	9,333,196
24	Interstate-270	St.Louis	MO	12,004	8,093,925
25	Interstate-85	Dekalb	GA	37,447	8,063,559
26	Interstate-35	Bexar	TX	8,347	8,054,315
27	Interstate-40	Davidson	TN	9,444	7,456,072
28	Interstate-30	Dallas	TX	5,898	4,255,520
29	Interstate-4	Orange	FL	5,787	2,972,579
30	Interstate-35	Tarrant	TX	6,251	2,673,818
31	Interstate-95	Stafford	VA	7,167	2,494,465
32	Interstate-95	Prince William	VA	7,362	2,473,004
33	Interstate-95	Camden	GA	15,965	2,106,314

Rank	Road	County	State	Average Annual Daily Traffic Trucks	Total Truck Delay (Hours)
34	Interstate-20	Dallas	TX	9,509	2,092,388
35	Interstate-65	Davidson	TN	9,215	1,561,735
36	Interstate-24	Hamilton	TN	13,917	1,476,003
37	U.S.-290	Harris	TX	5,293	1,427,162
38	Interstate-40	Knox	TN	10,964	1,294,135
39	Interstate-10	Bexar	TX	5,963	1,116,467
40	Interstate-35	McLennan	TX	12,999	984,308
41	Interstate-10	East Baton Rouge	LA	10,580	20,630,672
42	Interstate-85	Troup	GA	9,988	10,375,879
43	U.S.-74	Union	NC	1,962	9,333,196
44	Interstate-77	Mecklenburg	NC	4,012	8,093,925
45	U.S.-31	Davidson	TN	1,330	8,063,559
46	U.S.-75	Dallas	TX	3,998	8,054,315
47	Interstate-20	Cobb	GA	36,142	7,456,072
48	Interstate-20	Douglas	GA	19,790	4,255,520
49	Interstate-95	Palm Beach	FL	7,788	2,972,579
50	Interstate-95	Miami-Dade	FL	4,808	2,673,818

Source: CPCS Analysis of 2019 NPMRDS and HPMS Data

Figure 21: Top Bottlenecks by County (ranked by cost of truck delay, excluding <1-mile segments) (2019)

Rank	Road	County	State	Average Annual Daily Traffic Trucks	Cost of Truck Delay (Millions of 2019 Dollars)
1	Interstate-75	Fulton	GA	70,687	$541
2	Interstate-285	Dekalb	GA	36,067	$365
3	Interstate-85	Gwinnett	GA	34,444	$291
4	Interstate-75	Cobb	GA	63,196	$235
5	Interstate-75	Henry	GA	40,189	$216
6	Interstate-285	Fulton	GA	35,530	$180
7	Interstate-45	Harris	TX	6,520	$149
8	Interstate-69	Harris	TX	6,470	$140
9	U.S.-19	Fulton	GA	28,744	$131
10	Interstate-20	Fulton	GA	40,920	$119
11	Interstate-20	Dekalb	GA	38,525	$119
12	Interstate-285	Cobb	GA	35,118	$118
13	Interstate-35	Travis	TX	7,078	$113
14	Interstate-10	Harris	TX	8,497	$112
15	Interstate-85	Fulton	GA	15,674	$98
16	Interstate-95	Fairfax	VA	9,023	$97
17	Interstate-35	Dallas	TX	7,491	$97
18	Interstate-610	Harris	TX	6,343	$89
19	Interstate-95	Broward	FL	13,232	$84
20	Interstate-635	Dallas	TX	6,546	$84
21	Interstate-75	Clayton	GA	42,827	$80
22	Interstate-10	Hudspeth	TX	4,665	$77
23	Interstate-24	Davidson	TN	9,301	$76
24	Interstate-270	St Louis	MO	12,004	$64
25	Interstate-85	Dekalb	GA	37,447	$62
26	Interstate-40	Davidson	TN	9,444	$58
27	Interstate-35	Bexar	TX	8,347	$58
28	Interstate-30	Dallas	TX	5,898	$57
29	Interstate-4	Orange	FL	5,787	$53
30	Interstate-95	Stafford	VA	7,167	$49
31	Interstate-35	Tarrant	TX	6,251	$48
32	Interstate-95	Prince William	VA	7,362	$47
33	Interstate-95	Camden	GA	15,965	$42

Rank	Road	County	State	Average Annual Daily Traffic Trucks	Cost of Truck Delay (Millions of 2019 Dollars)
34	Interstate-65	Davidson	TN	9,215	$41
35	Interstate-20	Dallas	TX	9,509	$41
36	Interstate-24	Hamilton	TN	13,917	$40
37	Interstate-10	Bexar	TX	5,963	$38
38	Interstate-40	Knox	TN	10,964	$38
39	Interstate-35	McLennan	TX	12,999	$38
40	Interstate-10	East Baton Rouge	LA	10,580	$38
41	U.S.-290	Harris	TX	5,293	$38
42	Interstate-85	Troup	GA	9,988	$37
43	U.S.-31	Davidson	TN	1,330	$36
44	U.S.-74	Union	NC	1,962	$35
45	Interstate-77	Mecklenburg	NC	4,012	$35
46	U.S.-75	Dallas	GA	70,687	$541
47	U.S.-27	Polk	GA	36,067	$365
48	Interstate-20	Douglas	GA	34,444	$291
49	Interstate-20	Cobb	GA	63,196	$235
50	Interstate-95	Miami-Dade	GA	40,189	$216

Source: CPCS Analysis of 2019 NPMRDS and HPMS Data

2.6 Top Congested Truck Trade Lanes

The top 20 congested truck trade lanes are detailed in Figure 22. A cluster of top congested trade lanes in the region have an origin, destination, or intersection in Atlanta, Birmingham, Chattanooga, Greenville, and Nashville. The truck delay per mile on these trade lanes ranges from 5 thousand to 50 thousand hours of truck delay per mile. **Appendix A** provides profiles of the top 20 congested trade lanes and where delays occur.

Figure 22: Top Congested Trade Lanes (Map)

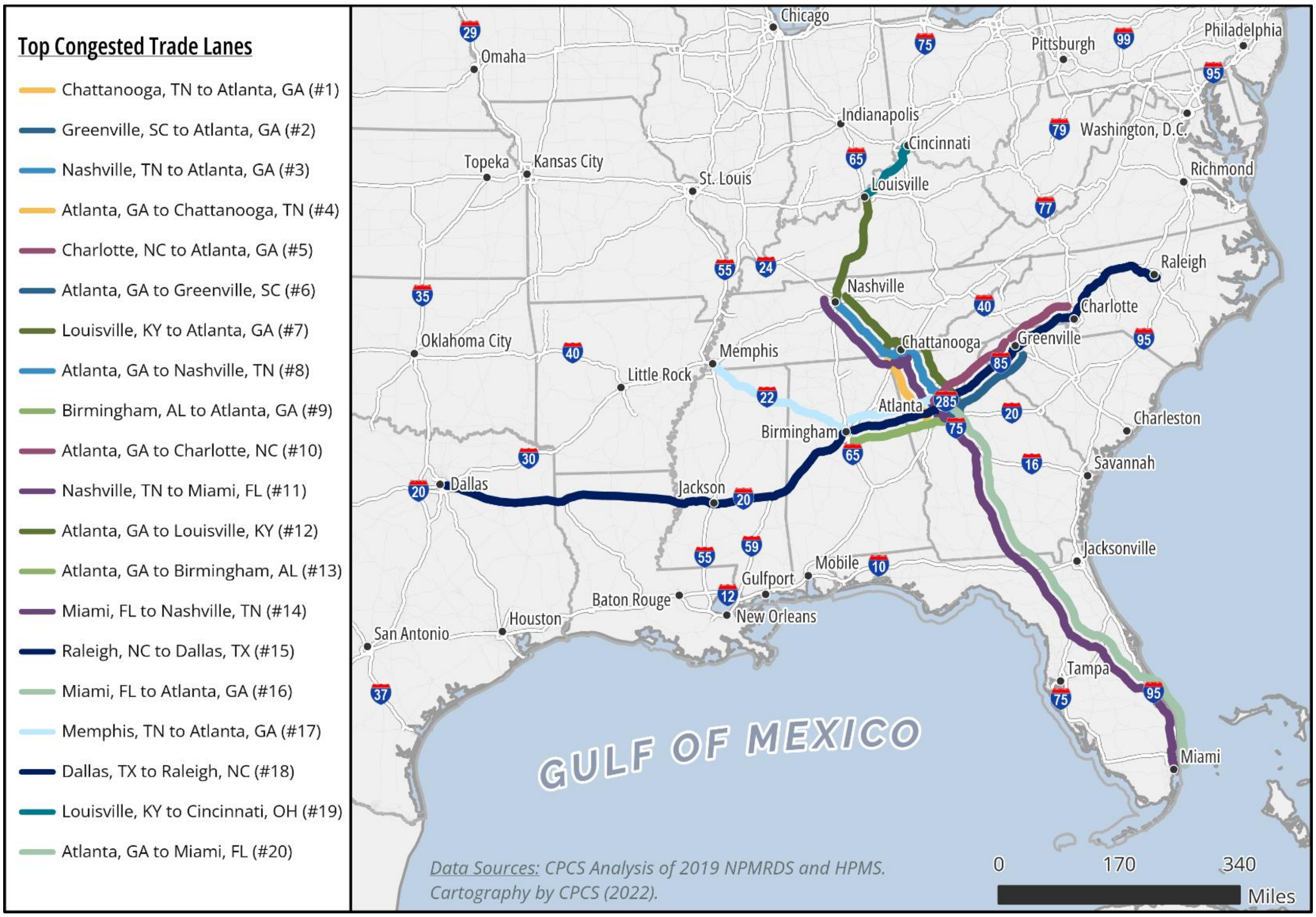


Figure 23: Top Congested Trade Lanes (Table)

Rank	Trade Lane	Main Corridors	Average Annual Daily Traffic Trucks	Truck Delay per Mile (Hours)	Total Truck Delay (Hours)	Truck Fuel Wasted (Millions of Gallons)	Cost of Truck Delay (Millions)
1	Chattanooga, TN – Atlanta, GA	I-75	31,959	49,928	5,996,193	10	$396
2	Greenville, SC - Atlanta, GA	I-85 and I-75	17,251	41,465	6,013,595	10	$397
3	Nashville, TN - Atlanta, GA	I-24 and I-75	19,933	26,763	6,805,031	11	$449
4	Atlanta, GA - Chattanooga	I-75	25,669	26,368	3,434,654	6	$227
5	Charlotte, NC - Atlanta, GA	I-85	11,789	26,019	6,410,758	10	$423
6	Atlanta, GA – Greenville, SC	I-85 and I-75	17,041	20,411	2,964,864	5	$196
7	Louisville, KY - Atlanta, GA	I-65, I-24, and I-75	15,116	17,447	7,548,409	12	$498
8	Atlanta, GA – Nashville, TN	I-24 and I-75	17,341	16,481	4,380,416	7	$289
9	Birmingham, AL – Atlanta, GA	I-20	13,590	14,129	2,032,049	3	$134
10	Atlanta, GA – Charlotte, NC	I-24 and I-75	11,662	13,234	3,261,154	5	$215
11	Nashville, TN – Miami, FL	I-24, I-75, Florida's Turnpike, and I-95	13,393	11,276	10,330,386	16	$679
12	Atlanta, GA – Louisville, KY	I-65, I-24, and I-75	13,713	11,264	4,987,478	8	$329
13	Atlanta, GA – Birmingham, AL	I-20	13,621	10,547	1,555,998	2	$102
14	Miami, FL – Nashville, TN	I-24, I-75, Florida's Turnpike, and I-95	12,826	10,393	9,573,480	15	$629
15	Raleigh, NC – Dallas, TX	I-40, I-85, and I-20	7,325	7,970	9,350,501	15	$615
16	Miami, FL – Atlanta, GA	I-95, Florida's Turnpike, and I-75	10,993	6,716	4,401,612	6	$288

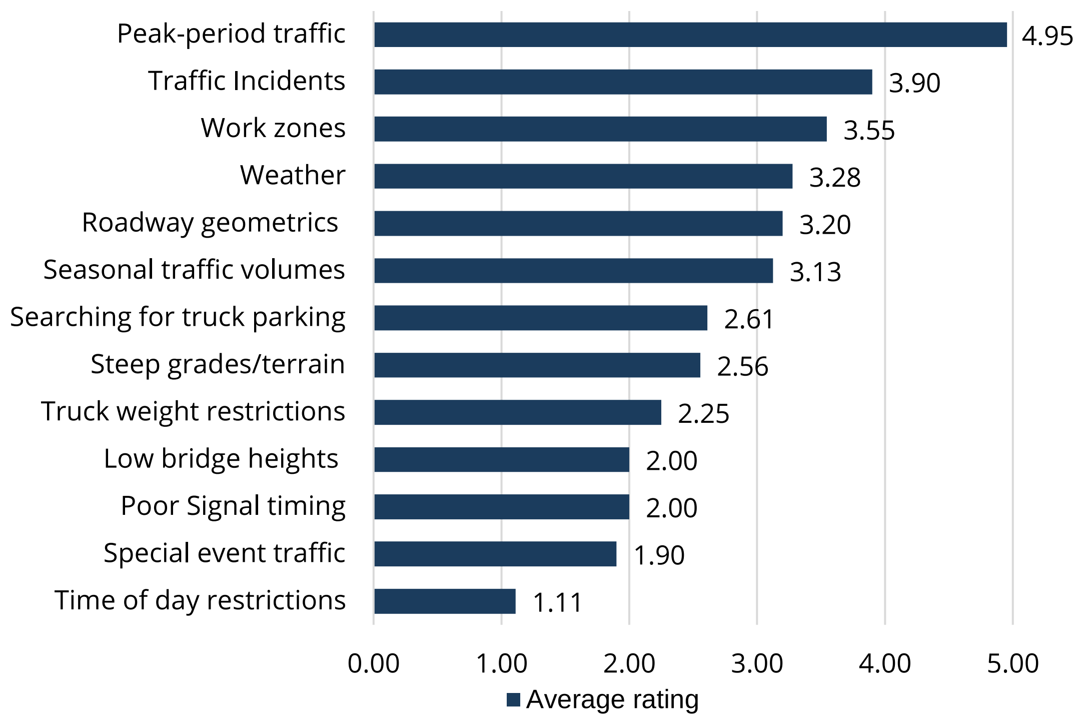
Rank	Trade Lane	Main Corridors	Average Annual Daily Traffic Trucks	Truck Delay per Mile (Hours)	Total Truck Delay (Hours)	Truck Fuel Wasted (Millions of Gallons)	Cost of Truck Delay (Millions)
17	Memphis, TN – Atlanta, GA	I-22 and I-20	7,065	6,240	2,409,200	4	$159
18	Dallas, TX – Raleigh, NC	I-40, I-85, and I-20	7,258	5,758	6,767,394	11	$446
19	Louisville, KY – Cincinnati, OH	I-7	6,838	5,740	570,007	1	$38
20	Atlanta, GA – Miami, FL	I-95, Florida's Turnpike, and I-75	10,880	5,326	3,525,355	5	$230

Source: CPCS Analysis of 2019 NPMRDS and HPMS Data

2.7 Bottleneck Causes

Peak-period traffic is the top bottleneck cause in the Southeast, followed by traffic incidents, work zones, and weather. For this study, Southeast states ranked bottleneck causes on a scale from 1 (not important) to 5 (most important), as shown in Figure 24.

Figure 24: State-Ranked Top Bottleneck Causes



Source: ITTS' 2021 consultations with Southeast States. Alabama, Arkansas, Georgia, Kansas, Kentucky, Louisiana, Mississippi, Missouri, North Carolina, South Carolina, Tennessee, Texas, and Virginia participated in the consultations.

Traffic Incidents: many states mentioned traffic incidents usually were tied to bad weather conditions. Missouri and Tennessee also emphasized the size and weight of trucks made it more dangerous for them during traffic incidents, even though highway patrols and DOTs used signs and message boards to notify drivers promptly. In addition, trucks were constrained by the roads they could travel on, thus truck drivers often chose to wait instead of taking alternative routes.

Work Zones: LA, MS, MO, NC, and TN scored work zones higher than average. Although work zones caused non-recurring and/or temporary bottlenecks, construction and highway improvements made congestion inevitable during the period of work. Furthermore, Missouri also pointed out the impact of emergency work zones should be considered separately since it was hard to notify road users beforehand.

Weather: besides weather being one of the leading causes of traffic incidents, extreme weather conditions, such as flooding, snow, and hurricanes, can also cause post-weather traffic increases due to delayed goods movements and increased restocking demand. In addition, weather events usually happen across state borders and impact traffic flows in multiple states. Georgia gave the example of the increasing traffic causing bottlenecks after the flooding in the Carolinas.

Roadway Geometrics: lane drop is the top roadway geometrics issue identified by the states. The lane drop sometimes happens at state borders, requiring multi-state coordination efforts.

Seasonal Traffic Volumes: Georgia, Missouri, and Texas both ranked seasonal traffic volumes as a more important cause, attributing seasonal traffic to the agriculture industry in the South.

Search for Truck Parking: Alabama, Louisiana, Mississippi, and Missouri all scored searching for truck parking higher than or equal to three. Mississippi pointed out that the limited public truck parking, such as welcoming centers and rest areas, led to truck congestion. Although North Carolina didn't rank truck parking as a top cause for truck bottlenecks, truck parking was considered to be a more severe issue than truck bottlenecks in the state.

Steep Grades/Terrains: Alabama, Georgia, Missouri, and Tennessee considered steep grades/terrains as a more critical cause than other states. I-24 in GA and TN, I-44 in MO, and east TN were the concerns areas given the states.

Truck Weight Restrictions: Alabama, Georgia, Kentucky, and Mississippi rated truck weight restrictions as a more prominent issue. Georgia mentioned that although the bridge conditions were not bad, and the state was replacing many bridges, the weight restrictions still could cause truck bottlenecks, especially in rural areas.

Poor Signal Timing: except for Kentucky, most of the states didn't rank poor signal timing as a major truck bottleneck cause. Kentucky stated that Metropolitan Planning Organizations (MPOs) had been working on updating signal timing. However, it needed to be reevaluated constantly. Signal timing also rarely considered trucks' needs exclusively.

Low Bridge Heights: Kentucky mentioned that they had a lot of parkways that weren't meeting Interstate standards. Currently, they are attempting to upgrade parkways to interstates.

Special Event Traffic: Among the three states ranked special event traffic higher than the average of the Southwest states, Georgia stated that the bottlenecks caused by special event traffic often overlapped with congestion areas induced by peak-period traffic.

Additional bottleneck causes identified by states include changing land use, functionally obsolete bridges, lack of road connectivity, patchwork oversize/overweight policies across states, and speed limits.

2.8 Current Strategies

Southeast states employ a variety of strategies to address top bottlenecks in their states – policies, partnerships and programs, and projects.

Based on a review of freight studies as well as individual consultations and committee discussions, Figure 25 lists types of current strategies states use to address top bottlenecks across the Southeast.

Figure 25: Current Southeast Strategies to Address Bottlenecks

Policies	
	Maintain and improve designated freight networks for freight efficiency and connectivity, and prepare freight system for increasing goods movements and emerging urban delivery patterns.
	Identify locations with existing bottlenecks or at risk of becoming a bottleneck and monitor them for issues or improvement opportunities. • Risk factors include unfavorable infrastructure trends, no recognized route redundancy, a correlation between truck VMT and substandard pavement/bridge ratings on the freight network, O/D trends, etc. • Conduct studies for identified freight highway bottlenecks to identify opportunities for improvement
	Integrate considerations for and prioritize severe congestion locations and efficiency of goods movement in the highway project planning process.
	Define and implement performance measures • To measure and report congestion for the freight network • To track the implementation of projects to reduce congestion
Partnerships and Programs	
	Promote the use of freight technologies (e.g., ITS, CV, AV, TPIMS, WIM) proven to increase the efficiency and reliability of freight movements
	Consider cost-effective methods of capacity expansion before building new lane-miles
	Partner with the private sector to identify opportunities to improve freight flow and reduce congestion (e.g., routing, off-hour delivery times, mode shift, etc.)

	Work with multi-state partners to make corridor-wide system improvements and share information & best practices	
	Secure funding for congestion reduction construction projects (e.g., Texas Clear Lanes Program, value pricing, P3s)	
Project Types		
	Widen and repave roads, ramps, bridges, and tunnels; **add lanes**; **improve** interchanges, intersections, and access	*Traditional*
	Enhance routing options for trucks in urban areas, last-mile connectors	
	Provide truck-only lanes, key bypass routes, truck climbing lanes	
	Implement proven technology solutions (e.g., ITS applications, dynamic message signs, real-time information) to improve mobility and traffic management	
	Other non-traditional capacity improvements to improve congestion (e.g., managed lanes, value pricing, time of day truck restrictions, non-Interstate signal timing)	
	Other innovative designs to improve capacity (e.g., diverging diamond interchanges, super-twos, super streets, etc.).	*Innovative*

2.9 Multi-State Strategies and Collaborations

Many states expressed that collaboration with other states is key to addressing shared bottlenecks across the region from infrastructure improvement projects to operational improvements and technology deployments.

Infrastructure Improvement Projects: Many Southeast states are collaborating to address bottlenecks on multi-state corridors by widening interstates and lanes, improving freeway connectivity, implementing bridge improvements and/or additional bridge crossings, and introducing truck-only lanes. For example, the Georgia Department of Transportation (GDOT) and Tennessee Department of Transportation (TDOT) have been collaborating to widen I-24 from two lanes to three lanes in both directions.

Technology Systems: Other states are working to deploy new technologies on multi-state corridors to improve traffic mobility. These include multi-state traveler information systems, truck parking availability systems, smart corridors, the use of TSMO with messaging boards to communicate incident alerts or travel time estimates, GPS rerouting, and ramp meters through expanded broadband, as well as the advancement of connected, autonomous, and electric vehicle technologies. For example, through a $6.85 million USDOT Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) grant, a coalition of Texas, New Mexico, Arizona, and California DOTs has started installing a Truck Parking Availability System along I-10. For another example, the Eastern Transportation Coalition received funding from FHWA to pilot and demonstrate a real-time truck parking information system. The pilot installed five Virginia sites along the I-95 corridor and turned the system over to the Virginia Department of Transportation (VDOT) for continued operation.

Operational Improvements: Other states are also turning to non-technology-related operational improvements on multi-state corridors, such as diverting truck traffic to other modes, incentivizing diversion of passenger traffic to transit or other modes, and opening shoulders to buses during peak hours. VDOT in particular notes its support of rail intermodal corridors and hopes to divert more truck traffic to rail in the future.

Planning and Project Development: Common among all Southeast states is an impetus for multi-state coordination in planning and project development. States recognize that coordinating the identification of high-priority freight corridors with other states and MPOs is critical to addressing top bottlenecks. The Mid-America Association of State Transportation Officials (MAASTO) conducted an I-70 dedicated truck lane study that involved Missouri, Illinois, Indiana, and Ohio. The study examined the feasibility of the dedicated truck lanes on I-70 based on an analysis of I-70's current needs, future truck volume, available funding, and stakeholder feedback.

The ITTS Regional Bottlenecks Assessment for Goods Movement Study is another example of multi-state collaboration in which Southeast states identified top bottlenecks using a common platform, datasets, and a singular methodology. ITTS facilitates multi-state collaboration around freight planning through regular forums and by funding regional studies of importance to member states.

2.10 Summary

Southeast states employ a variety of strategies to address top bottlenecks in their states including through policies, partnerships and programs, and projects. Many states expressed that collaboration with other states is key to addressing shared bottlenecks across the region from infrastructure improvement projects to operational improvements and technology deployments. The next technical memo will document specific needs and existing, planning, and potential future strategies to address top bottlenecks noted in this Technical Memo.

3 ITTS Methodology

The ITTS Regional Bottleneck Assessment for Goods Movement study aims to develop a common understanding of truck bottlenecks across the Southeast through a single methodology to assess the extent, duration, and severity of truck bottlenecks. In coordination with ITTS, the Project Team identified 2019 as the analysis year to provide a regional overview of truck bottlenecks without disruptions from the COVID-19 pandemic. The study uses 2019 NPMRDS and HPMS data as primary data sources and has two main components:

1. Segment-based bottleneck analysis to understand the top bottleneck segments across the NHS in the Southeast, providing a common platform for studying top bottlenecks.
2. Trips-based bottleneck analysis to understand the top bottleneck segments on the top truck trade lanes in the Southeast, which shows how bottlenecks in a certain state may affect multi-state economic competitiveness.

Both the segment and trips-based bottleneck analyses exemplify the need for multi-state coordination to address top bottlenecks in the region.

The ITTS study used the following performance measures to assess roadway performance: average truck speeds, truck travel time reliability index, truck delay per mile, annual hours of truck delay, and annual cost of truck delay. The overall methodology involved a process of filling missing truck data with passenger car data, matching data to impute travel times for 15-minute bins with no travel times, applying truck volumes from HPMS, estimating delay, and estimating truck cost and wasted fuel. To develop trips-based bottlenecks, the Project Team conflated the NPMRDS' TMC and the FHWA FAF networks and applied a routability-fixing algorithm to develop origin-destination routings.

3.1 Introduction

The ITTS regional bottleneck assessment study is not intended to recreate existing bottleneck analysis performed by FHWA or individual states. Instead, the purpose of the ITTS study is to assist in developing a common understanding of truck bottlenecks across the Southeast through a single methodology by assessing the extent, duration, and severity of truck bottlenecks. To this end, the ITTS bottlenecks study uses NPMRDS and HPMS from 2019 data as primary data sources for the assessment of top bottlenecks. In coordination with ITTS, the Project Team identified 2019 as the analysis year to provide a regional overview of truck bottlenecks without disruptions from the COVID-19 pandemic. The study has two components:

1. Segment-based bottleneck analysis to understand the top bottleneck segments across the entire NHS in the Southeast, providing a common platform for studying top bottlenecks in the Southeast.

2. Trips-based bottleneck analysis to understand the top bottleneck segments on the top truck trade lanes in the Southeast, which shows how bottlenecks in certain states affect multi-state economic competitiveness.

3.2 State and Regional Review

The Project Team started developing the study methodology by reviewing the bottleneck methodologies used by states in the Southeast. The documents cited come from state consultations in August 2021, survey-based validation of the most current bottleneck methodology in February 2022, State Freight Plans, and state bottleneck studies. Due to different levels of bottleneck methodology details described in the referenced documents, the lengths and the details of each state's methodology summarized here vary.

Alabama

Data: NPMRDS; traffic volumes; truck percent

Performance Measures: TTTR; V/C ratio; percent of freight truck traffic

Outside of measures submitted to FHWA, the Alabama Statewide Freight Plan 2017 is the latest document with public information about Alabama's bottlenecks. Performance measures used by Alabama DOT to assess bottlenecks were volume to capacity (V/C) ratio and percent of freight truck traffic.

The Mid-Period Freight Bottleneck Report (2020) explains that Alabama DOT (ALDOT) uses both the V/C ratio and the percentage of trucks on the roadway to identify truck bottlenecks. ALDOT collected traffic volumes, truck percent, and V/C ratio. After the completion of data collection, ArcGIS was used to analyze the data and identify locations that meet pre-determined freight bottleneck criteria (listed in the table below).

Freight Bottleneck Criteria Thresholds

Volume-to-Capacity Ratio	Percent Trucks
V/C > 1.00	5%
V/C > 0.85	10%
V/C > 0.70	15%

Source: Alabama Mid-Period Freight Bottleneck Report (2020)

Referenced Documents:

- Alabama Statewide Freight Plan (2017)
- Mid-Period Freight Bottleneck Report (2020)
- ALDOT Consultation (August 3, 2021)

Arkansas

Data	Performance Measures
Data: NPMRDS; truck GPS data; Arkansas Travel Demand Model (which provides V/C ratio; statewide vertical grade data; statewide commercial truck crash data; construction activities events	**Performance Measures**: TTTR; V/C ratio; daily total delay per mile of truck travel (DTDPM); Level of Service (LOS); percent of interstate system mileage providing reliable truck travel times; percent of interstate system with mileage uncongested

Arkansas completed an internal statewide bottleneck analysis in 2020 as part of federal requirements. Moving forward, Arkansas DOT (ARDOT) will pursue the identification of truck freight bottlenecks using the FHWA Truck Freight Bottleneck Reporting Guidebook (July 2018).

For the 2020 bottleneck analysis, ARDOT followed FHWA recommended 6-step process to identify bottlenecks. ARDOT only conducted bottleneck analysis on road segments with more than 3,000 trucks per day. Then, 2019 NPMRDS data, statewide LOS, statewide vertical grades data, statewide commercial truck crash data, and construction activities events were used to identify recurrent and non-recurrent congestion. ARDOT chose the daily total delay per mile (DTDPM) of truck travel, a comparative measure based on segment length and truck volume calculated using the NPMRDS dataset, as the performance measure for the truck bottleneck analysis. To validate identified bottlenecks, ARDOT reviewed the identified segments' lengths and their adjacent segments to ensure no false positives or false negatives occurred. Roadway users and stakeholders also contributed their input to the validation process. A more detailed description of the process can be found in ARDOT's Mid-Year Report on Truck Freight Bottlenecks.

Referenced Document:

- Mid-Year Report on Truck Freight Bottlenecks (2020)
- ARDOT Consultation (August 11, 2021)

Florida

Data	Performance Measures
Data: NPMRDS	**Performance Measures**: Truck vehicle hours of delay per segment mile (VHD/M); truck vehicle hours of unreliability per segment mile (VHU/M)

The Florida Freight Mobility and Trade Plan (2020) reported the top 100 truck bottlenecks for recurring or non-recurring congestion in the state.

The NPMRDS data from 2018 was first filtered to only include weekdays and non-federal holidays and then used to calculate VHD/M for recurring congestion and VHU/M for non-recurring congestion. VHD was the number of hours of travel above free-flow condition, while VHU was the accumulated difference between the 95th percentile travel and the average travel time. Finally, VHD and VHU were normalized by segment mileage to get the two performance measures – VHD/M and VHU/M.

Referenced Document:

- Florida Freight Mobility and Trade Plan Technical Memorandum 3 Performance and Conditions (2020)

Georgia

Data: ATRI GPS data; GDOT Statewide Travel Demand Model	**Performance Measures**: TTTR; V/C ratio; average speeds on interstates; average HERO (Metro Atlanta) Response Time; Daily Hours of Truck Delay on Georgia Interstates

Georgia completed the last bottleneck analysis in its 2018 State Freight and Logistics Plan and updated the list of bottlenecks based on the national ATRI bottleneck listing of Georgia locations annually. The most recent reporting document is the 2020 State Biennial Performance Report, submitted to FHWA in August 2020. Georgia DOT (GDOT) identifies two types of truck bottlenecks – corridor-level bottlenecks and site-specific bottlenecks.

GDOT evaluates corridor-level congestion using a V/C ratio generated from the Statewide Travel Demand Model. The V/C ratio is based on 24-hour all-vehicle volumes and 24-hour capacities (which is the number of vehicles that can be handled on the roadway).

Additionally, GDOT also uses ATRI GPS data to gain more insights into the corridor-level bottlenecks in Georgia. The analysis evaluates the following three components:

- A statewide truck speed analysis on the interstate system during four time periods – morning peak (6:00 AM to 10:00 AM), mid-day (10:00 AM to 3:00 PM), afternoon peak (3:00 PM to 7:00 PM), and off-peak (7:00 PM to 6:00 AM)
- A corridor-level comparative analysis of the ten most congested corridors based on average speed data during 24 hours and the top 50 truck locations.
- A detailed analysis of the ten most congested corridors to gain an understanding of existing delay characters, including the average speed, segment reliability, and time-of-day reliability (buffer index) by direction.

Lastly, GDOT reviewed the numerous national-level truck bottleneck studies and summarized the rankings of Georgia locations.

Referenced Documents:

- Georgia Statewide Freight and Logistics Plan Truck Modal Profile (2018)
- GDOT Mid-Performance Period Progress Report (2020)
- GDOT Consultation (August 9, 2021)

Kentucky

Data: NPMRDS

Performance Measures: 95th percentile speeds; TTTR; weighted value of delay

The last bottleneck update was the federal submission of the FHWA Annual PM3 Report in October 2020.

The Kentucky Transportation Cabinet (KYTC) considers three different criteria when evaluating bottlenecks. The state reviews 95th percentile speeds, TTTR index, and weighted value of delay. For 95th percentile speeds, links are ranked in order of ascending speeds. The maximum TTTR index is another criterion reviewed, and roadway segments are ranked by maximum TTTR during five time periods – AM peak, mid-day, PM peak, weekends, and overnights for all days. Finally, to avoid false positive and false negative results caused by segment lengths, KYTC also calculated the weighted value of delay, which is the product of length, truck AADT, and maximum TTTR. This weighted value of delay accumulates delay not just by roadway link but also with consideration of truck AADT, where roads with lesser AADT are sorted down the list.

Referenced Documents:

- KYTC Consultation (August 2, 2021)

Louisiana

Data: NPMRDS

Performance Measures: Annual truck hours of delay

The most recent bottlenecks assessment completed for Louisiana was part of the 2018 Louisiana Freight Mobility Plan. To evaluate congestion, The Louisiana Department of Transportation and Development (LA DOTD) uses annual truck hours of delay calculated from NPMRDS. LA DOTD also evaluates the freight network performance by looking at the following indicators:

- The percent of miles on freight network Tiers 1 (National Freight Primary Network) and 2 (the remainder of the Interstate system) in an uncongested condition;
- The number of bottlenecks on the freight network addressed by capital projects; and
- The hours of incident-induced downtime on Tiers 1 and 2.

Referenced Documents:

- Louisiana Freight Mobility Plan (2018)
- LADOTD Consultation (July 30, 2021)

Mississippi

Data: NPMRDS; Statewide Travel Demand Model	**Performance Measures**: TTTR; LOS

The Mississippi Department of Transportation (MDOT) updated the major truck freight bottlenecks in the Transportation Performance Management Mid-Performance Period Progress Report.

Using the NPMRDS, MDOT analyzed the TTTR measured freight reliability via the TTTR index. MDOT also used existing and anticipated highway LOS to evaluate the reliability of truck freight flow on six Tier I Corridors and seven Tier II Corridors in their 2017 State Freight Plan.

In addition to the above-mentioned truck bottleneck analysis, the latest Mississippi long-range transportation plan (MULTIPLAN 2045) includes an analysis of the LOS of the highway network using the 2019 Statewide Travel Demand Model.

Lastly, MDOT also gathered information from the ATRI's nationwide bottleneck analysis and input from the state's shippers and carriers.

Referenced Documents:

- Transportation Performance Management Mid-Performance Period Progress Report Truck Freight Bottleneck Update (September 22, 2020)
- Mississippi State Freight Plan (Amended in 2017)
- MDOT Consultation (August 4, 2021)

Missouri

Data: NPMRDS	**Performance Measures**: TTTR; average truck speed; AADT

The Missouri Department of Transportation (MoDOT) is currently nearing the completion of its State Freight and Rail Plan update, which includes Missouri's most recent freight bottlenecks analysis.

In the State Freight and Rail Plan update, MoDOT identified freight bottlenecks of interest, referencing ATRI's top 100 truck bottleneck list in 2019 and using NPMRDS data to generate performance measures of length-weighted minimum average truck speed and maximum TTTR. Average truck speed and TTTR were also reviewed across all five time periods to understand where there is severe congestion and persistent unreliability. MoDOT also identified locations in the state where trucks can have significant delays due to crash-related traffic backups.

Referenced Documents:

- State Freight and Rail Plan Update Appendix – Draft Bottlenecks Subsection (March 7, 2022)
- Missouri DOT consultation Notes
- MoDOT Consultation (August 25, 2021)

North Carolina

Data: NPMRDS; Regional Integrated Transportation Information System (RITIS)	**Performance Measures**: TTTR; V/C ratios; Truck Buffer Time Index (BTI)

The recent update of the truck freight bottleneck analysis was the Mid-Performance Period Report submitted to FHWA in October 2020.

When setting the truck bottleneck baseline in 2018, the North Carolina DOT (NCDOT) used V/C ratios, BTI, and TTTR. They first analyzed V/C ratios and the BTI. The former indicates the severity of congestion on the roadways. A roadway with a V/C ratio higher or equal to 0.5 was considered as having capacity constraints. The BTI represents the extra time required to be added into scheduling for an on-time arrival for 95 percent of truck trips. The higher the BTI, the longer additional travel time is needed to ensure on-time arrival. The areas identified via V/C ratios and BTI were further validated using TTTR provided by RITIS. For the update in 2020, NCDOT compared the baseline bottlenecks to the 2019 TTTR from RITIS and identified a list of bottlenecks that appeared in the baseline list and the obtained high TTTR values (2.75 or greater). NCDOT also uses RITIS's bottleneck ranking tool as a reference. Even though the ranking tool evaluates the congestion-weighted delay of all vehicles, it is helpful to review and identify additional bottlenecks.

Referenced Documents:

- NCDOT Mid-Period Performance Progress Report – Progress of Addressing Congestion at Truck Freight Bottlenecks (September 2020)]

South Carolina

Data: NPMRDS; ATRI cost of delay data	**Performance Measures**: Truck speeds and volume; LOS; TTTR; Annual hours of truck delay; Percent of Interstate segments with reliable travel times

The most recent bottleneck analyses were the updated State Freight Plan (2020) and the performance measure reporting to the FHWA.

The South Carolina DOT (SCDOT) Travel Demand Model was used to calculate the percent of Interstate segments with reliable travel times. The key inputs include speed/travel time, density (vehicle counts/capacity), and delay time. Another performance measure is the TTTR index. The index was calculated by using the NPMRDS dataset and taking the sum of maximum TTTR for each segment divided by total interstate miles. SCDOT defined critical speed themselves, choosing free flow as the average speed between 10 PM and 5 AM and the 85^{th} percentile as the critical speed.

Quantification of speed was based on hours – hourly speed and hourly volume. SCDOT used K and V count factors from continuous count stations (CCS). To come up with reasonable hourly volumes, the DOT did a correlation analysis between TMC and count station (count line) and CCS, to apply the right TMC. For the cost of truck bottlenecks, SCDOT depended on ATRI's data because they documented all types of costs of delay to monetize the factors.

Referenced Documents:

- South Carolina State Freight Plan Update (2020)
- SCDOT Consultation (August 3, 2021)

Tennessee

Data: NPMRDS; ATRI	**Performance Measures**: Truck AADT; Interstate Lane width; changes in speed limit; daily Interstate capacity; volume/capacity ratios; LOS; TTTR; freight travel time variability

The latest bottleneck study (Tennessee Interstate Freight Bottleneck Analysis) was a report that used truck AADT, Interstate Lane width, changes in speed limit, daily Interstate capacity, and volume/capacity ratios to identify 60 bottlenecks in 2019. Besides the study, Tennessee DOT (TDOT) also references ATRI's annual bottleneck analysis.

The State Freight Plan updated in 2019 doesn't incorporate the 60 bottlenecks identified in the above-mentioned bottleneck study. The bottleneck analysis in the amended plan still uses multiple data sources from 2012. The data includes truck speeds from ATRI and NPMRDS, capacity analysis, and truck volumes. TDOT also used its EValuation of roadway Efficiency (EVE) program and the Tennessee Roadway Information Management System network to evaluate the LOS of all roadway segments. The LOS analysis covered both passenger and freight movements. However, the data used in those analyses were from 2012, which is outdated. TDOT mentioned that they had planned to develop a new bottleneck analysis in the future.

TTTR and the freight travel time variability are the other measures used to evaluate the congestion in the state. TTTR represents the average reliability of all reporting segments on the Interstate system, while the freight travel time variability is the 95th percentile travel time compared to the travel time during free-flow conditions.

Referenced Documents:

- Tennessee Interstate Freight Bottleneck Analysis (2019)
- Tennessee Statewide Multimodal Freight Plan (Amended in 2019)
- TDOT Consultation (July 30, 2021)

	Texas	
	Data: Roadway-Highway Inventory (RHiNo) database; INRIX	**Performance Measures**: total delay per mile of road; Texas Congestion Index (TCI); total delay; Planning Time Index (95th percentile); congestion cost; time of congestion

The most recent bottleneck identification analysis was conducted in 2017 for the 2018 Freight Mobility Plan.

The Texas DOT (TxDOT), in partnership with the Texas A&M Transportation Institute (TTI), annually produces a ranked list of Texas's most congested roadways. Truck delay per mile is the primary performance measure used for the bottleneck ranking and is identified as the performance measure that best identifies the most congested segments. In addition to total delay per mile, other performance measures calculated related to freight bottlenecks are Texas Congestion Index (TCI), total delay, planning time index (PTI), delay cost, fuel cost, time of congestion, excess CO2, excess fuel consumed, and total CO2 produced. The three environmental-related performance measures are defined below:

- Excess CO2 was developed using the EPA's Motor Vehicle Emission Simulator (MOVES-2010) model which considers such factors as vehicle emission rates, climate data, and vehicle speeds to generate CO2 from mobile sources. The model is run for every 15 minutes for both the measured speed and corresponding free-flow speed to calculate the amount of excess CO2 produced during congestion.
- Excess fuel consumed is Based on the relationship between CO2 emissions and fuel usage, the amount of excess fuel consumed in congestion is calculated concurrently when the excess CO2 is calculated by comparing rates at the measured speed and the free-flow speed for each segment.
- The total CO2 produced refers to annual tons of excess CO2 produced in congestion plus during free-flow driving conditions

The total delay per mile, TCI, total delay, PTI, and congestion cost were calculated using four data inputs – actual travel speed, free-flow travel speed, and vehicle volume (total vehicle and truck). TTI calculates its own reference or uncongested speeds for use in calculations. Traffic and road data (e.g., traffic volumes, truck volumes, number of lanes, etc.) come from TxDOT's Roadway-Highway Inventory (RHiNo) database, with speed data for its most recent publication (2020 list) obtained from INRIX. Examined road segments are usually between three and ten miles long except for major road segments that are less than three miles long. A 7-step process was taken to evaluate road segments and identify bottlenecks. The details can be found in the TTI's "Analysis Procedures and Mobility Performance Measures 100 Most Congested Texas Road Sections - Technical Memorandum".

Referenced Documents:

- Analysis Procedures and Mobility Performance Measures 100 Most Congested Texas Road Sections - Technical Memorandum (2021)
- Texas's Most Congested Roadways, Frequently Asked Questions
- TxDOT Consultation (August 5, 2021)

Virginia

Data: INRIX speed data; VDOT traffic counts; RITIS Travel Time Index	**Performance Measures**: Travel Time Index; safety; truck restriction;

The most recent truck bottleneck assessment is the new Virginia Transportation Plan.

The Virginia DDOT (VDOT) evaluated several truck performance measures, including congestion, reliability, safety, and truck restrictions. Three congestion and reliability measures, including cumulative truck congestion, Travel Time Index (TTI), PTI, and Level of Travel Time Reliability (LOTTR) are examined. Segments with above-average congestion and reliability measures were identified as potential freight bottlenecks. The analysis was conducted on the Corridors of Statewide Significance (CoSS), which are corridors that 1) involve multiple travel modes or is an extended freight corridor; 2) connect regions, states, and/or major activity centers; 3) carry a high volume of travel; and 4) provides a unique state function and/or addresses statewide goals.

Cumulative truck delay is the number of hours where truck speed is less than 75 percent for referenced speed. Travel Time Index indicates the ratio of the travel time during the peak period to the time required to make the same trip at reference speeds. To calculate TTI, VDOT utilized RITIS to retrieve the weekday and weekend day average hourly travel time index. Then, the number of hours during weekdays and between 6 AM and 8 PM that had a TTI greater than 1.3 and 1.5 was calculated separately. Roadway segments with a TTI exceeding 1.5 for at least one hour, or 1.3 for at least three hours, are considered segments requiring congestion mitigation.

LOTTR was calculated using observed speed data from INRIX and traffic volume data from VDOT Traffic Monitoring System. To calculate LOTTR, VMT data developed from traffic volume during weekday and weekend day hours between 6 AM and 8 PM was joined to INRIX TMCs that contained traffic speed data. The longer (80^{th} percentile) travel times were then divided by the normal (50th percentile) travel time, resulting in a ratio referred to as LOTTR. The number of weekday and weekend LOTTR hours between 6 AM and 8 PM that exceed 1.5 was counted separately, then multiplied by two factors (5/7 for weekdays and 2/7 for weekends) to get the weighted average LOTTR. The segments with weighted LOTTR greater than 1.5 were considered those with reliability needs.

Referenced Documents:

- Technical Guide for the Identification and Prioritization of the VTRANS Mid-Term Needs (2021)
- 2020 VDOT Mid Performance Period Report (2020)
- VTrans 2040 Freight Element (2017)
- VDOT Consultation (August 13, 2021)

3.3 ITTS Methodology Overview and Performance Measures

The ITTS study is an aggregate regional planning-level analysis. To allow member states to compare results and understand multi-state impacts, consistent data sources and methods are applied across the entire Southeast region. Figure 26 includes the data inputs and outputs for the ITTS study.

Figure 26: ITTS Study Data Inputs and Outputs

Inputs	Outputs
• NPMRDS 2019: truck travel speed, travel time data • HPMS 2019: truck counts, truck classification, number of lanes, speed limits • Road Network Data: TMC Network, National Highway Freight Network, Critical Rural and Urban Freight Corridors • Top Origin-Destination Pairings: Consultations, Literature Review, and Data Analysis of FreightWaves and FHWA Freight Analysis Framework 5	Performance Measure Calculations: • Average Truck Speed • Truck Travel Time Reliability index • Truck Delay per Mile • Annual Hours of Truck Delay • Annual Costs of Truck Delay Ranked top truck bottlenecks, state-identified bottleneck causes, and connections to supply chains

The performance measure outputs are detailed below.

Average Truck Speed is a nominal measure derived from NPMRDS's raw truck speeds. The Project Team compiled average truck speeds using 15-minute time bins for 2019. Additionally, the data were segmented into four times of the day: AM Peak, Midday, PM Peak, Overnight, and Weekend (defined below).

- AM Peak: 6:00am – 10:00am
- Mid-Day: 10:00am – 4:00pm
- PM Peak: 4:00pm – 8:00pm
- Overnight: 10:00pm – 6:00am
- Weekend: Saturday and Sunday

Truck Travel Time Reliability Index (TTTR) is a federally-required performance measure and illustrates the uncertainty of truck travel times. Larger values indicate less reliability in truck travel times, while values closer to 1.0 indicate a relatively predictable travel time. As required by the FAST Act, each state must submit this information to FHWA annually. This study includes a measure of TTTR for all segments. States should expect some differences in ITTS, and state results based on the dataset and data cleaning processes used.

$$Truck\ Travel\ Time\ Reliability\ Index\ (TTTR):$$
$$= 95th\ percentile\ truck\ speed \ / \ 50th\ percentile\ truck\ speed$$

Truck Delay is the excess truck travel time for each segment, calculated as the difference between actual truck travel time and the travel time based on reference speeds. **Truck Delay per Mile** takes the excess truck travel time for each segment and normalizes this based on the length of each segment to allow comparisons. Top truck bottlenecks in the region are ranked based on delay per mile.

Annual Hours of Truck Delay measures the aggregate hours of truck delay over the full 2019 year for each segment. The Project Team also calculated annual hours of truck delay for each state, interstate, and the full Southeast region.

Annual Cost of Truck Delay includes the cost of truck delay based on the value of time and the wasted truck fuel costs. The Project Team calculated annual costs of truck delay for each segment in the full Southeast Region. The methodology for calculating Commercial Motor Vehicle (CMV, truck) delay cost and fuel cost is described in Section 3.3.3.

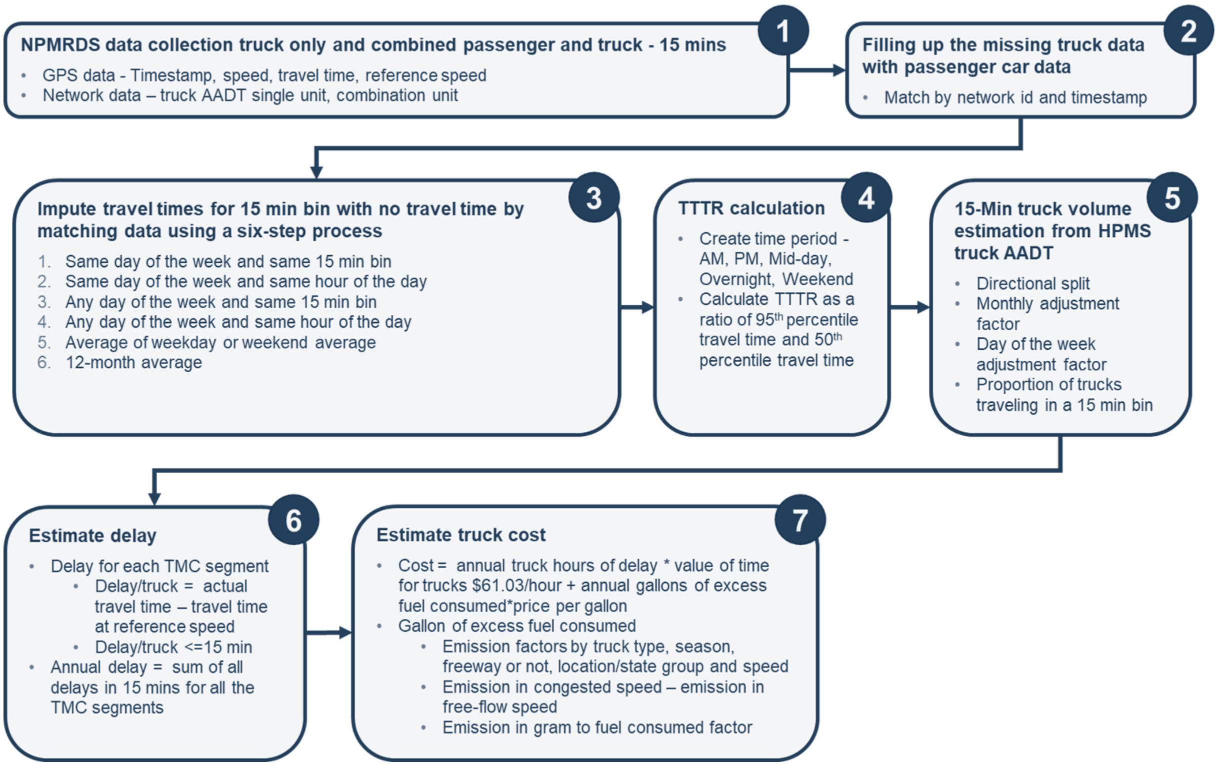
$$Annual\ Cost\ of\ Delay\ =\ Annual\ CMV\ Delay\ Cost +\ Annual\ CMV\ Fuel\ Cost$$

3.3.1 Data Analysis

NPMRDS Dataset Overview: NPMRDS is a national database compiled by INRIX under contract to FHWA and includes historical average travel time from vehicle probe data by all vehicles, passenger vehicles, and freight trucks. This means that INRIX's travel times are based on actual observed speeds, rather than from estimated or modeled values. Travel times are reported in NPMRDS where there are statistically-significant sample sizes for freight and passenger traffic at the following geographic coverages: U.S. interstate system, National Highway System including intermodal connectors, Strategic Defense Network Roadways (STRAHNET), and border crossings on principal arterials. Travel times are compiled on TMC network segments every 5 minutes across a calendar year. The TMC network shows short directional roadway segments that have been defined by commercial traffic information providers.

The overall ITTS bottleneck assessment workflow is illustrated in Figure 27.

Figure 27: ITTS Bottleneck Assessment Workflow



Source: CPCS Analysis of FHWA Bottlenecks Methodology and NPMRDS Dataset

The Project Team extracted all 15-minute travel times in 2019 through NPMRDS for the full Southeast region and calculated travel time indices for each TMC segment. The data collection included both truck and combined passenger and truck travel time data. The Project Team also used NPMRDS 2021 dataset which is conflated with HPMS 2019 to extract the truck volumes from HPMS 2019. Indices were then developed for each of the other performance measures – TTTR, truck delay per mile, annual hours of truck delay, and annual cost of truck delay. This allows the measures to be aggregated spatially and by segment, roadway, county, state, and multi-state regions.

For TMC segments that are missing values during 15-minute periods, the Project Team estimated travel times based on historical observations over the 12 months by applying speed data by passenger cars first. Notably, a high percentage of segments on higher functional classes are missing truck speeds. Figure 28 depicts the sample size by functional class for truck speeds and passenger car and truck speeds combined. As a result, while aggregate results reflect all functional classes, the top bottlenecks identified in Section 2.5 focus on Southeast interstates and U.S.-highways (functional classes 1-3).

Figure 28: NPMRDS 2019 Truck and Passenger Car Sample Sizes by Functional Class

Functional Classification System	Truck-only sample (%)	Combined passenger car and truck sample (%)
1 (Interstate)	84.9	93.9
2 (Principal Arterial – Other Freeways and Expressways)	47.9	75.8
3 (Principal Arterial – Other)	18.2	46.9
4 (Minor Arterial)	10.4	33.3
5 (Major Collector)	6.8	19.6
6 (Minor Collector)	1.9	8.2
7 (Local)	5.0	18.3

Source: CPCS Analysis of NPMRDS 2019 Data

If speed data for passenger cars is missing, the data is then run through the process developed by the TTI, where each subsequent step is only taken if data from the current step is unavailable:

1. Same day of the week and same 15 min bin
2. Same day of the week and same hour of the day
3. Any day of the week and same 15 min bin
4. Any day of the week and same hour of the day
5. Average of weekday or weekend average
6. 12-month average

Notably, the segmentation is different in the FHWA freight mobility tool compared to this ITTS study, as TMC segments are not aggregated here. This is to facilitate the usage of the dataset for each member state's individual planning purposes. Thus, differences may be observed between the tools due to segmentation. ITTS' shorter segments more closely match state bottleneck submittals to the FHWA and have more applications for state-level comparisons.

HPMS Dataset Overview: The HPMS dataset from FHWA includes traffic volume information for average annual daily traffic (AADT) for single-unit trucks and buses, combination trucks, and passenger vehicles.

Truck volumes are estimated based on HPMS 2019 truck AADT based on time-of-day, day-of-week, and month-of-year traffic volume profiles to account for seasonal variation in truck volumes. Because the NPMRDS 2019 dataset was previously conflated with HPMS 2017 data, **the Project Team updated the HPMS data to 2019 to allow for consistency in assessing 2019 bottlenecks with both speed and volume information from the same year. This contrasts with the FHWA freight mobility tool, which uses HPMS 2017 data.**

In addition to different segment sizes between the ITTS and FHWA approaches, the difference in HPMS years accounts for some of the difference in delay between the ITTS and FHWA results as shown in Figure 29. There are also large differences in truck vehicle-miles-traveled (VMT) between 2017 and 2019 HPMS data in some states. For example, the Project Team found that Georgia's 2019 truck VMT was 2.95 times that of 2017 truck VMT, and South Carolina's 2019 truck VMT was only 58 percent that of 2017 truck VMT. However, combined VMT changes (truck and passenger car) by state between 2017 and 2019 HPMS data files differed by only -5 percent to +7 percent. The Project Team verified these numbers with GDOT and SCDOT directly and an explanation of these differences is provided in **Appendix B.**

Figure 29: Total Truck Delay Comparison by State – ITTS and FHWA Tools

State	Total Hours of Delay (ITTS Tool)	Total Hours of Delay (FHWA Tool)	Difference (%)
Alabama	9,182,193	9,570,542	-4.06
Arkansas	5,540,867	5,754,862	-3.72
Florida	34,644,056	40,424,749	-14.30
Georgia	59,922,593	25,915,822	+131.22
Kentucky	8,336,040	8,614,799	-3.24
Louisiana	13,124,910	15,279,657	-14.10
Mississippi	6,359,945	5,495,147	+15.74
Missouri	15,089,107	13,640,467	+10.62
North Carolina	13,683,306	12,397,400	+10.37
South Carolina	6,179,452	12,124,281	-49.03
Tennessee	21,426,687	20,091,704	+6.64
Texas	64,134,756	62,024,730	+3.40
Virginia	13,077,246	12,505,731	+4.57

Source: CPCS Analysis of NPMRDS 2019 Data and FHWA Bottlenecks Tool

In assessing NPMRDS data, the Project Team found that single-unit truck and combination truck AADTs were assigned to opposite fields. This was subsequently reported and corrected by the NPMRDS Support Team on March 25, 2022. The truck AADT fields were reversed at the creation of the 2020 and 2021 NPMRDS attribute tables using HPMS 2018 and 2019 data conflation. The Project Team corrected this issue independently, in advance of the NPMRDS correction, for the NPMRDS 2021 / HPMS 2019 dataset. Figure 30 illustrates this issue.

Figure 30: NPMRDS Truck Volume Data Issue

thrulanes	route_numb	route_sign	route_qual	altrtename	aadt	aadt_singl	aadt_combi	nhs	nhs_pct
10	70	2	1	70	148866	7246	10840	1	100
10	70	2	1	70	148866	7246	10840	1	100

AADTs reversed for trucks

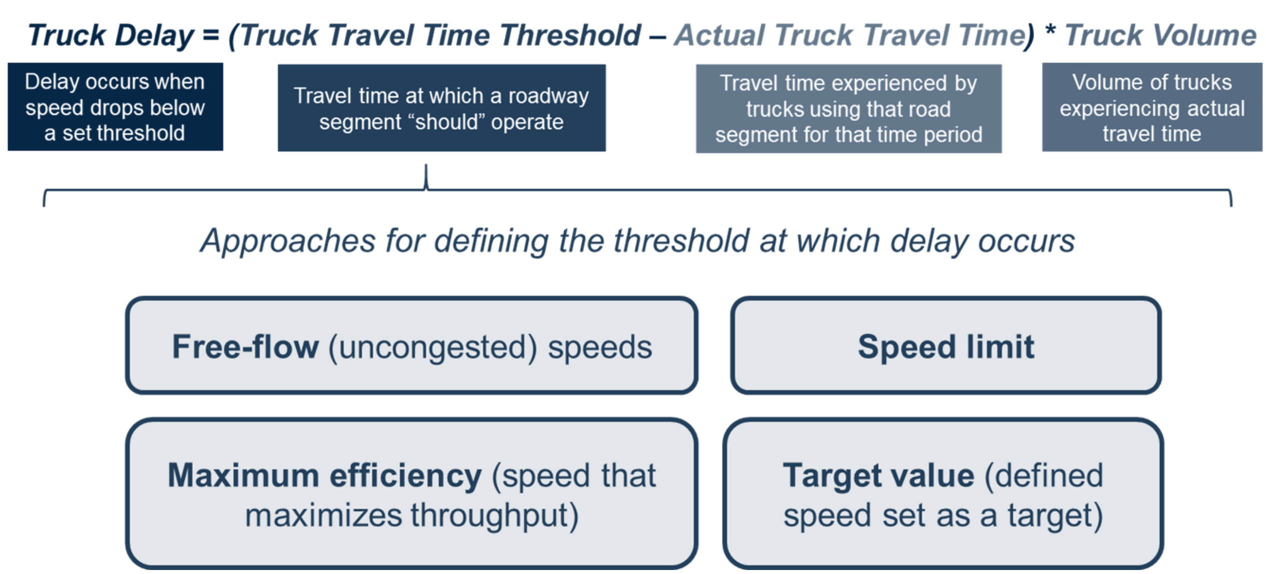
Source: NPMRDS Support Team Email Received March 25, 2022

Additionally, the NPMRDS conflated HPMS data also assigned AADT in both directions within the TMC network, effectively double-counting AADT on segments with bi-directional flows. The Project Team has corrected this within the dataset.

3.3.2 Delay Calculations

The Project Team explored different approaches to define the threshold at which delay occurs, including free-flow (uncongested) speeds, speed limit, maximum efficiency (speed that maximizes throughput), and a target value (defined speed set as a target). This is shown in Figure 31.

Figure 31: Delay Calculation Methodologies



Source: CPCS Analysis of NCHRP 854

Choosing which approach to use is usually based on four interrelated considerations as noted in NCHRP 854:

- **Local Policy Goals** – ensuring compatibility of approach across agencies and USDOT
- **Sensitivity Analysis** – ensuring computed delay matches public perception

- **Relationship between Thresholds and Targets** – ensuring the extent of the problem and extent of delay that is unacceptable to the region are correlated
- **Data Availability** – ensuring regional datasets are available to compute delays

Based on consultations with the ITTS Steering Committee, delay at free-flow was the most appropriate option because trucks do not necessarily travel at speed limits even under uncongested conditions. To ensure the study results are compatible with other planning studies, the NPMRDS approach to free-flow conditions was chosen, based on the 85th percentile point of the observed speeds on that segment for all time periods.

Figure 32 illustrates other example approaches for calculating delay.

Figure 32: Example Approaches for Calculating Delay

Source	Approach
NPMRDS	Existing "reference_speed" field: • Defined as the calculated "free flow" mean speed for the roadway segment in mph • Attribute calculated based upon the 85th percentile point of the observed speeds on that segment for all time periods
NCHRP 854	Documented approaches for delay calculations • Compared to free-flow • Using speed limit • From maximum efficiency – the maximum vehicle throughput (usually at speeds slightly below the speed limit) • From target value – the specific operating targets for roads
FHWA Freight Mobility Tool	Reference time of 85th percentile speed during off-peak and overnight time periods. • Delay calculated for each 15-minute period • Delay for each period multiplied by 15-minute truck volumes (estimated from AADTT) using typical time-of-day traffic volume profiles. Delay for each 15-minute period aggregated for annual truck hours of delay. • Total truck hours of delay divided by segment length to get total truck hours of delay per mile.
TTI	Reference speed calculated based on 85th percentile for all weeknight speeds between 10 PM – 6 AM • Average truck speeds at every 15 minutes • If at least half of the 15-minute time periods on weeknights are not populated with a speed, weekday speeds between 11 PM – 4 PM also added to the pool, 85th percentile for combination used
ATRI	Free flow assumed at 55 mph at all locations screened, and delay as truck speed deviation from free flow. • Extract all weekdays in one year and calculate truck speed for each hour of the day • Multiply hours based on truck volume by hour, and sum all 24 hours
State DOTs	State approaches vary • Different reference times (e.g., free flow assumed at MPH vs percentile-based) • Different use of speed limits (e.g., speed limit MPH vs. percent of posted speed limit) • Varied application of additional considerations or criteria (e.g., truck volumes, segment lengths, times of day, etc.)

The Project Team applied actual 15-minute travel times for each TMC segment against the reference speed of 85^{th} percentiles for each segment and aggregated this over the full year of 2019.

3.3.3 Delay Cost Calculations

Truck Delay Cost is an estimate of the value of lost truck time and the increased operating costs of trucks driving in congested conditions.

$$\begin{aligned} &\mathit{Annual\ Truck\ Delay\ Cost} \\ &= \mathit{Daily\ Truck\ Hours\ of\ Delay} \times \mathit{Value\ of\ Truck\ Time} \times \mathit{Annual\ Factor} \end{aligned}$$

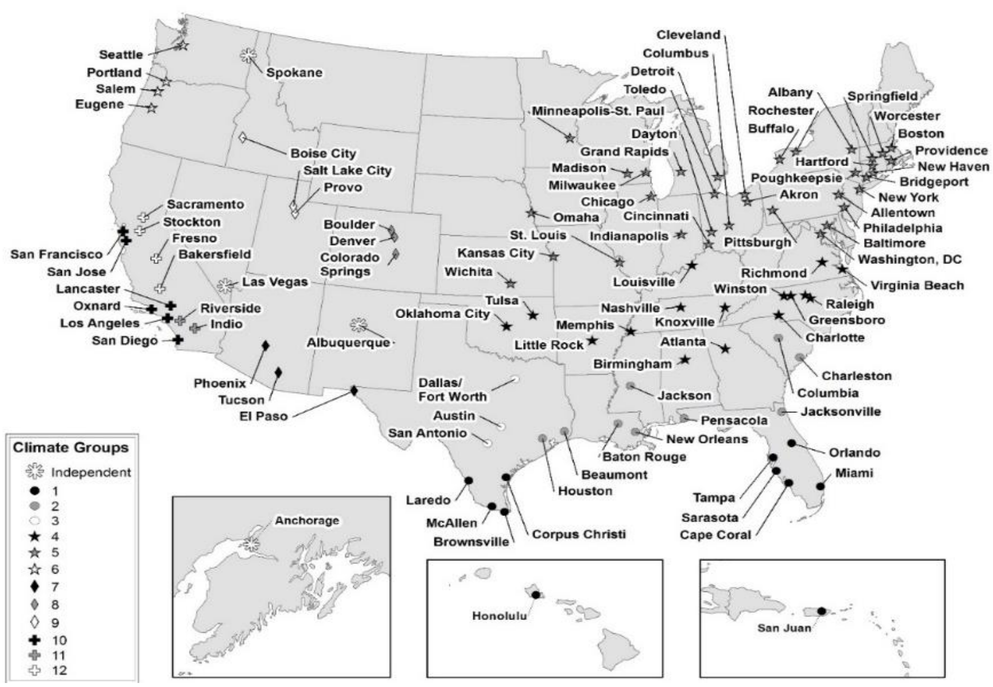
The value of truck time is based on the 2019 ATRI estimate ($49.49/hr) and includes the cost of truck/trailer lease or purchase payments, repairs and maintenance, truck insurance premiums, permits and licenses, tires, tolls, driver waves, and driver benefits.

Truck Fuel Cost is fuel cost due to congestion and is calculated by associating the wasted fuel, the percentage of trucks in the vehicle mix, and the fuel costs.

$$\begin{aligned} &\mathit{Annual\ Truck\ Fuel\ Cost} \\ &= \mathit{Daily\ Wasted\ Fuel} \times \mathit{Percent\ of\ Trucks} \times \mathit{Fuel\ Cost} \times \mathit{Annual\ Conversion\ Factor} \end{aligned}$$

Fuel wasted in congestion is calculated by subtracting fuel that would be consumed in free flow conditions from fuel consumed in congestion. Fuel estimates were developed in consultation with the TTI's CO2 emission calculations based on the U.S. Environmental Protection Agency's (EPA) MOtor Vehicle Emission Simulator (MOVES) model which estimates emissions from mobile sources. The method uses the HPMS dataset, INRIX traffic speed data, and the MOVES model. Firstly, U.S. climate regions are grouped by state. Figure 33 indicates the 16 climate groupings for each of the 50 U.S. states.

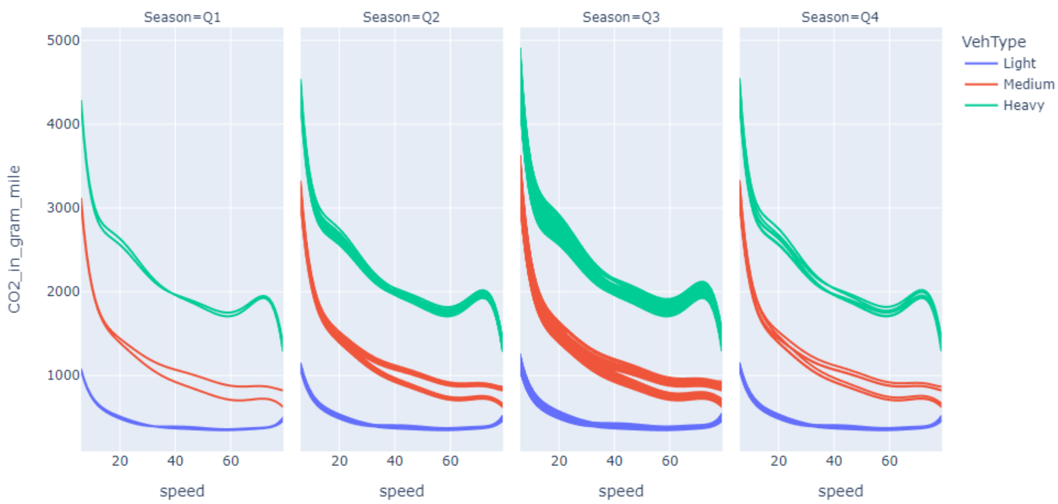
Figure 33: United States Map of Climate Groupings



Source: Texas Transportation Institute Methodology for FHWA Freight Mobility Tool

The Project Team adapted TTI's emission curves for these 16 groupings by correlating speed and emission rates for each grouping, season (four quarters of a year), functional classification (freeway or arterial), and vehicle type (light, medium, and heavy-duty) based on the MOVES model. Representations of these emission curves are shown in Figure 34.

Figure 34: U.S. Emission Curves based on MOVES Model



Source: CPCS Analysis of Texas Transportation Institute Methodology for FHWA Freight Mobility Tool

The emission curves were applied based on the MOVES model's classification of vehicles for passenger cars, passenger trucks, single-unit short-haul trucks, and combination short-haul trucks as shown in Figure 35.

Figure 35: Vehicle Types based on HPMS and MOVES Model

Vehicle Type	MOVES "SourceType" Selected for Emission Rates	Weighted (based on VMT)	MOVES "SourceType" ID	Fuel Type
Light-Duty Vehicles	Passenger Cars	59%	21	Gasoline
	Passenger Trucks	41%	31	Gasoline
Medium-Duty Trucks	Single Unit Short-Haul Trucks	None	52	Diesel
Heavy-Duty Trucks	Combination Short-Haul Trucks	None	61	Diesel

Source: Texas Transportation Institute Methodology for FHWA Freight Mobility Tool

These values were used to calculate fuel consumption during congested conditions and free-flow conditions. The difference between congested and free-flow conditions is the wasted fuel due to congestion. Consistent with the FHWA methodology, the Project Team used $3.06 per gallon in 2019 as the diesel price across the U.S., without applying different prices per state.[1]

[1] Note: during the project, the Texas Transportation Institute also reported they were working on updating CO2 numbers utilizing the newest MOVES3 model which would be integrated into the FHWA Freight Mobility Tool. Future ITTS updates may wish to incorporate these changes.

This is the diesel price per gallon based on the American Automobile Association national average for 2019.

$$Wasted\ Fuel\ =\ Fuel\ Consumption\ during\ Congestion -\ \ Free\ Flow\ Fuel\ Consumption$$

$$Wasted\ Fuel\ Cost\ =\ Wasted\ Fuel\ x\ \$3.09\ per\ gallon$$

Cost of Truck Delay combines the cost due to truck delay and wasted fuel to determine the annual cost due to congestion for trucks.

$$Annual\ CMV\ Cost\ Due\ to\ Congestion\ =\ Annual\ CMV\ Delay\ Cost +\ Annual\ CMV\ Fuel\ Cost$$

3.4 Top Southeast Truck Trade Lanes

The top Southeast truck trade lanes identified for the trips-based tool were developed based on a review of the top 200 trade lanes nationwide in the FreightWaves database,[2] top origin-destination pairings by volume in the FHWA Freight Analysis Framework V5,[3] top origin-destination pairings cited in the Southeast region's state freight plans, through consultations with Southeast states, and vetting by the team. Figure 36 lists the top Southeast truck trade lanes used for the ITTS bottlenecks study.

Figure 36: Top Southeast Truck Trade Lanes

Origin	Destination	Corridor(s)
Atlanta, GA	Birmingham, AL	I-20
Atlanta, GA	Charlotte, NC	I-85
Atlanta, GA	Chattanooga, TN	I-75
Atlanta, GA	Cincinnati, OH	I-75
Atlanta, GA	Dallas, TX	I-20
Atlanta, GA	Greenville, SC	I-85
Atlanta, GA	Louisville, KY	I-75/I-24/I-65
Atlanta, GA	Memphis, TN	I-20/I-22
Atlanta, GA	Miami, FL	I-75/Florida's Turnpike/I-95
Atlanta, GA	Mobile, AL	I-85/I-65
Atlanta, GA	Nashville, TN	I-75/I-24
Birmingham, AL	Chattanooga, TN	I-59
Birmingham, AL	Jackson, MS	I-20

[2] Freight Waves SONAR offers insight to domestic and global data to provide insight on the freight market economy in real time. The Project Team used Freight Waves to obtain volumes for the top trade lanes nationwide, and identified the top origin and destination markets, as defined by Freight Waves, in the Southeast Region.

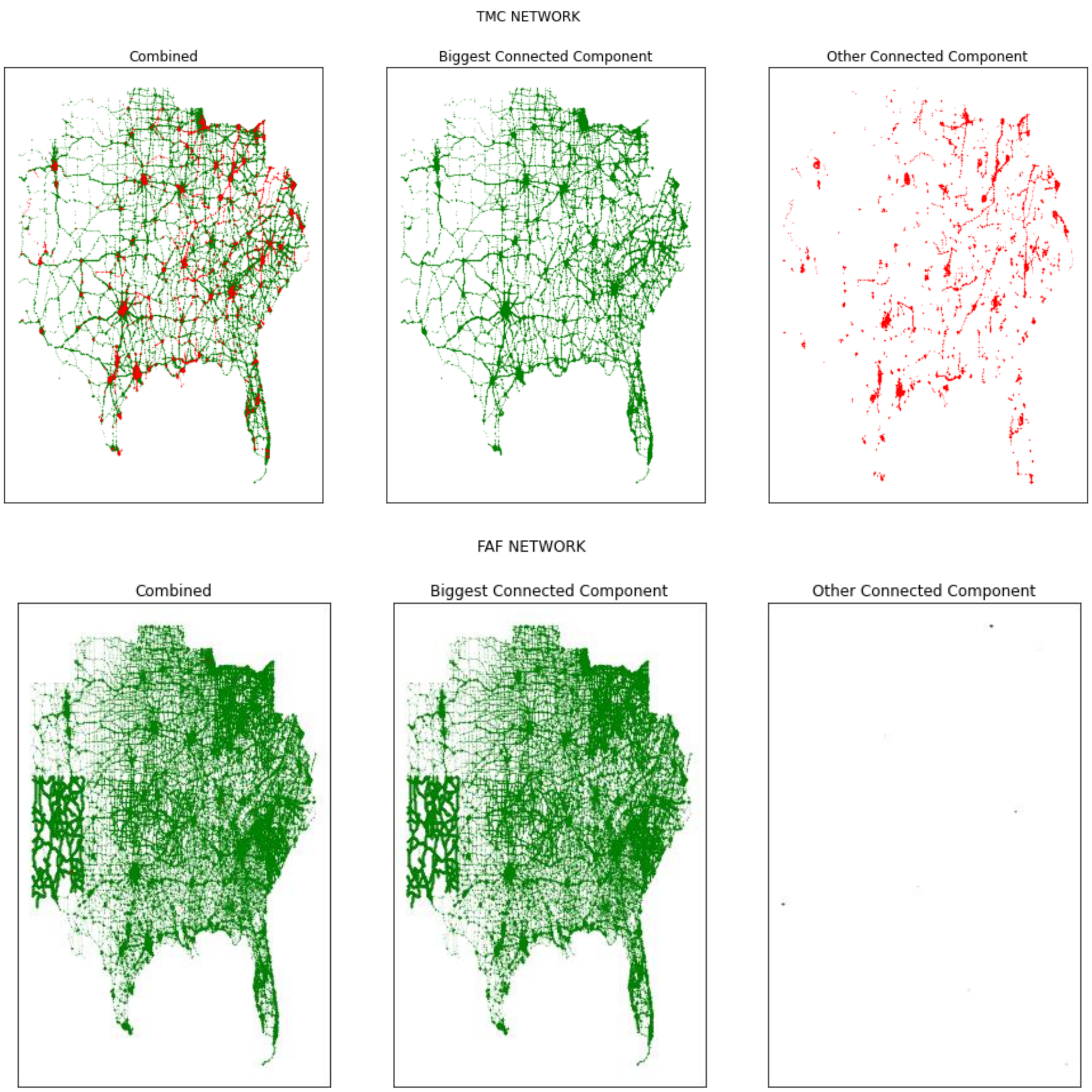
[3] The Freight Analysis Framework (FAF), produced through a partnership between Bureau of Transportation Statistics (BTS) and Federal Highway Administration (FHWA), integrates data from a variety of sources to create a comprehensive picture of freight movement among states and major metropolitan areas by all modes of transportation. The Project Team used FAF version 5 to obtain information on goods movement between all metro regions in the United States, rank top origins and destinations based on tonnage, and identify the top metro origins and destinations in the Southeast Region.

Origin	Destination	Corridor(s)
Birmingham, AL	New Orleans, LA	I-20/I-59
Birmingham, AL	Dallas, TX	I-20
Dallas, TX	Little Rock, AR	I-30
Dallas, TX	Nashville, TN	I-30/I-40
Dallas, TX	Raleigh, NC	I-20/I-85/I-40
Nashville, TN	Little Rock, AR	I-40
Nashville, TN	Miami, FL	I-24/I-75/FL Turnpike/I-95
Nashville, TN	St. Louis, MO	I-24/I-57/I-64
Jackson, MS	El Paso, TX	I-20/I-10
Jackson, MS	Little Rock, AR	I-20/US 65/I-530
Jackson, MS	New Orleans, LA	I-55/I-10
Memphis, TN	Gulfport, MS	I-55/US 49
Memphis, TN	New Orleans, LA	I-55/I-10
Memphis, TN	St. Louis, MO	I-55
Jacksonville, FL	El Paso, TX	I-10
Jacksonville, FL	Mobile, AL	I-10
Jacksonville, FL	Savannah, GA	I-95
Charlotte, NC	Charleston, SC	I-77/I-26
Charlotte, NC	Richmond, VA	I-85/I-95
Houston, TX	Baton Rouge, LA	I-10
Houston, TX	Mobile, AL	I-10
Cincinnati, OH	Louisville, KY	I-71
Richmond, VA	Tampa, FL	I-95/US 301/I-75

3.4.1 Network Conflation

The trips-based bottlenecks analysis requires specific routing from origin to destination for the top truck trade lanes. The TMC network is used for NPMRDS data and contains more detailed segments than the simplified FAF network. However, the TMC network is not designed for routing as many segments are separated from one another. FAF by contrast is routable but does not have directionality or NPMRDS values. Figure 37 illustrates the combined network, largest connected components, and other connected components for both the TMC and FAF networks. As shown, the FAF network is significantly more connected and thus more "routable" than the TMC network.

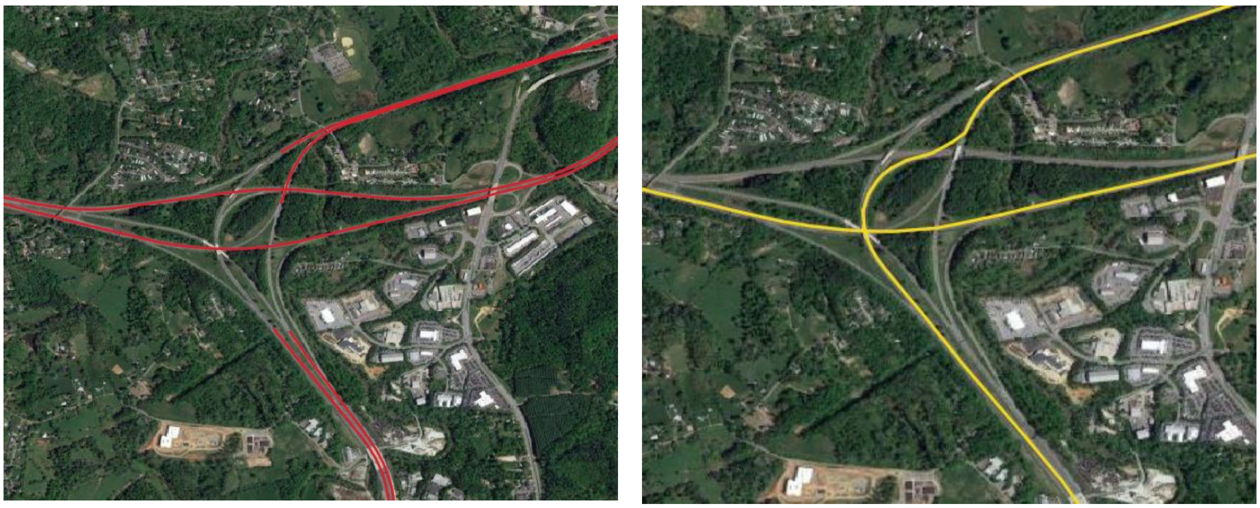
Figure 37: Routability Differences between the TMC Network and FAF Network



Source: CPCS Analysis of TMC and FAF Networks

Some connections are missing from the TMC network, such as in the interchange satellite imagery shown in Figure 38. In this example, the FAF network uses a simplified connected network, while the TMC network contains a more detailed network – but with broken connections.

Figure 38: Example Connections in TMC Network (Left) and FAF Network (Right)

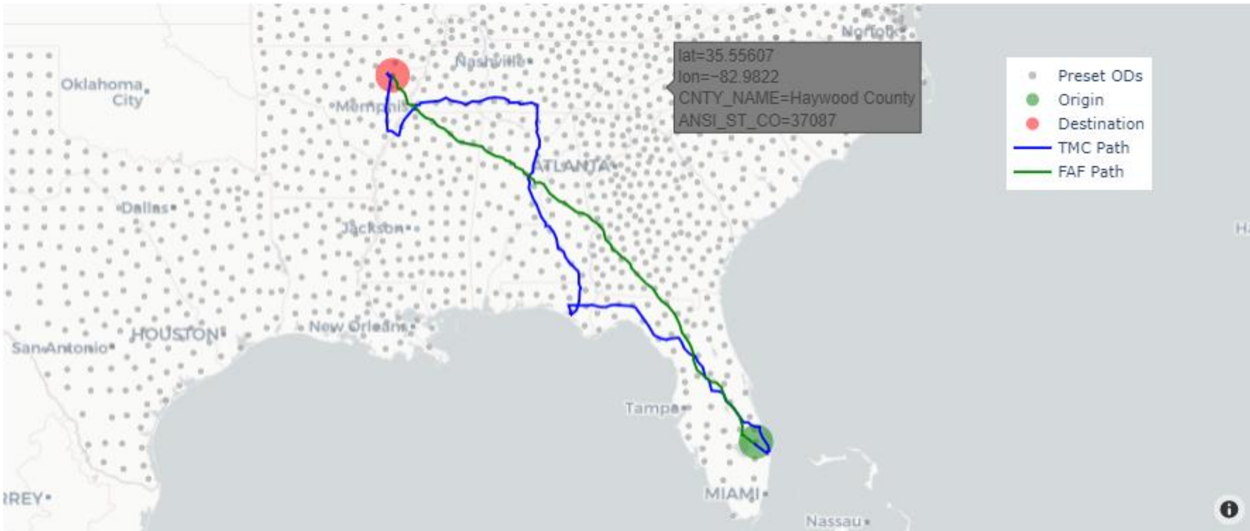


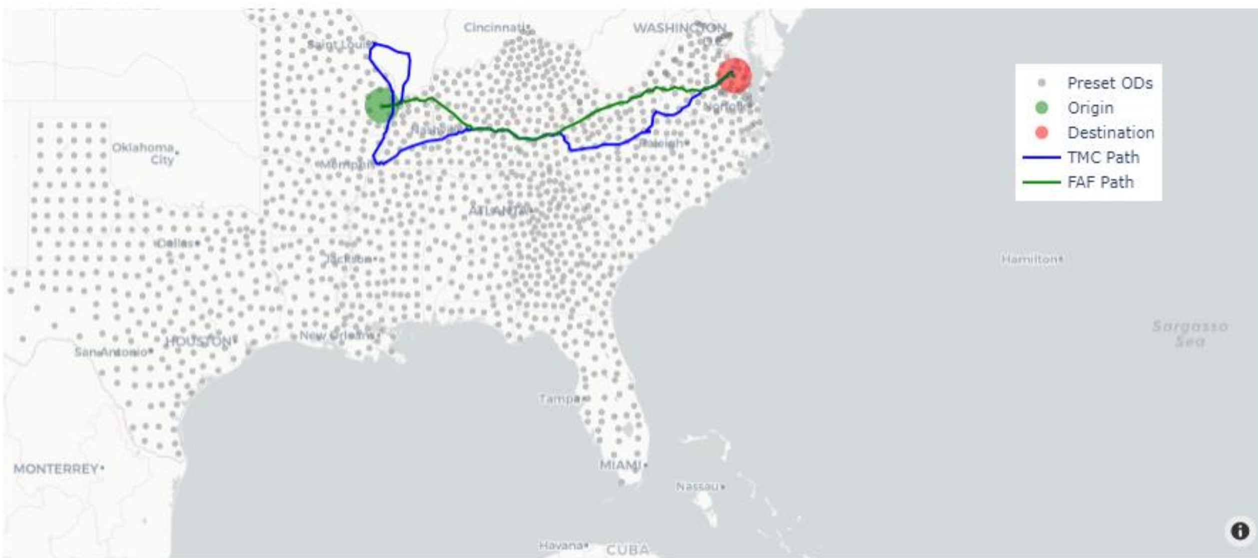
Source: CPCS Analysis of TMC and FAF Networks

The ITTS study routed trips based on the shortest path free-flow travel time between origin and destination using the FAF network and matched TMC paths to the FAF network.

However, the missing TMC connections make it difficult to develop an accurate routing path in contrast to the simplified and connected FAF network. Therefore, an additional process was required to develop an accurate routable path. Two examples are shown in Figure 39.

Figure 39: Example Comparisons of TMC and FAF Routing Paths





Source: CPCS Analysis of TMC and FAF Networks

The Project Team developed a Routability Fixing Algorithm to fix broken connections in the TMC network and match routes to the FAF network.

The Routability Fixing Algorithm locates all connection points needed in the TMC network by tracing the FAF network's connections. Then, it repairs broken connections on the TMC network by linking the identified connections from the FAF network. The algorithm identifies the disjointed nodes along road segments and connects segments based on an increasing threshold distance based on the location of the segment (rural vs urban) and the functional system of the segment.

Figure 40 depicts the total combined network before applying the Routability Fixing Algorithm on top and after applying the algorithm on the bottom. As shown, significantly more segments are connected after applying the algorithm – allowing the study to conduct a trips-based bottlenecks analysis.

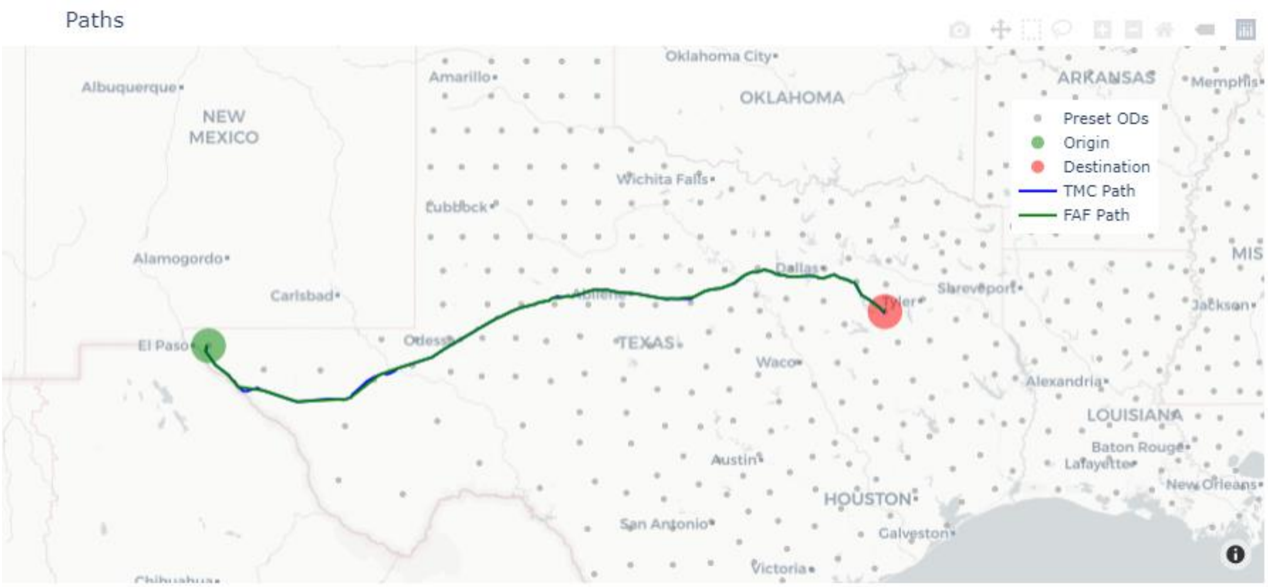
Figure 40: Routability Fixing Algorithm (Top – Before Algorithm; Bottom – After Algorithm)

Source: CPCS Analysis of TMC and FAF Network

Some missing connections still exist after deploying the Routability Fixing Algorithm because the distance of the break is larger than the threshold distance the Project Team applied. Since a higher threshold distance may join unexpected links, the Project Team applied a manual joining process for the top truck trade lanes identified. University of Arkansas students participated in this process of joining segments in the TMC network to develop routable networks that match the FAF route for the trips-based bottleneck analysis.

Finally, the Project Team compared the TMC and FAF paths to ensure the routes fully match. Figure 41 illustrates an example of the routing validation process showing that the TMC and FAF paths are a perfect match. The small deviations between the TMC and FAF paths in Figure 41 are due to the simplification of the FAF network versus the TMC network.

Figure 41: Routing Validation



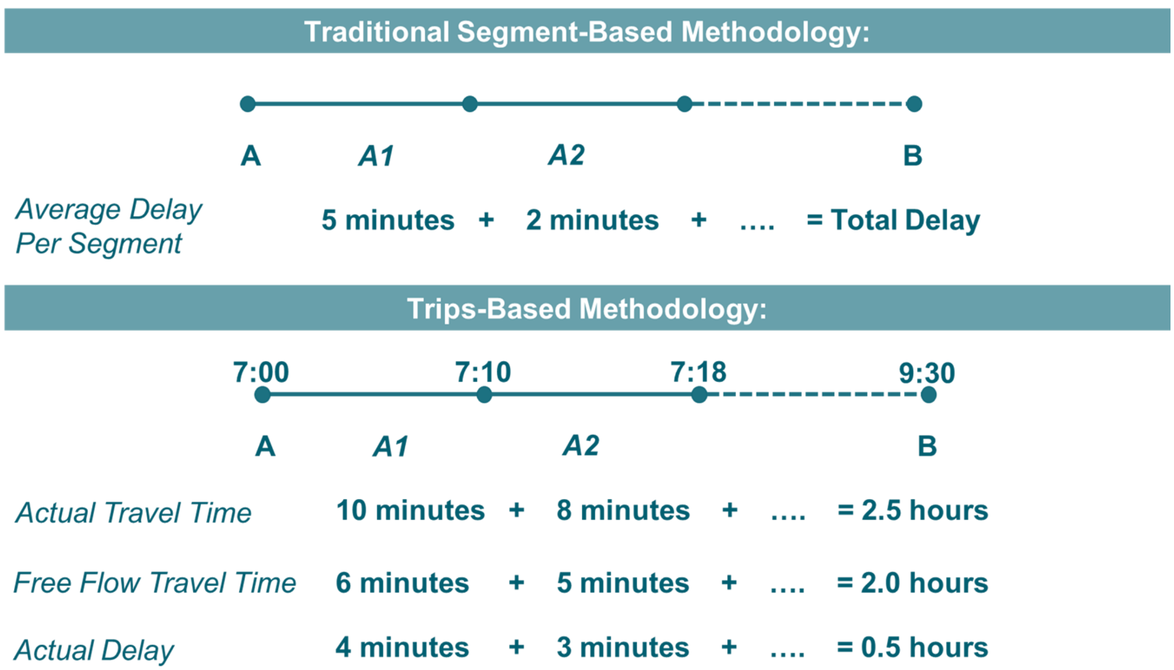
Source: CPCS Analysis of TMC and FAF Network

3.4.2 Trip-Based Calculations

Traditionally, the total delay for a trip is calculated by adding up the average delay for each segment on the TMC network. However, this is an approximate method that does not consider how bottlenecks on one segment may affect travel time on the next segment. This becomes a key issue when calculating trip times for long-haul truck movements that may cover multiple states.

ITTS sought to use a more real-world approach to calculating travel time and delays. To do so, the Project Team simulated truck travel times for each segment based on the actual travel time on each segment of the trip rather than applying averages throughout. The free flow travel time is then subtracted from actual travel times to derive the actual total truck delay of the trip. This approach is illustrated in Figure 42. **Appendix A** contains detailed delay information for the top 20 congested trade lanes.

Figure 42: Methodology Diagrams for Segment-Based and Trips-Based Approaches



3.5 Summary

The ITTS Regional Bottlenecks Assessment for Goods Movement study was developed as an information-sharing tool with a common platform for assessing the extent, duration, and severity of truck bottlenecks across the Southeast. The two components of the study include both segment-based bottleneck analysis covering the entire NHS in the Southeast, as well as trip-based bottleneck analysis to show that bottlenecks in a certain state may affect multi-state economic competitiveness. The results of the analysis show how multi-state coordination is needed to address top bottlenecks in the region. Technical Memo 2 will delve into the Southeast's top bottlenecks, causes, needs, and potential strategies for multi-state collaboration.

Appendix A Top Congested Trade Lane Profiles

This appendix profiles the top twenty most congested trade lanes listed in Section 2.6.

A.1. Chattanooga, TN to Atlanta, GA and Atlanta, GA to Chattanooga, TN

I-75 is the main corridor connecting Chattanooga, TN and Atlanta, GA.

Chattanooga: Located at the convergence of three interstates (I-24, I-59, and I-75), Chattanooga is known as the center of "freight alley," an area that roughly defines freight traffic moving throughout the southeastern U.S., including Tennessee, South Carolina, North Carolina, Georgia, and Alabama. Chattanooga is also connected to two Class I railroads (CSX and Norfolk Southern). The Greater Chattanooga Region has thriving automotive manufacturing, advanced manufacturing, and food and beverage sectors, and it is home to major business establishments, such as the Volkswagen automotive assembly plant, Wacker Chemie AG, and Mars Inc., among others.

Figure 43: Routing for Chattanooga, TN to Atlanta, GA

Figure 44: Routing for Atlanta, GA to Chattanooga, TN

Atlanta: Atlanta is also a major multimodal hub for freight movements and distribution, served by multiple Interstates (I-20, I-75, and I-85), two Class I railroads (CSX and Norfolk Southern), and the Hartsfield-Jackson International Airport, the world's busiest passenger airport which also handled over 690,000 tons of cargo in 2021.[4] Atlanta also provides access to the Port of Savannah, one of the largest and fastest-growing container terminals in the U.S. As a result, the greater Atlanta area is home to warehousing and distribution operations across many sectors, including food and beverage (Chick-Fil-A, Coke, Frito Lay), paper and printing (Georgia Pacific, International Paper, Pratt Industries), and retail (Home Depot).

Trade Lane: Among long haul corridors in Atlanta, I-75 connecting Atlanta and Chattanooga has some of the highest truck volumes.[5] Chattanooga, TN and Atlanta, GA – both well-connected by multimodal freight system – are key generators and distributors of freight.

In 2019, this trade lane experienced almost 9.5 million hours of truck delay in both directions, with 6 million hours of truck delay at a cost of over $395 million occurring from Chattanooga to Atlanta, and nearly 3 million hours of truck delay leading to $227 million in costs from Atlanta to Chattanooga.

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[4] Hartsfield-Jackson Atlanta International Airport Operating Statistics. https://www.atl.com/business-information/statistics/

[5] Atlanta Regional Council, Atlanta Regional Freight Mobility Plan Update, 2016, https://cdn.atlantaregional.org/wp-content/uploads/atlanta-regional-freight-mobility-plan-update-2016.pdf

The red dots in Figure 43 and Figure 44 illustrate the locations with highest truck delays per mile. As shown, along this route, highest truck delay per mile occurs in the midtown area of Atlanta, as well as at the convergence of I-75 and I-285, north of the Atlanta city boundary. For northbound traffic, delays on I-75 occur at exits that connect to Barrett Parkway, I-575, GA-120, and Marietta Parkway in Marietta.

#1	Chattanooga, TN to Atlanta, GA			
31,958.9	46.9	1.74	6.0	$395.5
AADT Trucks	Average Truck Speed (Miles/Hour)	TTTR Index	Total Truck Delay (Million Hours)	Total Cost of Truck Delay (Millions)

#4	Atlanta, GA to Chattanooga, TN			
25,669.3	54.1	1.78	3.4	$226.9
AADT Trucks	Average Truck Speed (Miles/Hour)	TTTR Index	Total Truck Delay (Million Hours)	Total Cost of Truck Delay (Millions)

Source: CPCS Analysis of 2019 NPMRDS and HPMS Data

The shortest average travel time (2.36 hours) for traveling in both directions between Chattanooga to Atlanta occurs when drivers depart at 2:00 AM While the average travel time reaches 3.39 hours when drivers leave for Atlanta at 3:00 PM, drivers are likely to experience the longest average travel time (3.39 hours) in the other direction (from Atlanta to Chattanooga) when they depart at 5:00 PM (Figure 46). Trucks leaving at 6:00 AM from Chattanooga to Atlanta will experience another peak travel time at about 2.5 hours. This could be caused by the morning peak when commuters drive southbound into Atlanta.

Figure 45: Chattanooga, TN to Atlanta, GA Travel Time by Time of Day

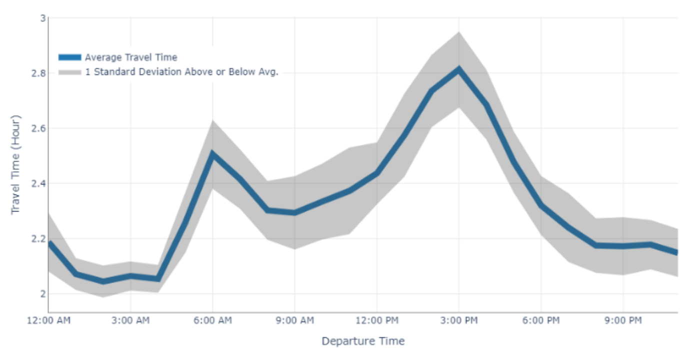
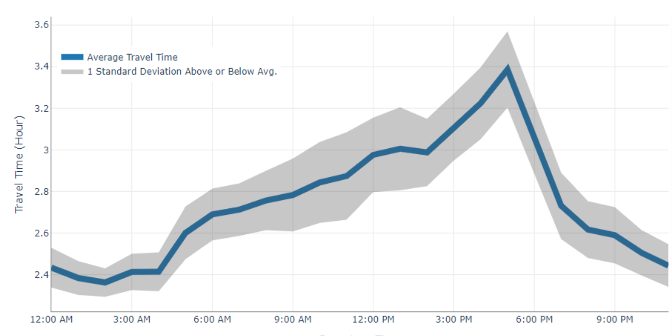


Figure 46: Atlanta, GA to Chattanooga, TN Travel Time by Time of Day



Source: CPCS Analysis of 2019 NPMRDS and HPMS Data

A.2. Greenville, SC to Atlanta, GA and Atlanta, GA to Greenville, SC

Greenville, SC and Atlanta, GA are primarily connected by I-85 and I-75.

Greenville: Greenville is served by I-85, which spans the region, and I-26, which connects Greenville to the Port of Charleston – the deepest seaport in the Southeast region. Greenville also provides access to two Class I (CSX and Norfolk Southern) railroads and the Greenville-Spartanburg International Airport, which provides cargo services through FedEx and UPS and the only scheduled non-stop air cargo services in the Carolinas to Germany and Mexico.[6]

Figure 47: Routing for Greenville, SC to Atlanta, GA

Figure 48: Routing for Atlanta, GA to Greenville, SC

Atlanta: See Section A.1. for details about freight activity in Atlanta.

Trade Lane: This trade lane helps facilitate nearly 3.5 million tons of goods worth over $7.1 billion moved by truck between Greenville and Atlanta. Top commodities moved from Greenville to Atlanta by truck, when considering both tonnage and value, include plastics/rubber, wood products, chemical products, and live animals/fish. A high value of machinery products also travels along this trade route. Meanwhile, top commodities moved from Atlanta to Greensville by truck include mixed freight, base metals, motorized vehicles, and other foodstuffs.[7]

Nearly 10 million hours of truck delay occurred along this trade lane in both directions in 2019, with 6 million hours of truck delay occurring from Greenville to Atlanta at a cost of $397 million, and nearly 3 million hours of truck delay from Atlanta to Greenville at a cost of $196 million.

As illustrated by the red dots in Figure 47 and Figure 48 above, the highest delays along this route, in both directions, occur on the roadways in Atlanta. Sections with the highest roadway delays are located in Downtown Atlanta, along I-75, and at I-85 N Pleasantdale Road Exit.

[6] Transportation & Infrastructure. Upstate SC Alliance. https://www.upstatescalliance.com/upstate-advantages/transportation-infrastructure/

[7] CPCS analysis of FHWA FAF5, 2017.

#2	**Greenville, SC to Atlanta, GA**			
17,250.8 AADT Trucks	**51.6** Average Truck Speed (Miles/Hour)	**1.48** TTTR Index	**6.0** Total Truck Delay (Million Hours)	**$397** Total Cost of Truck Delay (Millions)

#6	**Atlanta, GA to Greenville, SC**			
17,041.0 AADT Trucks	**59.9** Average Truck Speed (Miles/Hour)	**1.54** TTTR Index	**3.0** Total Truck Delay (Million Hours)	**$196.0** Total Cost of Truck Delay (Millions)

Source: CPCS Analysis of 2019 NPMRDS and HPMS Data

The shortest travel time between Greenville and Atlanta, in both directions, is 2.26 hours, when truckers depart between 2:30 and 3:00 AM As shown in Figure 49, the westbound travel time from Greenville, SC to Atlanta, GA peaks at 2.92 hours of travel time when drivers leave Greenville at 6:00 AM in the morning, and at 3.00 hours when drivers leave at 3:00 P.M in the afternoon. Meanwhile, as shown in Figure 50, the eastbound travel time from Atlanta, GA to Greenville, SC, gradually increases after midnight and reaches its peak when drivers depart at 5:00 PM, leading to a travel time of 3.02 hours.

Figure 49: Greenville, SC to Atlanta, GA Travel Time by Time of Day

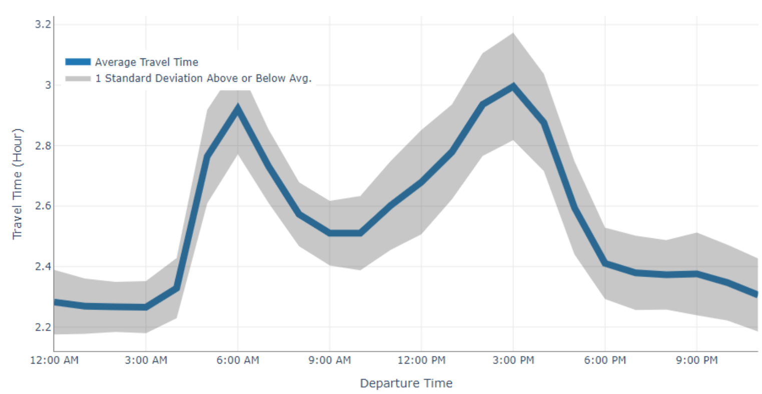
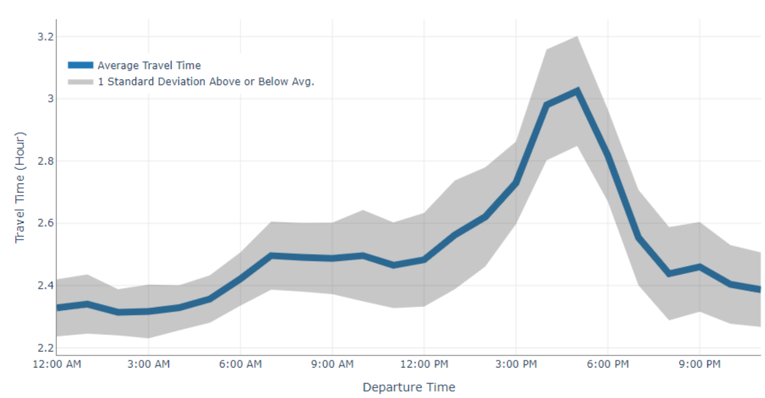


Figure 50: Atlanta, GA to Greenville, SC Travel Time by Time of Day



Source: CPCS Analysis of 2019 NPMRDS and HPMS Data

A.3. Nashville, TN to Atlanta, GA and Atlanta, GA to Nashville, TN

Nashville, TN and Atlanta, GA are connected by I-24 (between Nashville and Chattanooga) and I-75 (between Chattanooga and Atlanta).

Nashville: The Nashville region has been well-served by rail and water freight transportation since the 1800s. The original CSX railroad tracks are still in service between Nashville and Atlanta.[8] Nashville is also the convergence point of three Interstates (I-65, I-24, and I-40).

Atlanta: See Section A.1. for details about freight activity in Atlanta.

Trade Lane: This route supports the nearly 1.8 million tons of goods moved by truck between Nashville and Atlanta, totaling almost $10.7 billion in value. The top commodities transported by truck in both directions between Nashville and Atlanta include motorized vehicles, mixed freight, and base metals, by both tonnage and value. High volumes of other foodstuffs and other agricultural products are also moved from Nashville to Atlanta. Meanwhile, pharmaceuticals in high values also travel from Atlanta to Nashville.[9]

Figure 51: Routing for Nashville, TN to Atlanta, GA

Figure 52: Routing for Atlanta, GA to Nashville, TN

In 2019, nearly 11.2 million hours of truck delay occurred on this trade lane in both directions. Over 6.8 million hours of truck delay from Nashville to Atlanta led to $449 million in costs, while nearly 4.4 million hours of truck delay from Atlanta to Nashville cost about $289 million.

As illustrated by the red dots in Figure 51 and Figure 52 above, the highest delays along this route, in both directions, occur on the roadways in Atlanta. Sections with the highest roadway delays are located in midtown Atlanta and at the exit to I-285 southbound, as well as at the exit to I-575 and Marietta Parkway northbound.

[8] Freight in Middle Tennessee. https://www.gnrc.org/DocumentCenter/View/833/Freight-Brochure-

[9] CPCS analysis of FHWA FAF5, 2017.

#3	Nashville, TN to Atlanta, GA			
19,933.3	55.8	1.62	6.8	$449.2
AADT Trucks	Average Truck Speed (Miles/Hour)	TTTR Index	Total Truck Delay (Million Hours)	Total Cost of Truck Delay (Millions)

#8	Atlanta, GA to Nashville, TN			
17,340.8	60.2	1.65	4.4	$289.3
AADT Trucks	Average Truck Speed (Miles/Hour)	TTTR Index	Total Truck Delay (Million Hours)	Total Cost of Truck Delay (Millions)

Source: CPCS Analysis of 2019 NPMRDS and HPMS Data

In both directions, travel times increase throughout the day, peaking during afternoon and evening hours, then dipping to shorter travel times during the middle of the night. The shortest trip time from Nashville to Atlanta, as shown in Figure 53, is 1:00 and 2:00 AM, with travel times at 4.24 and 4.23 hours, respectively. Meanwhile, travel times are highest when drivers depart Nashville at 1:00 PM, with trip times averaging 5.1 hours. From Atlanta to Nashville, trip times are at their shortest of 4.47 hours when truck drivers leave at 11:00 PM, as shown in Figure 54. Travel times for this route peak at 5.5 hours, when drivers depart at 5:00 pm.

Figure 53: Nashville, TN to Atlanta, GA Travel Time by Time of Day

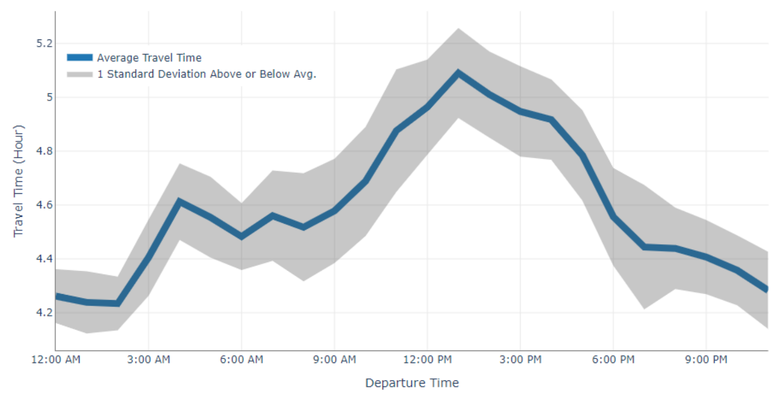
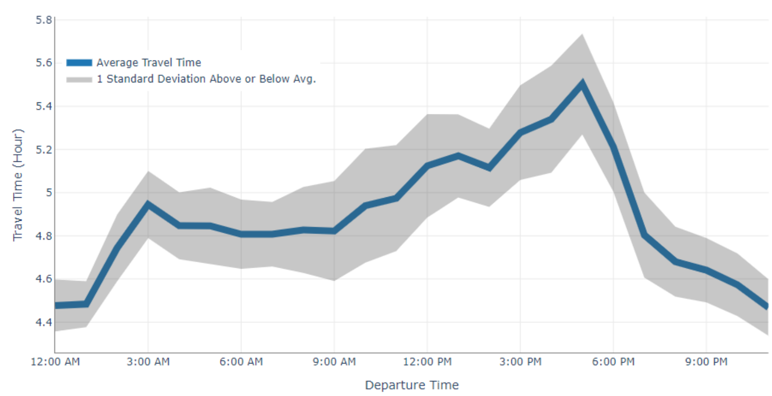


Figure 54: Atlanta, GA to Nashville, TN Travel Time by Time of Day



Source: CPCS Analysis of 2019 NPMRDS and HPMS Data

A.4. Charlotte, NC to Atlanta, GA and Atlanta, GA to Charlotte, NC

I-85 connects Charlotte, NC and Atlanta, GA.

Figure 55: Routing for Charlotte, NC to Atlanta, GA

Figure 56: Routing for Atlanta, GA to Charlotte, NC

Charlotte: Located in North Carolina and bordering South Carolina, Charlotte has a multi-modal freight system that supports the region's freight movements. While Interstates in Charlotte (I-85, I-77 and I-485) carry the majority of daily truck traffic, other roadways (US-74, NC-160, and SC-9) also play a vital role in moving freight along roadways. Charlotte is also served by two Class I rail (CSX and Norfolk Southern) routes, in addition to the North Carolina Railroad. The freight-dependent manufacturing sector employs nearly 12 percent of the greater Charlotte region's (bi-state) workforce.[10]

Atlanta: See Section A.1. for details about freight activity in Atlanta.

Trade Lane: This trade corridor supports nearly 2 million tons of goods worth nearly $8.4 billion moved by truck between Charlotte and Atlanta. A top commodity moved between these two freight hubs is plastics/rubber, when considering both tonnage and volume. Other high tonnage commodities moved include nonmetal mineral products in both directions and meat/seafood from Charlotte to Atlanta. Other high value commodities moved include motorized vehicles in both directions and textiles/leather from Charlotte to Atlanta.[11]

The trade lane between Charlotte and Atlanta saw 9.7 million hours of truck delay in both directions in 2019. From Charlotte to Atlanta, 6.4 million hours of truck delay led to costs of about $423 million. From Atlanta to Charlotte, 3.3 million hours of truck delay cost over $215 million.

As illustrated by the red dots in Figure 55 and Figure 56 above, the highest delays along this route, in both directions, occur on the roadways in Atlanta.

[10] Greater Charlotte Regional Freight Mobility Plan. December 2016. https://gclmpo.org/wp-content/uploads/Greater-Charlotte-Regional-Freight-Mobility-Plan-Executive-Summary-2016.pdf
[11] CPCS analysis of FHWA FAF5, 2017.

#5	Charlotte, NC to Atlanta, GA			
11,789.1	58.9	1.55	6.4	$422.6
AADT Trucks	Average Truck Speed (Miles/Hour)	TTTR Index	Total Truck Delay (Million Hours)	Total Cost of Truck Delay (Millions)

#10	Atlanta, GA to Charlotte, NC			
11,662.2	63.2	1.59	3.3	$215.2
AADT Trucks	Average Truck Speed (Miles/Hour)	TTTR Index	Total Truck Delay (Million Hours)	Total Cost of Truck Delay (Millions)

Source: CPCS Analysis of 2019 NPMRDS and HPMS Data

Travel times along this route vary based on direction throughout the day but have comparable travel times overnight. From Charlotte to Atlanta, travel times are lowest at 3.94 hours when drivers depart between 1:00 and 2:00 AM, as shown in Figure 57. Similarly, the travel from Atlanta to Charlotte averages 3.95 hours when drivers depart at 12:00 AM (midnight), as displayed in Figure 58. However, peak travel times differ between eastbound and westbound trips. The travel time for truck drivers moving westbound from Charlotte to Atlanta reaches 4.6 hours during the AM peak departure time of 4:00 AM, and 4.8 hours during the PM peak departure time of 1:00 PM. Meanwhile, trucks traveling eastbound from Atlanta to Charlotte at 5:00 PM experience travel times of 4.85 hours, which is over half an hour more than the 4.29 travel time for trucks departing at 4:00 AM.

Figure 57: Charlotte, NC to Atlanta, GA Travel Time by Time of Day

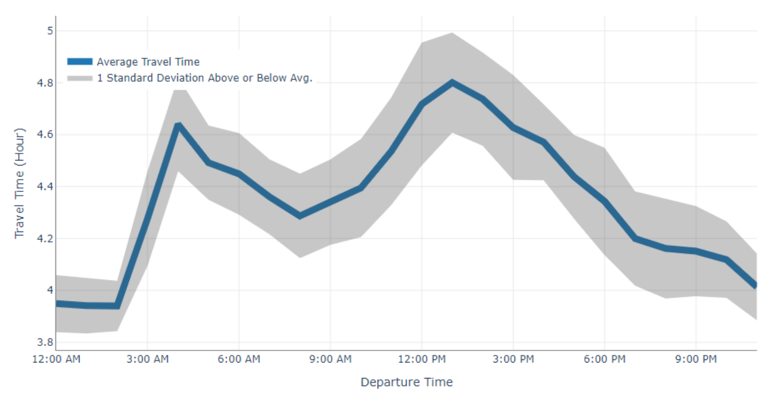
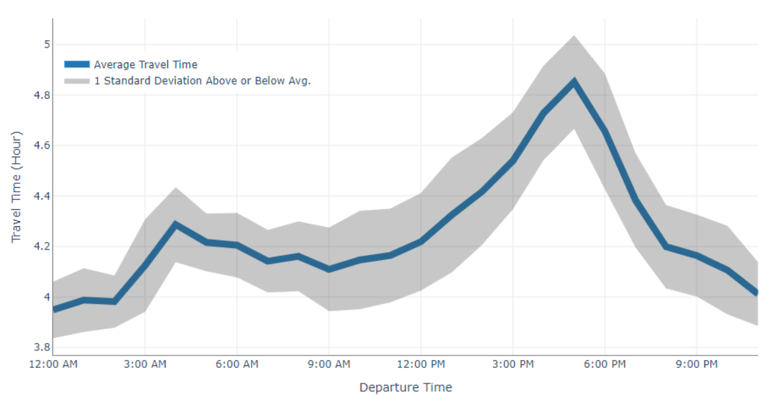


Figure 58: Atlanta, GA to Charlotte, NC Travel Time by Time of Day



Source: CPCS Analysis of 2019 NPMRDS and HPMS Data

A.5. Louisville, KY to Atlanta, GA and Atlanta, GA to Louisville, KY

Louisville and Atlanta are connected by three interstates – I-65 (Louisville to Nashville), I-24 (Nashville to Chattanooga), and I-75 (Chattanooga to Atlanta).

Louisville: Served by three Interstates (I-65, I-64, and I-71), the Greater Louisville region is within a one-day drive to more than 66 percent of major domestic markets.[12] In addition, Louisville is also the home to UPS WorldPort, UPS's primary hub in the U.S., processing an average of 1.5 million packages each day.[13] Louisville Muhammad Ali International Airport is another air cargo hub in the region, ranking the fifth busiest cargo airport in the world and the third in the U.S. in 2020.[14] The region is also served by three Class I railroads – Canadian Pacific, CSX, and Norfolk Southern (NS), besides multiple regional and short line railroads. The freight-reliant industries (mining, logging & construction, manufacturing, and trade, transportation & utilities) employed over 262,000 people in the Louisville Metropolitan Statistical Area in 2021.[15]

Atlanta: See Section A.1. for details about freight activity in Atlanta.

Figure 59: Routing for Louisville, KY to Atlanta, GA

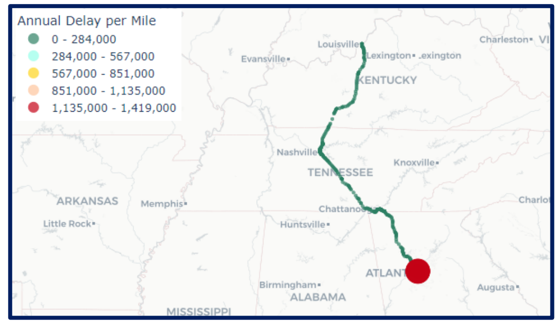


Figure 60: Routing for Atlanta, GA to Louisville, KY

Over 345 thousand tons of goods worth over $1.6 billion moved by truck between Louisville and Atlanta are supported by this trade lane. From Louisville to Atlanta, alcoholic beverages, base metals, and meat/seafood are among the top commodities moved by truck, by both tonnage and value. Meanwhile, top commodities transported by truck from Atlanta to Louisville include electronics, motorized vehicles, and base metals, as well as high values of pharmaceuticals.[16]

Over 12.5 million hours of truck delay occurred along both directions of this trade route in 2019. From Louisville to Atlanta, over 7.5 million hours of truck delay led to over $498 million in costs. From Atlanta to Louisville, 5 million hours of truck delay cost over $329 million.

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[12] Louisville Chamber of Commerce Infrastructure. https://www.greaterlouisville.com/infrastructure/
[13] Kentucky Logistics Quick Facts. https://ced.ky.gov/kyedc/pdfs/LogisticsQuickFacts.pdf
[14] Logistics: Driving the Greater Louisville region. https://www.lanereport.com/143359/2021/06/logistics-driving-the-greater-louisville-regions-economic-success/
[15] Employment Trends by Industry, Louisville Chamber of Commerce. https://www.greaterlouisville.com/economic-development/#tab-7
[16] CPCS analysis of FHWA FAF5, 2017.

As illustrated by the red dots in Figure 59 and Figure 60, the highest delays along this route, in both directions, occur on the roadways in Atlanta.

#7	Louisville, KY to Atlanta, GA			
15,115.6	**59.4**	**1.52**	**7.6**	**$498.1**
AADT Trucks	Average Truck Speed (Miles/Hour)	TTTR Index	Total Truck Delay (Million Hours)	Total Cost of Truck Delay (Millions)

#12	Atlanta, GA to Louisville, KY			
13,712.5	**61.9**	**1.51**	**5.0**	**$329.2**
AADT Trucks	Average Truck Speed (Miles/Hour)	TTTR Index	Total Truck Delay (Million Hours)	Total Cost of Truck Delay (Millions)

Source: CPCS Analysis of 2019 NPMRDS and HPMS Data

The shortest travel time along this trade lane occurs when truck drivers depart at 11:00 PM in both directions, with the trip from Louisville to Atlanta spanning 7.04 hours and the trip from Atlanta to Louisville spanning 7.34 hours. Truck travel times from Louisville to Atlanta increases during early morning hours, peaking at 8.11 hours with a departure time of 10:00 AM, as shown in Figure 61. Meanwhile, truck travel times from Atlanta to Louisville increase throughout the morning, reaching a peak of 8.34 hours at a departure time of 12:00 PM (noon) and again reaching 8.31 hours at a departure time of 3:00 PM, as displayed in Figure 62.

Figure 61: Louisville, KY to Atlanta, GA Travel Time by Time of Day

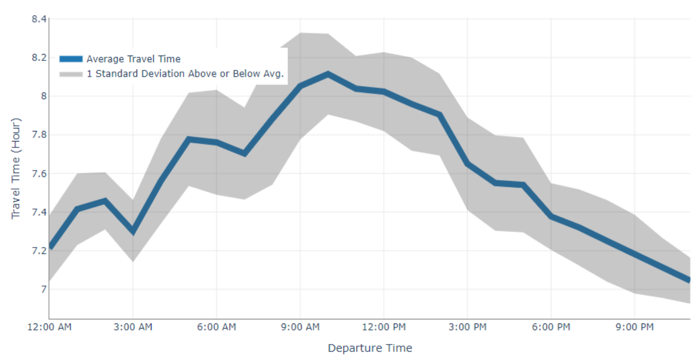
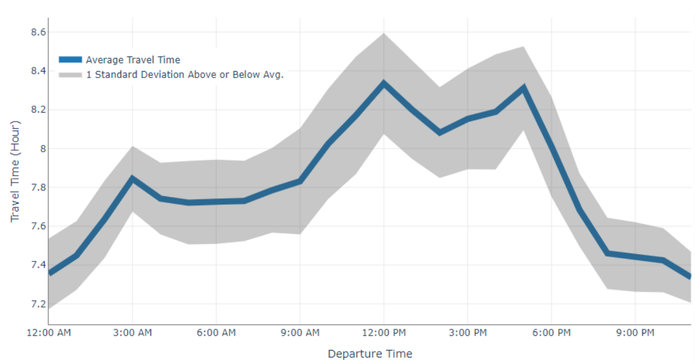


Figure 62: Atlanta, GA to Louisville, KY Travel Time by Time of Day



Source: CPCS Analysis of 2019 NPMRDS and HPMS Data

A.6. Birmingham, AL to Atlanta, GA and Atlanta, GA to Birmingham, AL

I-20 connects Birmingham, AL to Atlanta, GA.

Birmingham: Six interstates (I-65, I-59, I-459, I-20, and I-22) connect Birmingham to major markets in the U.S. The Greater Birmingham region also is well-served by Class I railroads (BNSF, CSX, and Norfolk Southern), and it has easy access to inland waterways and a deep-water seaport (Port of Mobile). Freight-dependent businesses bolster the region's economy. Manufacturing companies made up the largest share (35 percent) of Birmingham's top 100 companies by total revenue, while construction and food/beverage companies took up second and third place, respectively, in 2019.[17]

Figure 63: Routing for Birmingham, AL to Atlanta, GA

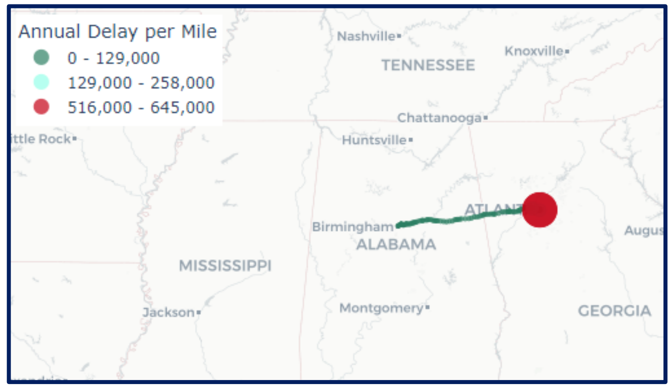


Figure 64: Routing for Atlanta, GA to Birmingham, AL

Atlanta: See Section A.1. for details about freight activity in Atlanta.

This trade corridor helps facilitate the nearly 4.9 million tons of goods worth almost $7.3 billion moved by truck between Birmingham and Atlanta. In both directions, based metals and mixed freight are among the top commodities moved, when considering both tonnage and value. Additional commodities moved from Birmingham to Atlanta by truck include articles of base metal, other foodstuffs, and nonmetal mineral products. Additional commodities transported by truck from Atlanta to Birmingham include motorized vehicles, other foodstuffs, and animal feeds.[18]

The trade route connecting Birmingham and Atlanta, in both directions, experienced over 3.6 million hours of truck delay in 2019, with over 2 million hours of truck delay from Birmingham to Atlanta leading to over $134 million in costs, and 1.6 million hours of truck delay from Atlanta to Birmingham resulting in costs of $102 million.

As illustrated by the red dots in Figure 63 and Figure 64 above, the highest delays along this route, in both directions, occur on the roadways in Atlanta.

[17] Before the storm: How key industries fared on the Birmingham 100. https://www.bizjournals.com/birmingham/news/2020/07/14/industry-highlights-from-the-birmingham-100.html

[18] CPCS analysis of FHWA FAF5, 2017.

#9	Birmingham, AL to Atlanta, GA			
13,589.9	65.0	1.42	2.0	$134.2
AADT Trucks	Average Truck Speed (Miles/Hour)	TTTR Index	Total Truck Delay (Million Hours)	Total Cost of Truck Delay (Millions)

#13	Atlanta, GA to Birmingham, AL			
13,621.0	65.6	1.33	1.6	$102.4
AADT Trucks	Average Truck Speed (Miles/Hour)	TTTR Index	Total Truck Delay (Million Hours)	Total Cost of Truck Delay (Millions)

Source: CPCS Analysis of 2019 NPMRDS and HPMS Data

Travel times in both directions are lowest overnight. From Birmingham to Atlanta, truck travel times are lowest at 2.29 hours when drivers depart at 11:00 PM, and from Atlanta to Birmingham, travel times are lowest at 2.35 hours when drivers depart at 2:00 PM. During the day, travel time patterns along this route vary by direction. As shown in Figure 65, the truck travel time eastbound from Birmingham to Atlanta reaches 2.57 hours during the AM peak departure time of 5:00 AM, and 2.55 hours during the PM peak departure time of 3:00 PM. Meanwhile, as displayed in Figure 66, the travel time for trucks traveling westbound from Atlanta to Birmingham increases throughout the day, peaking at 2.72 hours for trucks departing at 5:00 PM.

Figure 65: Birmingham, AL – Atlanta, GA Travel Time by Time of Day

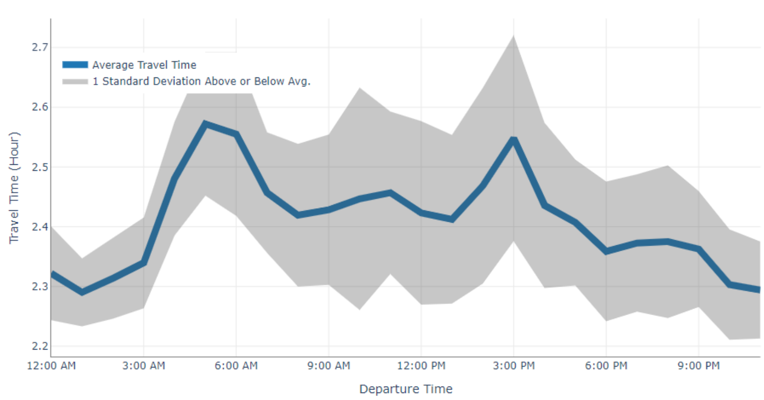
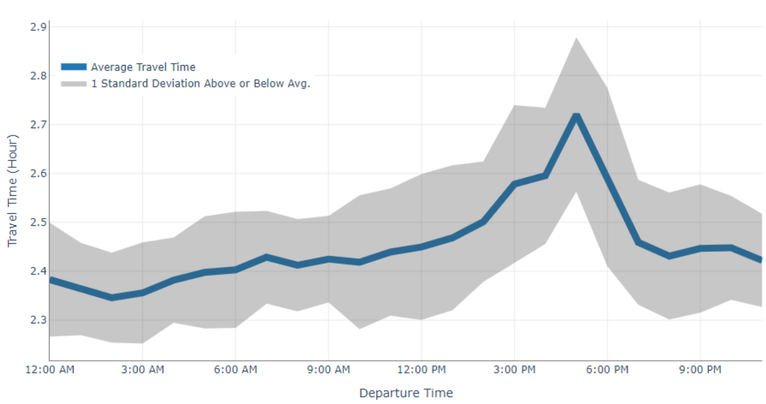


Figure 66: Atlanta, GA – Birmingham, AL Travel Time by Time of Day



Source: CPCS Analysis of 2019 NPMRDS and HPMS Data

A.7. Nashville, TN to Miami, FL and Miami, FL to Nashville, TN

Nashville and Miami are connected by several key corridors – I-24, I-75, Florida's Turnpike, and I-95.

Nashville: See Section A.3. for details about freight activity in Nashville.

Miami: Located at the southeastern edge of Florida, Miami has an extensive freight system, consisting of the Port of Miami, Miami International Airport, multiple Interstates (I-75, I-95, and I-395), and two Class I railroads (CSX and Norfolk Southern). Miami is also the industrial center of Florida's logistics and distribution, manufacturing, aviation and aerospace, and supporting companies, including FedEx, HEICO, Airbus Training Center, and Spirit Airline, among others.[19]

Figure 67: Routing for Nashville, TN to Miami, FL

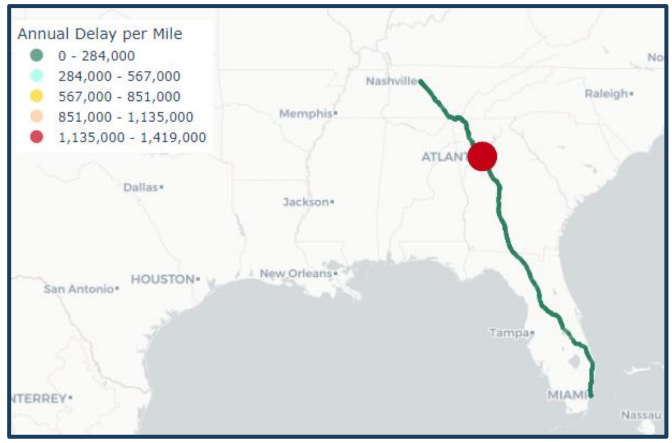
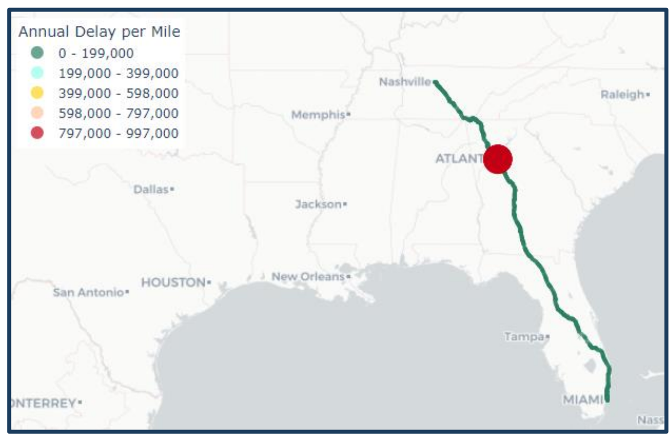


Figure 68: Routing for Miami, FL to Nashville, TN



Trade Lane: This route between Nashville and Miami supports the nearly 175 thousand tons of goods, which amounts to over $1.5 billion in value, moved by truck. From Nashville to Miami, top commodities moved by truck include motorized vehicles, textiles/leather, and meat/ seafood, when considering both tonnage and value. Meanwhile, top commodities that travel by truck from Miami to Nashville include textiles/leather, other agricultural products, and other foodstuffs.[20]

In 2019, nearly 20 million hours of truck delay occurred on this trade lane in both directions. From Nashville to Miami, 10.3 million hours of truck delay led to over $679 million in costs. From Miami to Nashville, 9.6 million hours of truck delay cost almost $629 million.

As illustrated by the red dots in Figure 67 and Figure 68, the highest delays along this route, in both directions, occur on the roadways in Atlanta.

[19] Freight Mobility and Trade Plan. Systems and Assets. April 2020. https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/rail/fmtp/april-2020/fmtp-tm2_systems-and-assests.pdf?sfvrsn=bb4fa0b2_2

[20] CPCS analysis of FHWA FAF5, 2017.

#11	Nashville, TN to Miami, FL			
13,392.9 AADT Trucks	65.1 Average Truck Speed (Miles/Hour)	1.45 TTTR Index	10.3 Total Truck Delay (Million Hours)	$679.1 Total Cost of Truck Delay (Millions)

#14	Miami, FL to Nashville, TN			
12,825.6 AADT Trucks	65.5 Average Truck Speed (Miles/Hour)	1.46 TTTR Index	9.6 Total Truck Delay (Million Hours)	$629.3 Total Cost of Truck Delay (Millions)

Source: CPCS Analysis of 2019 NPMRDS and HPMS Data

Truck travel times along this trade route see several peaks throughout the day, in both directions. From Nashville to Miami, truck travel times remain above 14.5 hours throughout the day, peaking when trucks depart at 4:00 AM (15.10 hours), 7:00 AM (15.10 hours), 12:00 AM (noon, at 15.31 hours), and 5:00 PM (15.48 hours). Truck travel times dip overnight, with the lowest truck travel time of 14.34 hours occurring when drivers depart at 11:00 PM. These patterns are illustrated in Figure 69. Meanwhile, from Miami to Nashville, truck travel times peak and dip throughout the day as well, though with less frequency. Truck travel times reach 15.75 hours during the AM peak departure time of 7:00 AM, and 15.44 hours during the PM peak departure time of 4:00 PM. Truck travel times are lowest (14.65 hours) when trucks depart between these hours at 12:00 PM (noon). This is shown in Figure 70.

Figure 69: Nashville, TN to Miami, FL Travel Time by Time of Day

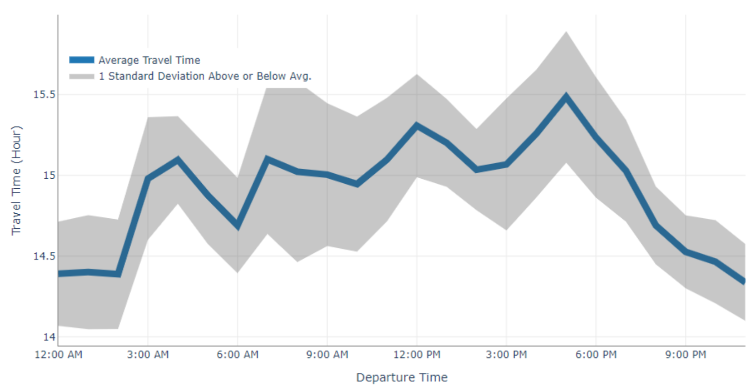
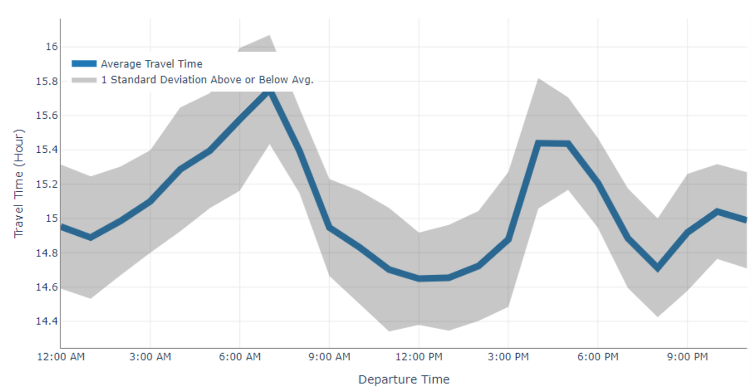


Figure 70: Miami, FL to Nashville, TN Travel Time by Time of Day



Source: CPCS Analysis of 2019 NPMRDS and HPMS Data

A.8. Raleigh, NC to Dallas, TX and Dallas, TX to Raleigh, NC

Raleigh, NC and Dallas, TX are connected by I-40 (between Raleigh and Greensboro), I-85 (between Greensboro and Atlanta), and I-20 (between Atlanta and Dallas).

Raleigh: Raleigh is the largest city in the Research Triangle metro area,[21] with highways and Interstates (I-40 and I-87) connecting Raleigh to the cities within and beyond the local region. Main freight-reliant industries in the region include high-tech manufacturing, equipment and supplies merchant wholesalers, and scientific research and development services. As of 2018, these three industries amounted to 2,472 establishments.[22]

Figure 71: Routing for Raleigh, NC to Dallas, TX

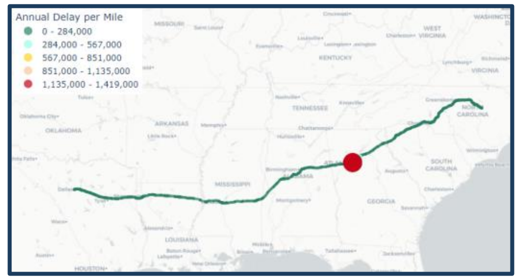
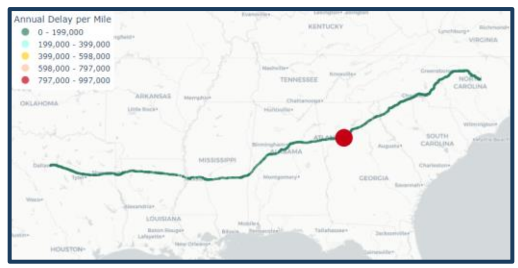


Figure 72: Routing for Dallas, TX to Raleigh, NC



Dallas: The Dallas region also has a robust roadway system, including several Interstates (I-20, I-30, I-35, I-45, and I-635) that are critical to connections between Mexico and Canada. BNSF, KCS, and UP also provide rail connections between Dallas and the rest of the U.S. Additionally, the Dallas-Fort Worth International Airport (9th busiest U.S. cargo airport) and Alliance Airport (regional hub for FedEx) offer efficient air cargo services that deliver freight to international and domestic markets.[23] In 2018, freight-related industries supported 23 percent (812,000) of jobs, generating $58 billion in income and $94 billion in Gross Regional Product in the Dallas District.[24]

Trade Lane: The trade lane between Raleigh and Dallas is one of the longest in the Southeast Region, spanning nearly 1,200 miles across seven states. This trade corridor helps facilitate movement of over 8.2 million tons of goods by truck, worth $1.9 billion, between Raleigh and Dallas. Among westbound truck movements from Raleigh to Dallas, gravel and nonmetal mineral products are top commodities moved by tonnage, while electronics and furniture are the top commodities moved by value. Meanwhile, nonmetal mineral products, natural sands,

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[21] The Research Triangle includes a dozen in North Carolina, and it gets its name from Research Triangle Park and three Tier 1 research universities—Duke University, North Carolina State University, and University of North Carolina Chapel Hill – located within the area. Research Triangle Regional Partnership, the Triangle, https://www.researchtriangle.org/the-triangle/

[22] Triangle Regional Freight Plan. February, 2018. https://nmcdn.io/e186d21f8c7946a19faed23c3da2f0da/8bfec28a290449a7b10eb1fee3a0e264/files/Triangle_Region_Freight_Plan_-_Final.pdf

[23] Dallas Chamber of Commerce. Transportation Infrastructure. https://www.dallaschamber.org/wp-content/uploads/2021/03/Connectivity-TransportationInfrastructure.pdf

[24] The Economic Role of Freight in the Dallas District. TxDOT. https://ftp.txdot.gov/pub/txdot/move-texas-freight/resources/economic-role-freight/freight-dallas.pdf

wood products, electronics, and nonmetallic minerals are the top commodities moved by truck eastbound direction from Dallas to Raleigh, when considering both tonnage and value.[25]

The trade lane between Raleigh and Dallas experienced 16.2 million hours of truck delay in both directions in 2019. Truck delays totaling 9.4 million hours from Raleigh to Dallas led to over $615 million in costs, while 6.8 million hours of truck delay from Dallas to Raleigh cost over $445 million.

As illustrated by the red dots in Figure 71 and Figure 72, the highest delays along this route, in both directions, occur on the roadways in Atlanta.

#15	Raleigh, NC to Dallas, TX			
7,324.8	66.2	1.33	9.4	$615.4
AADT Trucks	Average Truck Speed (Miles/Hour)	TTTR Index	Total Truck Delay (Million Hours)	Total Cost of Truck Delay (Millions)

#18	Dallas, TX to Raleigh, NC			
7,258.4	67.4	1.36	6.8	$445.7
AADT Trucks	Average Truck Speed (Miles/Hour)	TTTR Index	Total Truck Delay (Million Hours)	Total Cost of Truck Delay (Millions)

Source: CPCS Analysis of 2019 NPMRDS and HPMS Data

While the range of travel times between Raleigh and Dallas is similar, departure times for the highest and lowest travel times vary by direction. As shown in Figure 73, truck travel times westbound from Raleigh to Dallas reach their highest (19.46 hours) when drivers depart at 3:00 PM and their lowest (18.50 hours) when drivers depart at 8:00 PM. Meanwhile, as shown in Figure 74, truck travel times eastbound from Dallas to Raleigh are highest (19.39 hours) when drivers depart at 5:00 AM and lowest (18.48 hours) when drivers depart at 12:00 PM (noon).

Figure 73: Raleigh, NC to Dallas, TX Travel Time by Time of Day

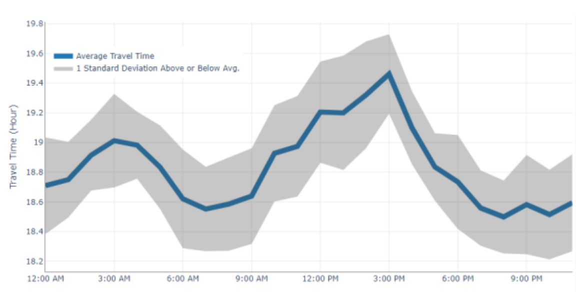
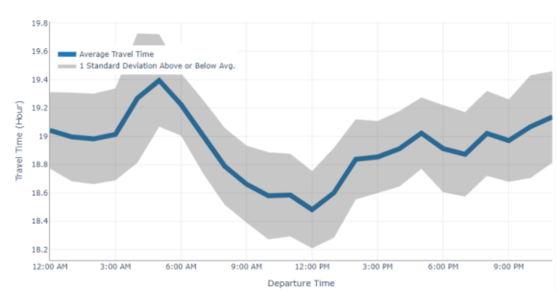


Figure 74: Dallas, TX to Raleigh, NC Travel Time by Time of Day



Source: CPCS Analysis of 2019 NPMRDS and HPMS Data

[25] CPCS analysis of FHWA FAF5, 2017.

A.9. Miami, FL to Atlanta, GA and Atlanta, GA to Miami, FL

Miami and Atlanta are connected by I-95, Florida's Turnpike, and I-75.

Miami: See Section A.7. for details about freight activity in Nashville.

Atlanta: See Section A.1. for details about freight activity in Atlanta.

Trade Lane: Over 1.9 million tons of goods worth nearly $6.4 billion moved by truck between Miami and Atlanta is supported by this trade corridor. From Miami to Atlanta, meat/seafood and other foodstuffs are among the top commodities moved by truck, when considering both tonnage and value. A high volume of natural sands also moves in this direction. Meanwhile, motorized vehicles and plastics/rubber are the top commodities moved by truck from Atlanta to Miami, by both tonnage and value.[26]

Figure 75: Routing for Miami, FL to Atlanta, GA

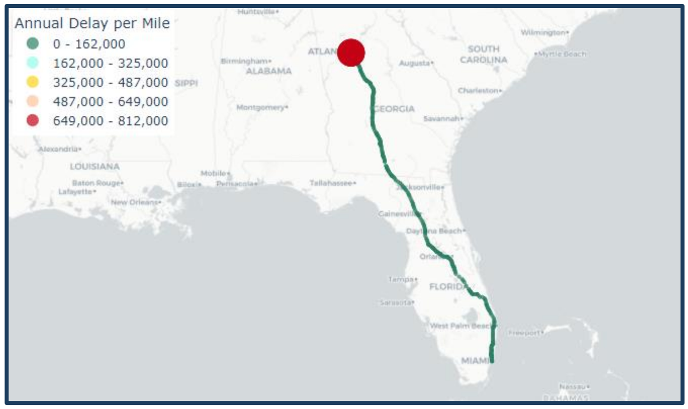
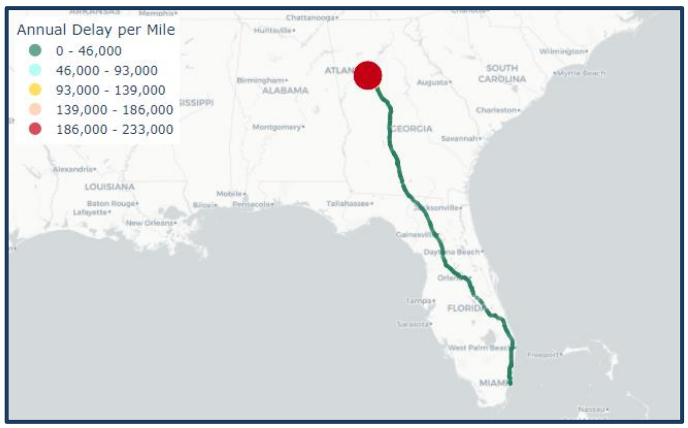


Figure 76: Routing for Atlanta, GA to Miami, FL



Over 7.9 million hours of truck delay occurred along both directions of this trade route in 2019. From Miami to Atlanta, 4.4 million hours of truck delay cost about $288 million. From Atlanta to Miami, over 3.5 million hours of truck delay led to almost $230 million in costs.

As illustrated by the red dots in Figure 75 and Figure 76 above, the highest delays along this route, in both directions, occur on the roadways in Atlanta.

[26] CPCS analysis of FHWA FAF5, 2017.

#16	Miami, FL to Atlanta, GA			
10,992.8	**69.9**	**1.38**	**4.4**	**$287.7**
AADT Trucks	Average Truck Speed (Miles/Hour)	TTTR Index	Total Truck Delay (Million Hours)	Total Cost of Truck Delay (Millions)

#20	Atlanta, GA to Miami, FL			
10,880.3	**70.3**	**1.39**	**3.53**	**$229.9**
AADT Trucks	Average Truck Speed (Miles/Hour)	TTTR Index	Total Truck Delay (Million Hours)	Total Cost of Truck Delay (Millions)

Source: CPCS Analysis of 2019 NPMRDS and HPMS Data

Travel times between Miami and Atlanta remain steady, with average travel times remaining between 9.89 and 10.71 hours throughout the day and night, in both directions. From Miami to Atlanta, travel times are lowest (9.89 hours) when trucks depart at 1:00 AM. Northbound travel times reach 10.36 hours during the AM peak departure time of 8:00 AM, and 10.55 hours during the PM peak departure time of 5:00 to 6:00 PM. These trends are shown in Figure 77. Meanwhile, from Atlanta to Miami, travel times are lowest in the morning (10.06 hours) when drivers depart at 4:00 AM, or in the evening (10.02 hours) when drivers depart at 7:00 PM. Southbound truck travel times peak at 10.71 hours when drivers depart at 10:00 PM. These patterns are illustrated in Figure 78.

Figure 77: Miami, FL to Atlanta, GA Travel Time by Time of Day

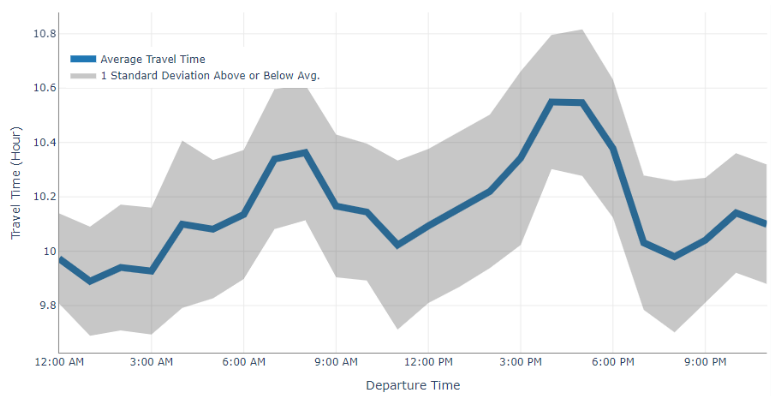
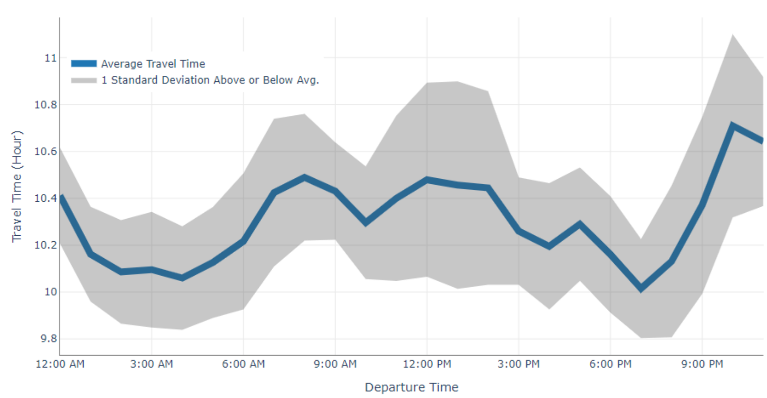


Figure 78: Atlanta, GA to Miami, FL Travel Time by Time of Day



Source: CPCS Analysis of 2019 NPMRDS and HPMS Data

A.10. Memphis, TN to Atlanta, GA

The primary corridors connecting Memphis to Atlanta are I-22 (Memphis to Birmingham) and I-20 (Birmingham to Atlanta).

Figure 79: Routing for Memphis, TN to Atlanta, GA

Memphis: Three key interstates (I-22, I-40, I-55), five Class I railroads (CN, BNSF Railway, CSX, Norfolk Southern, Union Pacific) and the Mississippi River meet in Memphis, making the region a key freight hub connecting the Southeast to the western U.S. The Memphis International Airport is also a global air cargo center.[27] As a result, Memphis has emerged as a national distribution hub with almost 160 million square feet of warehouse space and 42,000 acres of industrial parks in the greater tri-state region. Transportation and warehousing make up nearly 30 percent of employment in the Memphis region.[28]

Atlanta: See Section A.1. for details about freight activity in Atlanta.

This trade route supports the over 283 thousand tons of goods worth nearly $857 billion moving from Memphis to Atlanta by truck. Milled grain products are the top commodity transported from Memphis to Atlanta by truck, when considering both tonnage and value. Additional high-volume goods moved by truck are other foodstuffs and wood products, while other high value goods include electronics and motorized vehicles.[29]

In 2019, 2.4 hours of truck delay occurred on the route from Memphis to Atlanta, resulting in costs of over $159 million.

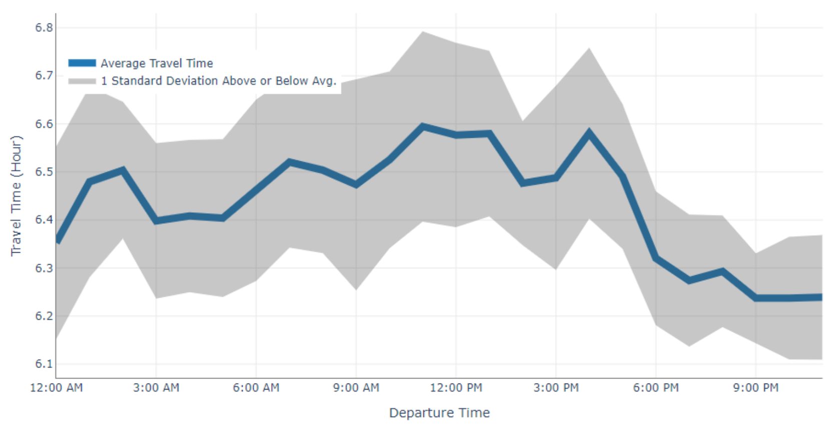
#17	Memphis, TN to Atlanta, GA			
7,065.4	**65.8**	**1.29**	**2.4**	**$159.3**
AADT Trucks	Average Truck Speed (Miles/Hour)	TTTR Index	Total Truck Delay (Million Hours)	Total Cost of Truck Delay (Millions)

Source: CPCS Analysis of 2019 NPMRDS and HPMS Data

[27] Memphis MPO, Greater Memphis Regional Freight Plan, https://memphismpo.org/sites/default/files/documents/plans/multi-modals/freight/greater-memphis-regional-frieght-plan.pdf
[28] Memphis MPO, Freight Planning, https://memphismpo.org/plans/multi-modal-plans/freight-planning
[29] CPCS analysis of FHWA FAF5, 2017.

Average truck travel times from Memphis to Atlanta remain relatively steady during the day and decrease during late evening hours. As shown in Figure 80, truck travel times reach 6.58 hours at a 4:00 PM departure time and dip to 6.24 at a 9:00 to 11:00 PM departure time.

Figure 80: Memphis, TN to Atlanta, GA Travel Time by Time of Day



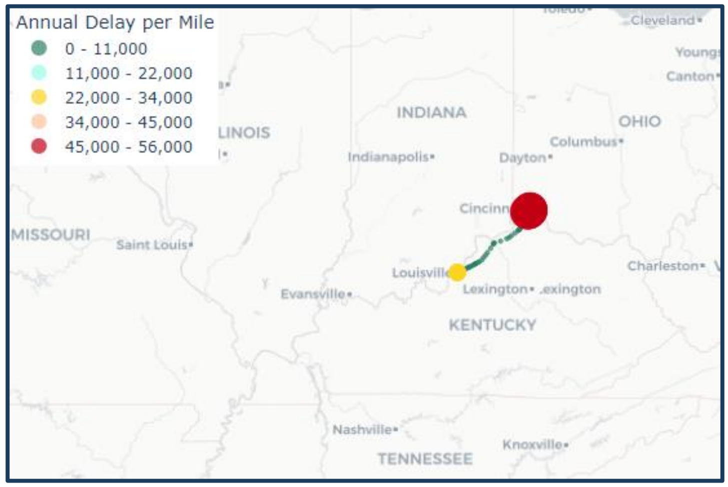
Source: CPCS Analysis of 2019 NPMRDS and HPMS Data

A.11. Louisville, KY to Cincinnati, OH

I-71 connects Louisville, KY to Cincinnati, OH.

Atlanta: See Section A.5. for details about freight activity in Louisville.

Figure 81: Routing for Louisville, KY to Cincinnati, OH



Cincinnati: Cincinnati, OH is located at the intersection of major Interstates (I-71, I-74, I-75) and two Class I rail lines (CSX and Norfolk Southern). Cincinnati provides further multimodal access through the Ports of Cincinnati and Northern Kentucky along the Ohio River, and the Cincinnati/Northern Kentucky International Airport, which is home to one of DHL's three global hubs and Amazon's largest hub.[30] Major freight businesses in the greater Cincinnati region include General Electric, AK Steel, Toyota, and Schwan Food Company.[31]

Trade Lane: This trade corridor helps facilitate almost 288 thousand tons of goods worth over $1.1 billion transported by truck from Louisville to Cincinnati. Top commodities moved from Louisville to Cincinnati by truck include motorized vehicles and mixed freight, when considering both tonnage and value. Other high-volume goods moved by truck are milled grain products and newsprint/paper, while additional high value goods include alcoholic beverages and machinery.[32]

The Louisville to Cincinnati corridor experienced 0.6 million hours of truck delay in 2019, leading to $37.6 million in costs.

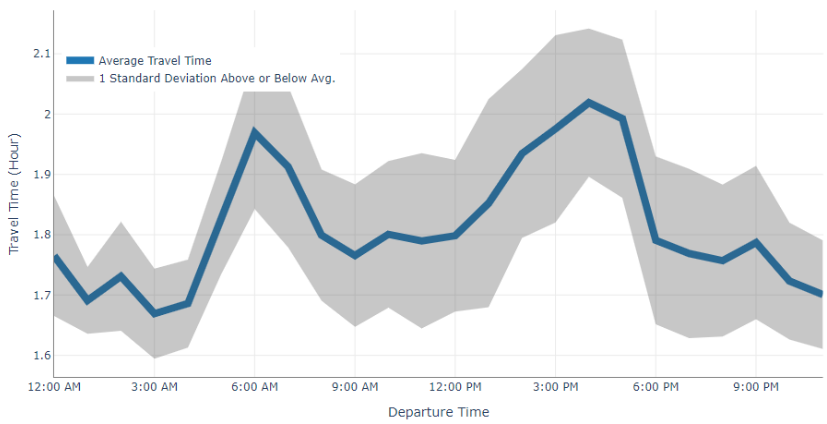
#19	Louisville, KY to Cincinnati, OH			
6,838.1	63.4	1.50	0.6	$37.6
AADT Trucks	Average Truck Speed (Miles/Hour)	TTTR Index	Total Truck Delay (Million Hours)	Total Cost of Truck Delay (Millions)

Source: CPCS Analysis of 2019 NPMRDS and HPMS Data

30 Ohio Department of Transportation, Transport Ohio, Working Paper 1: Characteristics of Ohio's Freight System, 2021, https://www.transportation.ohio.gov/programs/transport-ohio/transport-ohio-respository/working-paper-1
31 OKI Regional Council of Governments, OKI Regional Freight Plan, 2011, https://www.oki.org/wp-content/uploads/2021/09/2011-Freight-Plan-Complete-Full-Report-Appendices.pdf
32 CPCS analysis of FHWA FAF5, 2017.

From Louisville to Cincinnati, average truck travel times reach 1.97 hours during the AM peak departure time of 6:00 AM, and 2.02 hours during the PM peak departure time of 4:00 PM. Truck travel times decrease overnight, dipping to 1.67 hours when drivers depart at 3:00 AM. These trends are shown in Figure 82.

Figure 82: Louisville, KY to Cincinnati, OH Travel Time by Time of Day



Source: CPCS Analysis of 2019 NPMRDS and HPMS Data

Appendix B Truck Count Data Collection Methods

This appendix provides state DOT truck count data collection methods for Georgia, Mississippi, and South Carolina, collected in June 2022.

State DOT	Methodology
Georgia DOT	FHWA uses probe/observed data to determine delay while GDOT relies on the model and uses ATRI as a control.
Mississippi DOT	MDOT currently collects data at approximately 15,000 count locations statewide comprised of a majority of portable volume/classification and around 100 continuous/permanent counters. All portable counts are collected on a 3-year cycle including those for HPMS sampling.
South Carolina DOT	Beginning in 2018, SCDOT moved to collecting 48-hour classification counts for all portable data on a 2-year cycle. Prior to that, SCODT collected classification only at the HPMS samples on a 4-year cycle (approximately 500 locations/year). Any CCS classification data available was pulled for 1 week during a "typical" traffic month. Once new software was in place to utilize the 48-hour portable classification data, SCDOT utilized all CCS classification. Some of the portable locations have very little truck data. 2018 was SCDOT's first year collecting 48-hour classification data and there were a few software issues. The 2019 data collection went much smoother.