4. Georgia's Critical Freight Issues, Needs and Trends

Chapter 4 examines the critical issues and challenges facing the multimodal freight system in Georgia and the market trends that shape and drive them. Of the 358 industrial properties listed by the Georgia Department of Economic Development (GDEcD) as new or expanded development in FY 2022, 85 percent were identified as logistics-enabled by GDOT, indicating robust demand[66]. The freight-supported industries that account for 40 percent of Georgia employment[67] and contribute 30 percent of its GDP[68] depend on the five key indicators of freight performance – the KPI measures – introduced in Chapter 1. This chapter begins with those measures and reviews current multimodal performance in Georgia, encompassing assessment of urban and rural highway bottlenecks and their cost to industry, safety analysis, truck parking, and non-highway issues. It then explores nine major trends affecting Georgia's supply chains and freight system and the significance of trends for KPIs. Among them are supply chain shifts, disruption and risks; workforce and demographics; e-commerce; technology and automation; and alternative fuels. The chapter concludes with multimodal freight mobility strategies responsive to trends and performance challenges and describes the KPIs that strategies affect. This sets the stage for Chapter 5, where KPIs are forecast and monetized, and strategies are advanced through programs and investments.

4.1. Understanding Current Transportation and System Performance

Maintaining and enlarging the competitiveness of Georgia and its quality of life will be accomplished through strong performance in the five KPIs: safety, reliability, speed, cost, and risk. Defined in Chapter 1, the five were determined by the Advisory Committee on Supply Chain Competitiveness of the U.S. Department of Commerce, but they are widely acknowledged in the freight industry and were endorsed by the Georgia Freight Advisory Committee.

KPIs are the means through which strategies, programs and investments affect competitiveness and quality of life in Georgia. For instance, modal options by location enable shippers to make more effective decisions based on speed and reliability characteristics. Connectivity creates access for ports, airports and rail to warehouses and customers, influencing the cost, speed, reliability, safety, and risk exposure of shipments end-to-end, and thereby the attractiveness of each mode. Federal, State, and local governments fund the public network, affecting the cost and productivity, redundancy and risk, safety, and the reliability and travel times on the system. KPI improvement results in better outcomes for the general public, from safer roads and cleaner air to lower costs for household goods.

[66] https://www.georgia.org/center-of-innovation/areas-of-expertise/logistics/resources
[67] US Bureau of Labor Statistics, Quarterly Census of Employment and Wages, accessed October 2022
[68] US Bureau of Economic Analysis, 2021 Annual Gross domestic product (GDP) by state

This section discusses the current transportation system, focusing on highway and non-highway transportation, with a view towards understanding the performance of the system in respect to KPIs. Data in this section is drawn from multiple data sets, notably the National Performance Management Research Data Set (NPMRDS), American Transportation Research Institute (ATRI) and the Georgia Electronic Accident Reporting System (GEARS).

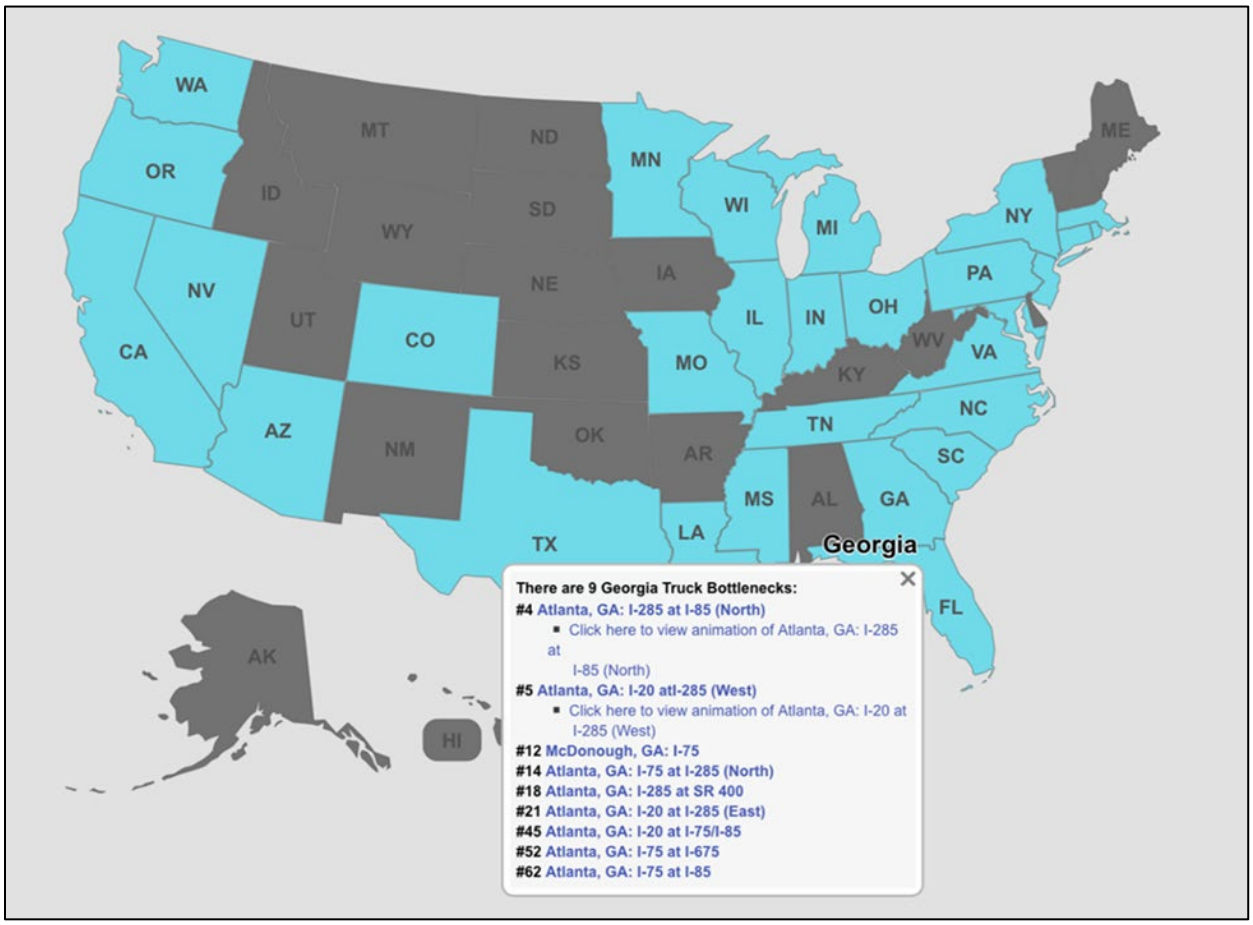
4.1.1. Highway

Central to highway freight performance are speed, reliability, and the cost to freight system users when those two indicators are reduced. Reductions in speed (predictable delay) and reliability (unpredictable delay) equate to congestion, and the cost to users is the cost of congestion. Concentrations of congestion are bottlenecks, which are thus prime generators of elevated costs in Georgia's freight system.

Bottlenecks are identified in different ways by different sources. ATRI publishes an annual Top 100 Bottleneck Report each year which uses GPS data from over one million freight trucks at over 300 major highway points to evaluate congestion on the nation's freight transportation system. In the 2022 edition using 2021 volumes (as shown in Figure 88), ATRI noted that Georgia is home to 2 of the top 5 bottlenecks and 5 of the top 20 overall worst congestion points in the nation. ATRI identifies bottlenecks by subtracting average truck speeds from assumed free flow speeds and multiplying by truck volumes, with adjustments for time of day. FHWA uses NPMRDS data comparing actual truck speeds to calculated free flow over 15-minute intervals, multiplies by reported truck volumes, and produces a national Top 100 list based on hours of delay per mile. Georgia has 5 bottlenecks on its latest list[69] (2020, which was affected by the pandemic). All were in Atlanta, none were in the top 20, and the highest ranking was number 24, the intersection of I-20 with the I-75/I-85 split. FHWA provides a cost of delay by corridor based on operating costs but does not rank individual bottlenecks with this measure. The analysis conducted for this Plan utilizes 2021 NPMRDS data and differs in several ways, most significantly through ranking by cost and accounting for the user cost of unreliability as well as the operating cost of delay. The cost analysis employed in the following pages follows the same method as the cost analysis in Chapter 5, which is focused on forecast rather than current congestion. While Chapter 5 necessarily works within a modeled environment in order to conduct forecasting, its portrayal of current congestion is comparable to the findings shown here.

[69] https://ops.fhwa.dot.gov/freight/freight_analysis/mobility_trends/index.htm

Figure 88. States with ATRI Top Truck Bottlenecks



Source: ATRI.org

The analysis of truck bottlenecks for this Plan used findings from the recently published NCHRP Report 925[70] to estimate the costs that congestion generates for trucking companies and businesses that use trucking services; this represents an improvement over analyses that estimate costs only to trucking companies and ignore broader supply chain impacts. The assessment presented here identifies bottlenecks through a more complete estimation of congestion costs to supply chains and the broader economy, which is critical for prioritizing and right-sizing solutions.

Table 82 lists the steps in the analysis. First, 2021 travel-time data from the National Performance Management Research Data Set (NPMRDS) published by the Federal Highway Administration (FHWA) was combined with hourly truck volume data to calculate the two

[70] Guerrero, S. E., Hirschman, I., Bryan, J., Noland, R., Hsieh, S., Schrank, D., and Guo, S. 2019. NCHRP Research Report 925: Estimating the Value of Truck Travel Time Reliability, Transportation Research Board, National Academies of Science, Engineering and Medicine.

congestion metrics NCHRP Report 925 recommends: Vehicle Hours of Excess Travel (VHET) and Vehicle Hours of Unreliability (VHU). The first metric quantified the impact of recurring congestion – in KPI terms, the reduction in speed - while the later metric quantified non-recurring congestion – in KPI terms, the reduction in reliability. The monetization parameters from NCHRP Report 925 were then used to estimate the user costs incurred by trucks as they face recurring and non-recurring congestion. The sum of the two is the cost KPI, representing the total cost of delay.

Table 82. Bottleneck Identification Overview

Component	Steps
Calculation of Congestion Metrics	Processed National Performance Management Research Data Set
	Approximated hourly truck volumes
	Estimated recurring congestion and non-recurring congestion metrics (KPIs: Speed and Reliability)
	Estimated user costs (KPI:Cost)
Bottleneck Identification	Categorize by Urban Atlanta, Urban Other, and Rural
	Set bottleneck thresholds
	Cluster bottlenecks
Assessment of Causes	Construction work zones

Source: NCHRP Report 925

The estimated user costs were then used to evaluate delay at congested locations, generating high costs to the movement of freight and representing bottlenecks for truck operations. The roadway network was broken up into Urban Atlanta-Region, Urban Other, and Rural categories, so that congested roads are prioritized relative to other roads of the same type. Otherwise bottlenecks in the Atlanta region would dominate the statewide analysis. The thresholds used to identify bottlenecks were set at the 95th percentile user costs per mile (top 5 percent of segments generating congestion costs). Once segments were identified as bottlenecks, they were aggregated into clusters.

Finally, the top bottlenecks were analyzed to determine whether they were caused by roadway construction work zones, which would exclude them from project development considerations. Work zone data was collected by analyzing GDOT records of construction logs for the year 2021.

Identification and Clustering

The thresholds used to identify bottlenecks were set at the top 5 percent of user costs per mile in each bottleneck type (Urban Atlanta, Urban Other, and Rural). Different thresholds for the user cost metric were used to identify bottlenecks in rural areas versus urban areas. Bottlenecks in urban areas typically have different magnitude and characteristics than bottlenecks in rural

areas. If the same threshold was used throughout the state, the highly congested roads in metropolitan areas would dominate the results. **Table 83** shows these thresholds. Roads were classified as being Urban Other or Rural based on the distinction made in NPMRDS (originally coming from the U.S. Census Bureau). Urban Atlanta was defined as roads in the territory of the Atlanta Regional Commission (ARC).

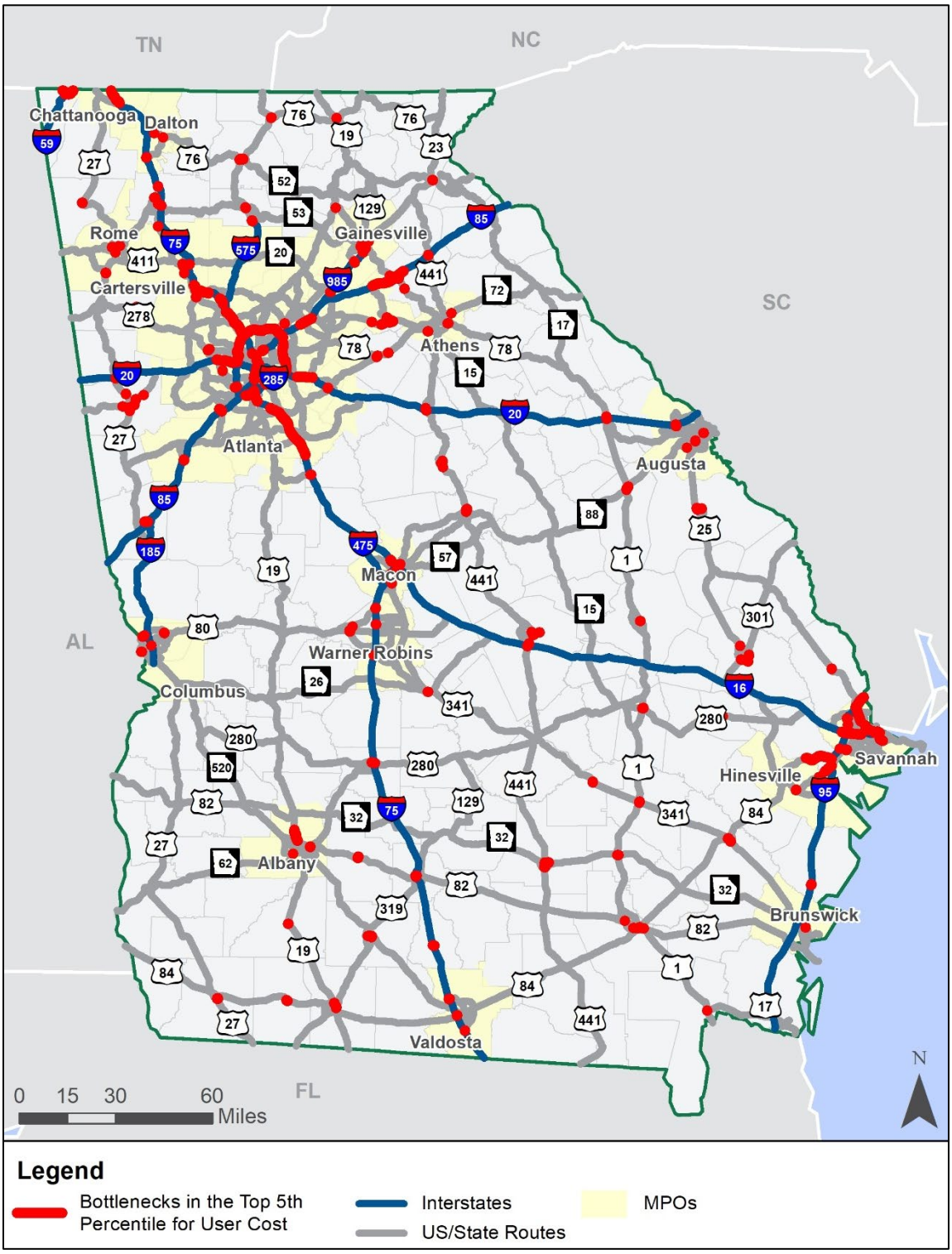
There were 219 roadway segments in Urban Atlanta with user costs higher than the threshold (in NPMRDS each segment is defined by a unique Traffic Message Channel TMC), totaling 111 centerline miles of roadway. In Urban Other, 184 roadway segments were above the threshold, combining for 56 centerline miles of roadway; in Rural, 143 roadway segments were above the threshold, combining for 72 miles of roadway. In total, roughly seventy percent of the bottleneck distance was identified in urban areas and thirty percent in rural areas. **Figure 89** displays a map of the bottlenecks, showing thorough coverage throughout Georgia, but concentrated in urban regions across the state, as highlighted in **Figure 90**.

Table 83. Truck Bottleneck Thresholds and Totals

Bottleneck Type	User Cost Threshold ($/mile-day)	Bottleneck Centerline Roadway Miles	Number of Bottleneck Segments (TMCs)
Urban Atlanta	21,602	111	219
Urban Other	7,089	56	184
Rural	4,077	72	143
Total		**239**	**546**

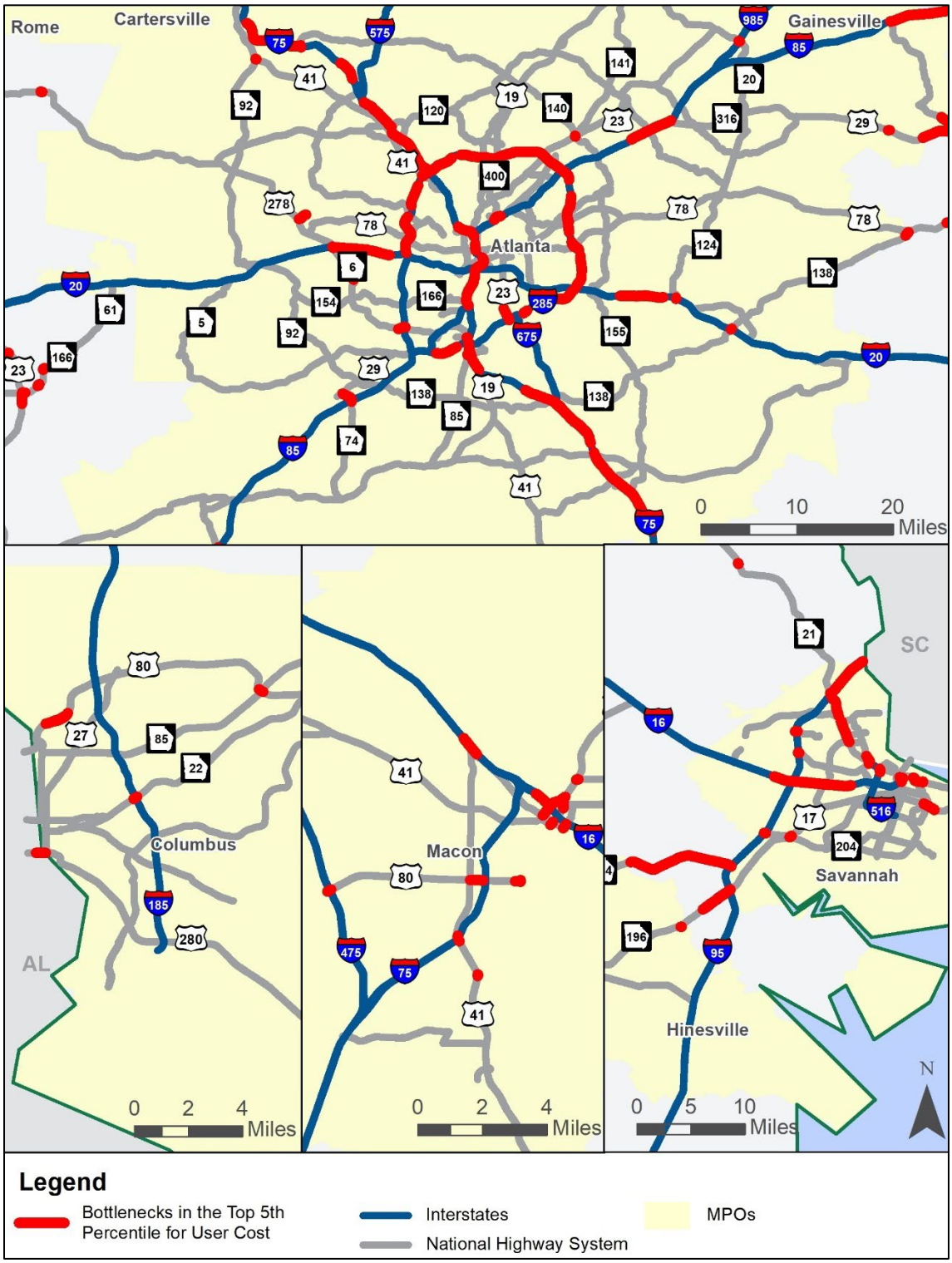
Source: NPMRDS and NCHRP Report 925

Figure 89. Truck Bottleneck Locations - Statewide



Source: NPMRDS and NHCRP Report 925

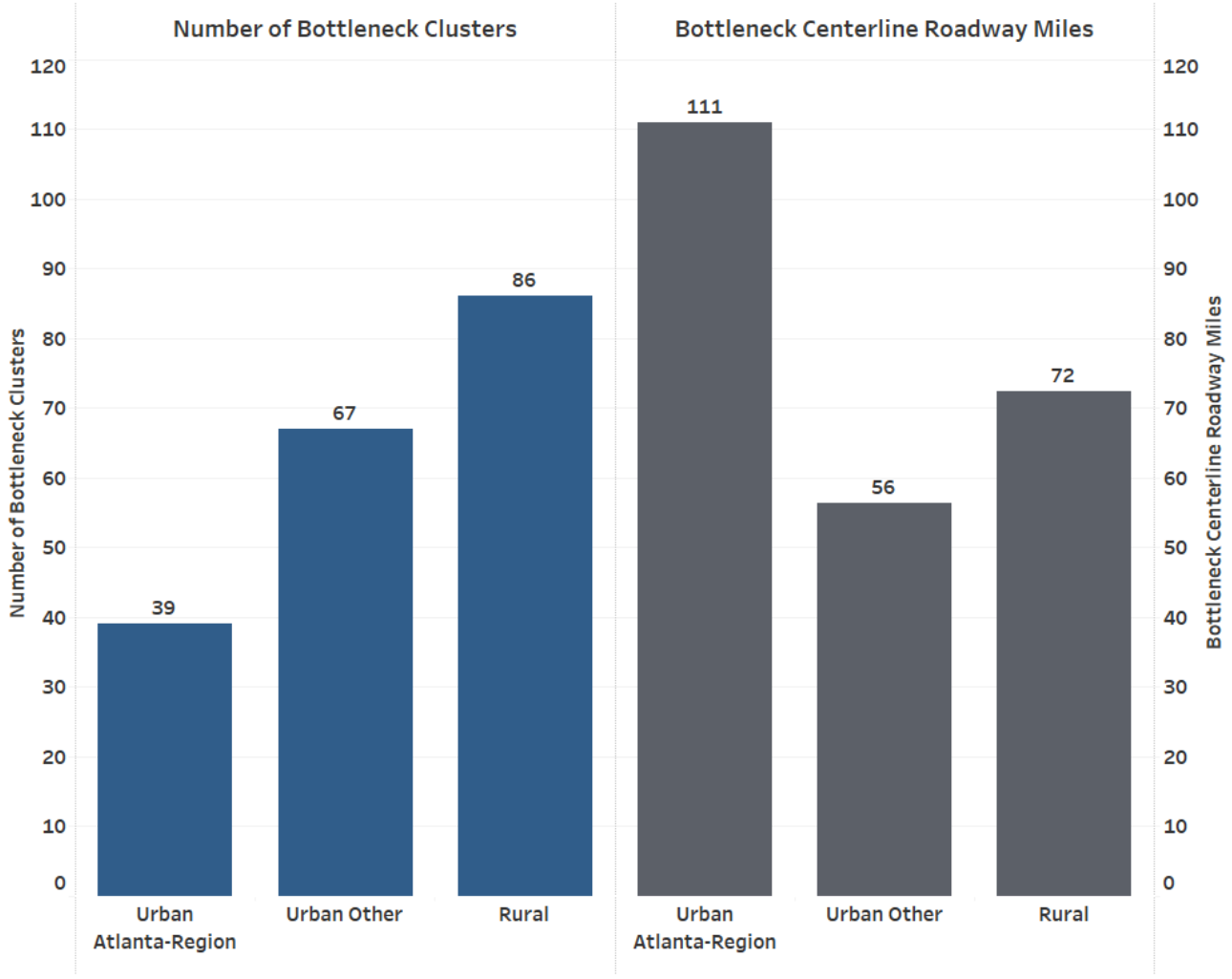
Figure 90. Truck Bottleneck Locations – Highlighted Metropolitan Areas



Source: NPMRDS and NCHRP Report 925

A manual process was conducted to combine consecutive bottlenecks into bottleneck clusters. Especially in urban areas, where the network is segmented more finely, numerous consecutive segments were designated as bottlenecks. For simplicity, and ease of interpreting the results, consecutive and near consecutive segments were combined into bottleneck clusters. In some cases, nearby roads that are not consecutive were combined into the same cluster if the underlying cause of the bottleneck was judged to be the same. As shown in **Figure 91**, this resulted in 86 bottleneck clusters in Rural, 39 in Urban Atlanta, and 67 in Urban Other areas, for a total of 192 bottleneck clusters.

Figure 91. Number of Bottleneck Clusters



Source: NPMRDS and NCHRP Report 925

Top Bottlenecks

This section describes the top 20 bottleneck clusters in Georgia for each of the bottleneck types (Urban-Atlanta, Urban Other, Rural) and the estimated costs they generate.

Urban Atlanta

The top 20 bottleneck clusters in the Atlanta region are listed in **Table 84** and mapped in **Figure 92**. In total, these bottlenecks represent 105 centerline miles of roadway that generate $3.50 million of user costs to trucks and shippers each day. About a third of these user costs accrue to the two top ranked bottleneck clusters on *I-75 NB from Bill Gardner Pkwy to I-675* (ID 92) and *I-75 SB from Hudson Bridge Rd to Mt Zion Blvd* (ID-91), because this is a heavily congested corridor and the longest defined bottlenecks in the study (accruing more congestion costs), and due to the large number of truck terminals in Henry County. As indicated by the northbound and southbound notations in the bottleneck names, the mileage and user costs listed in this table are for specific direction of travel. In a few instances the direction of travel is not mentioned, which implies that both directions of travel are part of the same bottleneck cluster.

The supply chains most impacted by these top 20 urban Atlanta bottlenecks include food and agriculture, construction and distribution (**Table 85**). Through trucks and empty units contribute significantly to congestion at these bottlenecks, accounting for close to half the impact in some cases. All top 20 bottleneck locations are projected to see at least 85 percent growth in truck traffic from 2019 to 2050.

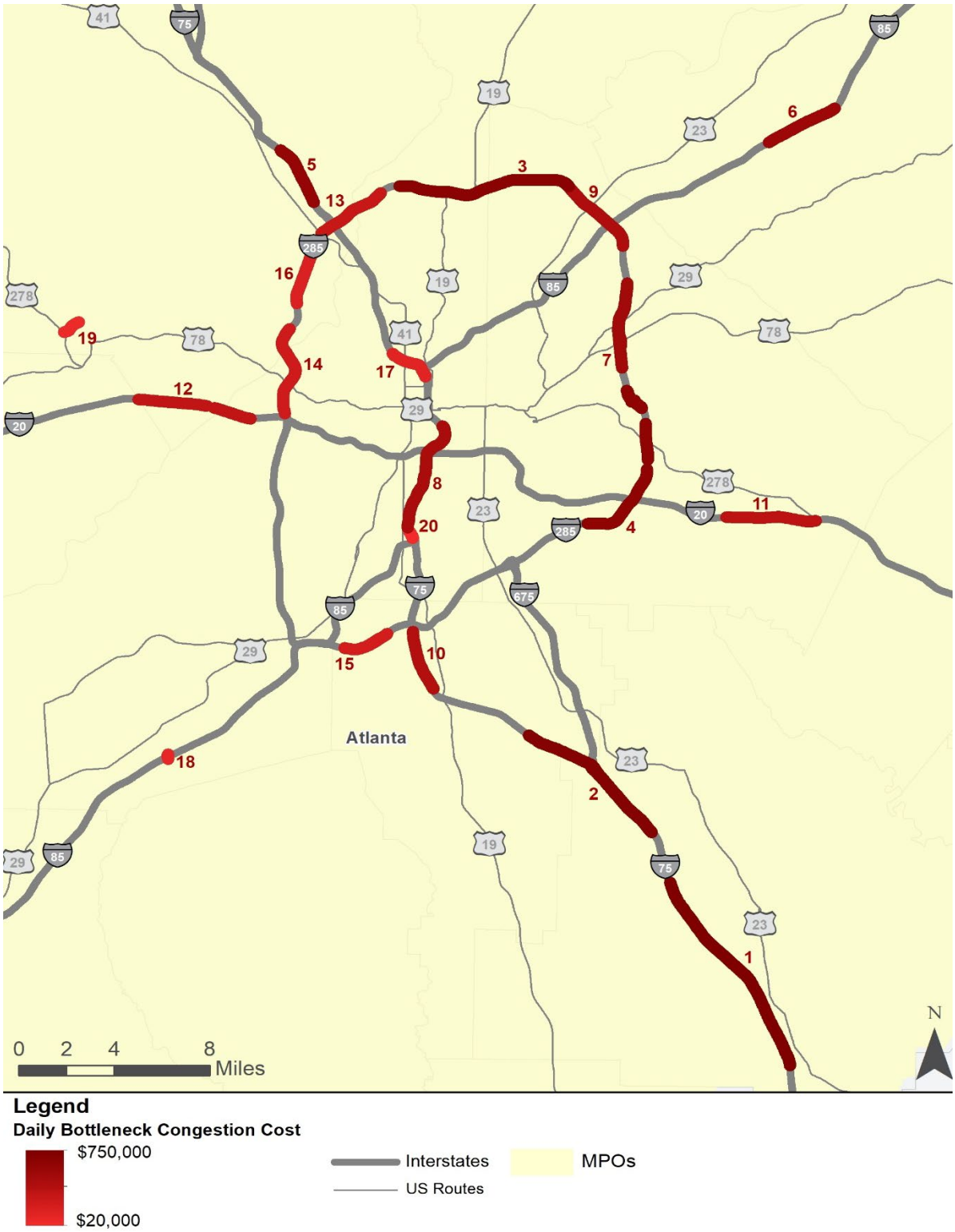
Table 84. Top 20 Bottlenecks in Urban Atlanta-Region

Rank	ID	Bottleneck Name	Total Miles	Average Daily Truck Volume	Congestion Costs in 2019 ($/day)	Growth in Truck Volumes (2019 to 2050)
1	92	I-75 NB from Bill Gardner Pkwy to I-675	18.8	18,132	747,825	98.0%
2	91	I-75 SB from Hudson Bridge Rd to Mt Zion Blvd	10.5	17,595	431,064	103.0%
3	51	I-285 Top End	8.5	21,570	283,500	93.6%
4	54	I-285 from Memorial Dr and I-20 East Interchange	7.7	20,861	233,927	105.4%
5	42	I-75 SB from I-285 North interchange to Roswell St	7.6	13,261	215,306	113.9%
6	46	I-85 SB from Beaver Ruin Rd to GA-316	6.8	13,415	202,133	118.0%
7	53	I-285 from Church St to Lavista Rd	6.5	19,658	196,274	114.5%
8	69	I-75/I-85 NB from I-75/I-85 South Split to John Lewis Freedom Pkwy	4.6	16,401	184,704	156.0%

Rank	ID	Bottleneck Name	Total Miles	Average Daily Truck Volume	Congestion Costs in 2019 ($/day)	Growth in Truck Volumes (2019 to 2050)
9	52	I-285 from I-85 to Peachtree Industrial Blvd	3.8	19,378	143,384	100.5%
10	81	I-75 NB from Tara Blvd to I-285 South Interchange	2.7	18,786	128,096	107.1%
11	73	I-20 WB from Evans Mill Rd to Panola Rd	3.8	12,863	125,801	97.4%
12	72	I-20 EB from Fulton Industrial Blvd to Thornton Rd	4.5	11,494	115,695	101.2%
13	61	I-285 CCW at I-75 North Interchange	3.6	22,206	103,790	91.6%
14	59	I-285 CCW from S Cobb Dr to I-20 West Interchange	4.1	12,256	98,666	92.7%
15	58	I-285 at Riverdale Rd	2.4	37,667	83,451	97.7%
16	60	I-285 CW from Atlanta Rd to Paces Ferry Rd	2.2	23,161	70,113	87.8%
17	67	I-75 SB from I-75//I-85 North Split to Howell Mill Rd	1.4	10,492	45,382	172.0%
18	90	GA-74 from I-85 to Roosevelt Hwy	1.4	4,196	39,191	112.0%
19	63	Dr Luke Glenn Garrett Jr Memorial Hwy	0.8	3,954	32,925	91.5%
20	70	I-85 SB at I-75/I-85 South Split	0.4	16,615	20,511	158.0%
TOTALS			104.8	--	3,501,737	

Source: Transearch and NPMRDS

Figure 92. Top 20 Bottlenecks in Urban Atlanta-Region (number labels represent rank in region)



Source: NPMRDS and NCHRP Report 925

Table 85. Supply Chains affected by Top 20 Bottleneck Clusters in Urban Atlanta-Region (% of Truck Units)

Rank	Bottleneck Name	Automotive	Chemicals & Plastics	Construction	Distribution	Electronics & Electrical	Energy	Food & Agriculture	Furnishings & Clothing	Health	Lumber & Paper	Metals & Machinery	Miscellaneous	Through Trucks	Empty Trucks
1	I-75 NB from Bill Gardner Pkwy to I-675	2.5%	2.3%	9.9%	6.6%	0.5%	1.6%	15.1%	1.7%	0.1%	7.9%	2.3%	3.2%	26.2%	20.1%
2	I-75 SB from Hudson Bridge Rd to Mt Zion Blvd	2.4%	2.3%	11.5%	6.3%	0.5%	1.4%	14.0%	1.6%	0.1%	7.4%	2.3%	3.2%	25.2%	21.7%
3	I-285 Top End	1.4%	2.6%	19.5%	4.2%	0.3%	1.9%	10.3%	0.9%	0.1%	3.5%	1.4%	3.3%	18.1%	32.2%
4	I-285 from Memorial Dr and I-20 East Interchange	1.6%	2.2%	14.4%	4.6%	0.4%	1.2%	8.7%	1.6%	0.1%	3.9%	1.3%	2.8%	31.3%	26.0%
5	I-75 SB from I-285 NIC to Roswell St	1.8%	2.5%	16.3%	4.4%	0.3%	2.6%	10.0%	1.2%	0.1%	4.9%	1.8%	7.4%	14.3%	32.4%
6	I-85 SB from Beaver Ruin Rd to GA-316	1.6%	2.4%	17.3%	5.0%	0.4%	1.6%	7.7%	0.8%	0.1%	2.7%	1.3%	4.1%	22.5%	32.9%
7	I-285 from Church St to Lavista Rd	1.5%	2.2%	16.1%	4.9%	0.4%	4.1%	8.2%	1.1%	0.1%	3.4%	1.2%	3.9%	20.1%	32.8%
8	I-75/I-85 NB from I-75/I-85 South Split to John Lewis Freedom Pkwy	0.4%	1.3%	17.8%	10.3%	0.1%	3.8%	3.8%	0.4%	0.1%	3.1%	0.7%	5.0%		53.0%
9	I-285 from I-85 to Peachtree Industrial Blvd	1.5%	2.6%	18.1%	4.5%	0.4%	2.6%	9.7%	1.0%	0.1%	3.5%	1.4%	3.6%	19.2%	32.0%

Rank	Bottleneck Name	Automotive	Chemicals & Plastics	Construction	Distribution	Electronics & Electrical	Energy	Food & Agriculture	Furnishings & Clothing	Health	Lumber & Paper	Metals & Machinery	Miscellaneous	Through Trucks	Empty Trucks
10	I-75 NB from Tara Blvd to I-285 South Interchange	2.2%	2.4%	14.2%	5.3%	0.5%	1.8%	12.3%	1.4%	0.1%	6.6%	2.0%	3.8%	20.9%	26.6%
11	I-20 WB from Evans Mill Rd to Panola Rd	1.1%	2.8%	13.8%	5.1%	0.2%	0.6%	8.3%	2.2%	0.0%	6.3%	1.1%	4.4%	26.2%	27.9%
12	I-20 EB from Fulton Industrial Blvd to Thornton Rd	1.1%	1.9%	21.0%	3.7%	0.5%	1.1%	7.8%	0.3%	0.1%	2.5%	0.8%	4.0%	23.9%	31.4%
13	I-285 CCW at I-75 North Interchange	1.7%	2.4%	18.1%	4.0%	0.4%	1.6%	10.8%	1.0%	0.1%	4.0%	1.5%	3.2%	22.3%	28.9%
14	I-285 CCW from S Cobb Dr to I-20 West Interchange	2.1%	2.1%	15.0%	3.7%	0.5%	1.0%	11.3%	1.1%	0.1%	5.1%	1.6%	3.4%	29.8%	23.2%
15	I-285 at Riverdale Rd	2.3%	2.3%	11.2%	3.4%	0.5%	0.7%	11.1%	1.9%	0.1%	6.1%	1.9%	3.0%	39.0%	16.6%
16	I-285 CW from Atlanta Rd to Paces Ferry Rd	2.2%	2.1%	14.3%	3.6%	0.5%	0.9%	11.9%	1.2%	0.1%	5.2%	1.7%	3.0%	32.5%	21.0%
17	I-75 SB from I-75//I-85 North Split to Howell Mill Rd	0.7%	2.1%	16.7%	5.3%	0.2%	4.9%	4.0%	0.3%	0.1%	2.5%	1.4%	16.3 %		45.5%
18	GA-74 from I-85 to Roosevelt Hwy	2.1%	2.0%	16.6%	3.5%	0.5%	0.7%	6.2%	1.9%	0.0%	3.6%	1.4%	3.1%	29.6%	28.6%
19	Dr Luke Glenn Garrett Jr Memorial Hwy	1.0%	2.1%	20.8%	2.7%	0.0%	1.3%	10.3%	0.4%	0.0%	4.1%	0.3%	3.7%	5.9%	47.4%
20	I-85 SB at I-75/I-85 South Split	0.4%	1.3%	18.1%	10.2%	0.1%	4.4%	3.8%	0.4%	0.1%	2.8%	0.7%	4.6%		53.2%

Source: Transearch and NPMRDS

Other Urban Bottlenecks

The top 20 bottleneck clusters in the other urban regions of the state are listed in **Table 86** and mapped in **Figure 93**. In total, these bottlenecks constitute 50 centerline miles of roadway in the urban regions around the state (excluding Atlanta), generating $0.6 million of user costs to trucks and shippers each day. About forty percent of these user costs accrue to the two top ranked bottleneck clusters *I-75 NB from Battlefield Pkwy to TN State Line* (ID 2) near Chattanooga and I-16 from Chatham Pkwy to Pooler Pkwy (ID-149). *I-75 NB from Battlefield Pkwy to TN State Line* (ID-2) accrues the highest portion of congestion costs per day within these clusters (22 percent) despite accounting for less than 8 percent of the mileage. Most bottleneck locations are projected to see at least 50 percent growth in truck traffic from 2019 to 2050. However, GA-22 at US-129 (ID-111) is projected to see an approximately 50 percent drop in traffic, due to a projected decrease in non-metallic minerals movement enroute at this location.

The supply chains most impacted by these top 20 other urban bottlenecks include food and agriculture, construction and lumber and paper (**Table 87**). Through trucks and empty units contribute significantly to congestion at these bottlenecks, with share of total congestion costs ranging from 30 percent to 90 percent.

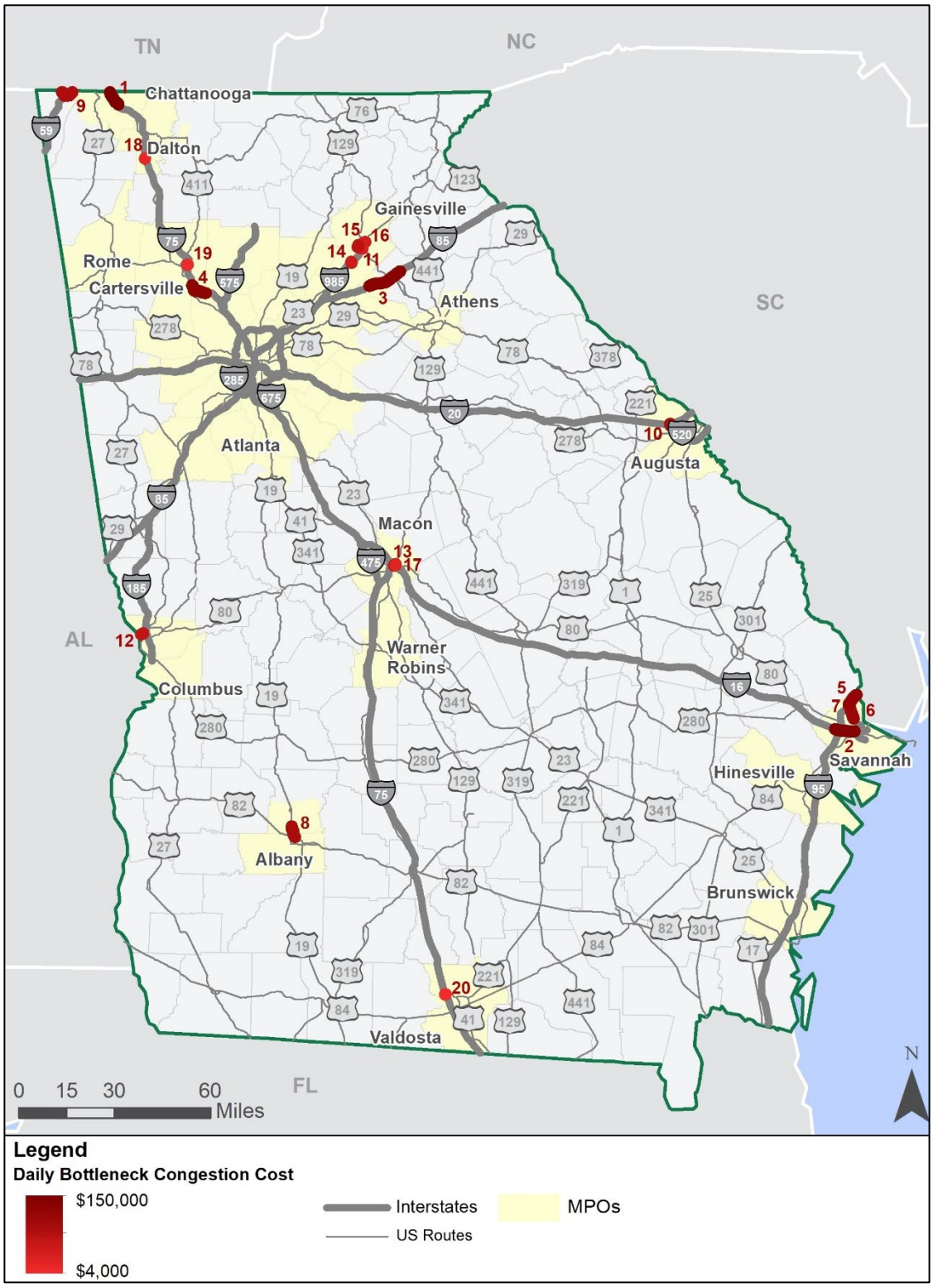
Table 86. Top 20 Urban Other Bottleneck Clusters

Rank	ID	Bottleneck Name	Total Miles	Average Daily Truck Volume	Congestion Costs in 2019 ($/day)	Units Growth (2019 to 2050)
1	2	I-75 NB from Battlefield Pkwy to TN State Line	4.8	18,858	148,003	91.0%
2	149	I-16 from Chatham Pkwy to Pooler Pkwy	8.7	5,659	124,699	85.9%
3	32	I-85 from GA-53 to GA-82	7.2	12,745	57,939	109.3%
4	35	I-75 SB from Cherokee Rd to Old Allatoona Rd	5.7	13,646	45,028	98.3%
5	140	I-95 NB from GA-21 to SC State Line	3.5	11,664	38,143	90.4%
6	142	GA-21 from GA-307 to GA-30	4.1	5,677	35,023	91.1%
7	141	GA-21 from Jimmy Deloach Pkwy to I-95	2.5	4,179	28,757	90.3%
8	161	GA-133 from US-82 to US-19	3.7	1,641	26,535	57.6%
9	1	I-24 EB at I-59	0.6	16,719	17,557	97.1%
10	95	GA-383 at I-20	1.3	2,060	15,293	77.6%
11	19	GA-369 in Gainesville	1	1,477	11,424	72.7%

Rank	ID	Bottleneck Name	Total Miles	Average Daily Truck Volume	Congestion Costs in 2019 ($/day)	Units Growth (2019 to 2050)
12	124	US-80 from Bradley Park Dr to GA-219	1.2	42,115	9,787	90.7%
13	113	US-129 at I-16	0.9	1,847	8,812	35.7%
14	22	GA-53 at I-985	0.8	1,900	8,675	98.2%
15	18	GA-369 at I-985	0.8	1,697	8,257	87.0%
16	20	GA-11 from I-985 to Athens St	1.1	2,355	8,148	72.8%
17	111	GA-22 at US-129	0.4	3,397	7,288	-49.4%
18	7	GA-3 at I-75	0.3	2,311	5,648	93.5%
19	28	GA-20 at I-75	0.5	2,772	5,488	90.0%
20	179	US-41 at I-75 in Valdosta	0.5	3,874	4,822	93.8%
TOTALS			49.6	--	615,326	

Source: Transearch and NPMRDS

Figure 93. Top 20 Urban Other Bottleneck Clusters



Source: NPMRDS and NCHRP Report 925

Table 87. Supply Chains affected by Top 20 Bottleneck Clusters in Urban Other (% of Truck Units)

Rank	Bottleneck Name	Automotive	Chemicals & Plastics	Construction	Distribution	Electronics & Electrical	Energy	Food & Agriculture	Furnishings & Clothing	Health	Lumber & Paper	Metals & Machinery	Miscellaneous	Through Trucks	Empty Trucks
1	I-75 NB from Battlefield Pkwy to TN State Line	2.5%	3.7%	13.0%	4.3%	0.5%	1.1%	17.4%	1.9%	0.1%	5.4%	2.9%	3.5%	20.6%	22.9%
2	I-16 from Chatham Pkwy to Poder Pkwy	3.0%	2.7%	7.2%	3.1%	1.2%	2.5%	14.9%	4.4%	0.3%	10.8%	4.5%	9.0%	1.4%	34.9%
3	I-85 from GA-53 to GA-82	1.6%	3.4%	12.1%	4.6%	0.4%	0.9%	7.9%	1.2%	0.1%	3.2%	1.6%	4.5%	40.2%	18.3%
4	I-75 SB from Cherokee Rd to Old Allatoona Rd	2.4%	3.3%	13.4%	4.8%	0.5%	1.3%	13.5%	1.6%	0.1%	6.1%	2.7%	4.8%	20.3%	25.2%
5	I-95 NB from GA-21 to SC State Line	1.1%	0.4%	1.6%	0.7%	0.1%	0.2%	2.6%	0.4%	0.0%	3.5%	0.3%	0.6%	84.4%	4.0%
6	GA-21 from GA-307 to GA-30	0.1%	0.3%	4.9%	0.1%	0.1%	3.4%	1.5%	0.4%	0.0%	7.1%	0.4%	13.9%		67.8%
7	GA-21 from Jimmy Deloach Pkwy to I-95	0.6%	0.4%	3.6%	0.8%	0.1%	1.8%	2.1%	0.4%	0.0%	5.7%	0.4%	7.1%	41.0%	36.1%
8	GA-133 from US-82 to US-19	1.5%	0.5%	12.4%	2.4%	0.2%	6.2%	16.1%	0.2%	0.0%	9.2%	0.4%	1.6%	6.4%	42.9%
9	I-24 EB at I-59	2.1%	3.0%	5.4%	3.9%	0.4%	0.1%	15.0%	1.6%	0.1%	4.1%	2.5%	2.6%	51.4%	7.9%
10	GA-383 at I-20	1.4%	3.5%	20.6%	6.4%	0.3%	1.5%	8.3%	0.6%	0.1%	8.6%	0.8%	5.6%	3.6%	38.9%

Rank	Bottleneck Name	Automotive	Chemicals & Plastics	Construction	Distribution	Electronics & Electrical	Energy	Food & Agriculture	Furnishings & Clothing	Health	Lumber & Paper	Metals & Machinery	Miscellaneous	Through Trucks	Empty Trucks
11	GA-369 in Gainesville	2.1%	1.9%	15.3%	1.6%	0.2%	2.0%	28.6%	0.4%	0.1%	1.2%	3.1%	2.1%		41.4%
12	US-80 from Bradley Park Dr to GA-219	1.8%	1.9%	15.4%	2.2%	0.7%	1.2%	9.9%	3.0%	0.1%	8.6%	2.3%	3.5%	20.9%	28.7%
13	US-129 at I-16	1.5%	2.3%	18.9%	3.4%	0.1%	1.6%	19.8%	0.3%	0.0%	12.2%	0.8%	4.9%	2.9%	31.2%
14	GA-53 at I-985	1.1%	1.1%	21.4%	3.0%	0.3%	1.1%	14.0%	0.2%	0.1%	1.5%	1.2%	3.1%	1.2%	50.9%
15	GA-369 at I-985	0.8%	0.8%	29.5%	2.7%	0.0%	0.8%	9.5%	0.4%	0.1%	2.4%	1.1%	2.2%	4.2%	45.5%
16	GA-11 from I-985 to Athens St	2.1%	1.9%	15.3%	1.6%	0.2%	2.0%	28.8%	0.4%	0.1%	1.2%	3.1%	2.1%		41.2%
17	GA-22 at US-129	0.3%	0.0%	16.7%	0.5%	0.0%	0.1%	2.7%	0.0%		5.9%	0.1%	30.6%		43.1%
18	GA-3 at I-75	2.7%	4.3%	13.9%	5.0%	0.5%	0.9%	15.1%	1.7%	0.1%	6.1%	3.1%	4.3%	20.5%	21.7%
19	GA-20 at I-75	2.0%	3.0%	17.5%	4.2%	0.4%	1.6%	15.1%	1.0%	0.1%	4.2%	2.4%	4.1%	11.9%	32.4%
20	US-41 at I-75 in Valdosta	0.9%	1.9%	8.5%	3.9%	0.2%	0.2%	7.7%	0.4%	0.0%	3.5%	0.5%	2.4%	57.8%	12.1%

Source: Transearch and NPMRDS

Rural

The top 20 bottleneck clusters in the rural regions in the state are listed in **Table 88** and mapped in **Figure 94**) In total, these bottlenecks constitute 48 centerline miles of roadway in rural regions around the state, generating $0.3 million of user costs to trucks and shippers each day. About thirty percent of these user costs accrue to the two top ranked bottleneck clusters, both of which are roadway sections located near or at interchanges/exits to *I-95 – GA-144 from I-95 to Liberty County Line* (ID 153) and *US-17 from Belfast Keller Rd to I-95* (ID-154).

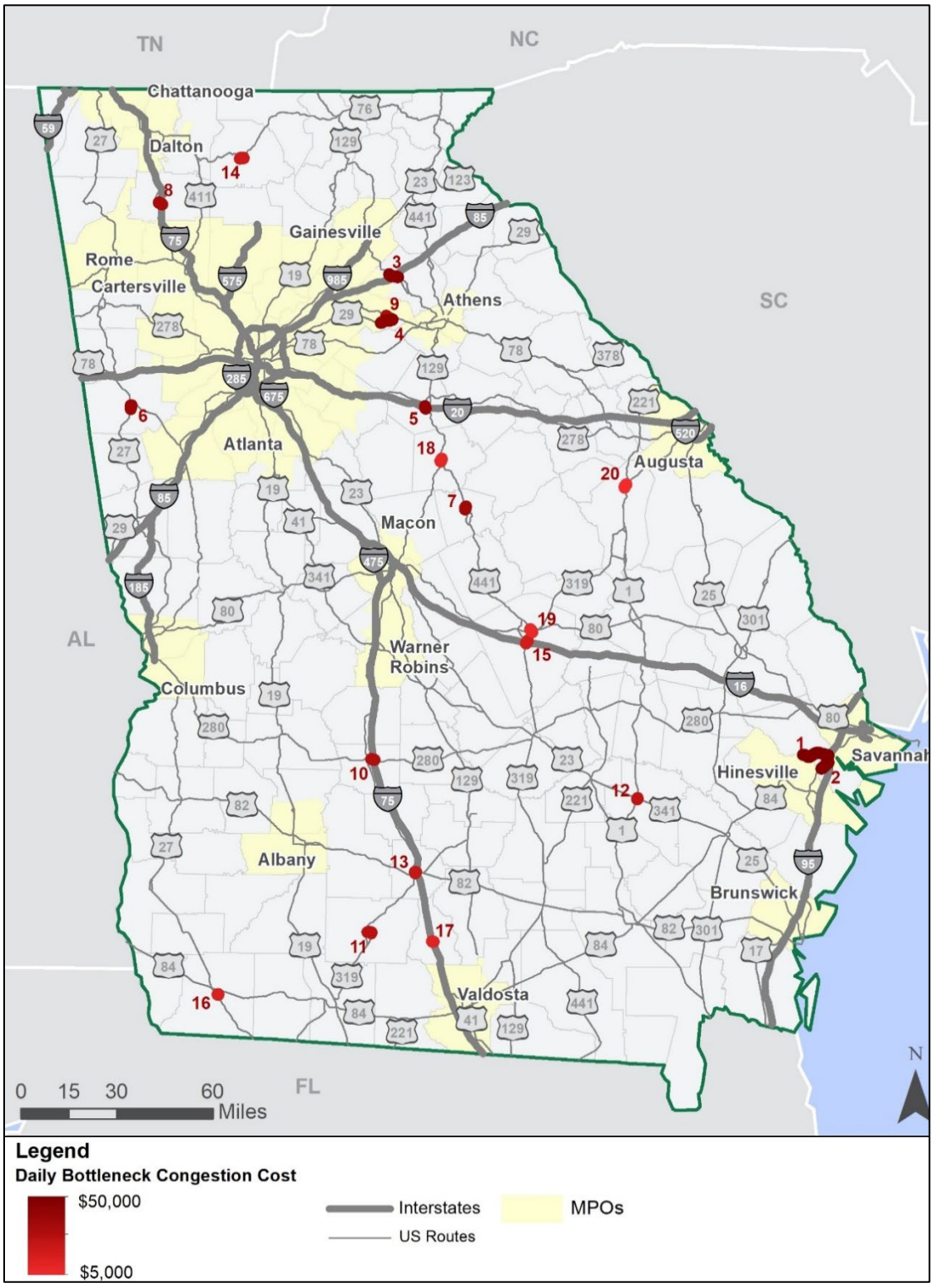
The supply chains most impacted by these top 20 rural bottlenecks include food and agriculture, construction and lumber and paper (Table 89). Through trucks and empty units contribute significantly to congestion at these bottlenecks, with share of total congestion costs ranging from 30 percent to 60 percent.

Table 88. Top 20 Rural Bottleneck Clusters

Rank	ID	Bottleneck Name	Total Miles	Average Daily Truck Volume	Congestion Costs in 2019 ($/day)	Units Growth (2019 to 2050)
1	153	GA-144 from I-95 to Liberty County Line	8.5	485	49,273	70.7%
2	154	US-17 from Belfast Keller Rd to I-95	5.2	2,147	35,212	62.8%
3	33	US-129 at I-85	4.3	2,754	30,652	116.7%
4	48	GA-316 from GA-53 to GA-11	3.9	2,684	22,461	84.5%
5	93	US-129 at I-20	1.6	2,854	15,940	66.8%
6	89	US-27 at GA-166	2.7	1,632	14,766	84.9%
7	104	US-441 in Milledgeville	2.1	1,729	13,499	42.4%
8	13	GA-53 from I-75 to US-41	1.5	1,647	12,699	81.2%
9	47	GA-53 from GA-316 to Atlanta Hwy	2.3	633	11,746	72.5%
10	157	US-280 in Cordele	1.6	2,123	10,200	72.8%
11	177	GA-37 in Moultrie	1.8	1,533	9,756	39.2%
12	159	US-1 in Baxley	0.9	1,758	8,463	62.5%
13	168	US-82/US-319 at I-75	1.5	1,267	7,810	72.3%
14	8	US-76 in Ellijay	1.4	634	6,954	59.7%
15	131	US-441 at I-16	1.2	1,542	6,403	93.8%
16	182	US-27 in Bainbridge	0.5	1,995	6,151	85.3%
17	178	GA-37 at I-75	0.9	2,090	6,030	40.4%
18	100	US-129 BR in Eatonton	1.1	1,527	5,843	53.4%
19	129	US-441 in Dublin	1.2	1,173	5,667	43.0%
20	103	US-1 in Wrens	1.2	2,233	5,626	12.9%
TOTALS			47.5	--	295,552	

Source: Transearch and NPMRDS

Figure 94. Top 20 Rural Bottleneck Clusters



Source: NPMRDS and NCHRP Report 925

Table 89. Supply Chains affected by Top 20 Rural Bottleneck Clusters (% of Truck Units)

Rank	Bottleneck Name	Automotive	Chemicals & Plastics	Construction	Distribution	Electronics & Electrical	Energy	Food & Agriculture	Furnishings & Clothing	Health	Lumber & Paper	Metals & Machinery	Miscellaneous	Through Trucks	Empty Trucks
1	GA-144 from I-95 to Liberty County Line	1.4%	0.9%	6.4%	0.8%	0.1%	2.1%	8.2%	0.5%	0.0%	17.0%	0.9%	1.5%	27.8%	32.4%
2	US-17 from Belfast Keller Rd to I-95	1.0%	2.3%	5.1%	2.2%	0.5%	2.0%	16.2%	0.5%	0.1%	22.3%	1.3%	5.1%	1.8%	39.6%
3	US-129 at I-85	3.1%	2.2%	18.3%	2.4%	0.1%	1.8%	19.8%	0.2%	0.0%	1.8%	1.5%	1.8%	3.0%	43.7%
4	GA-316 from GA-53 to GA-11	0.6%	0.8%	26.7%	4.8%	0.2%	3.2%	9.8%	0.2%	0.0%	2.9%	0.4%	2.4%	2.2%	45.9%
5	US-129 at I-20	1.1%	2.1%	15.2%	3.9%	0.1%	1.4%	11.8%	1.1%	0.0%	6.9%	1.4%	6.0%	11.5%	37.5%
6	US-27 at GA-166	1.6%	1.0%	25.0%	1.4%	0.1%	3.3%	10.3%	0.3%	0.0%	3.5%	0.8%	1.3%	1.0%	50.2%
7	US-441 in Milledgeville	0.4%	0.5%	9.1%	1.9%	0.0%	0.1%	10.4%	0.4%	0.0%	15.8%	0.8%	8.7%		51.9%
8	GA-53 from I-75 to US-41	2.1%	4.8%	13.0%	3.7%	0.3%	2.3%	15.2%	2.2%	0.1%	6.3%	2.6%	3.6%	14.2%	29.6%
9	GA-53 from GA-316 to Atlanta Hwy	1.2%	0.9%	19.7%	4.6%	0.0%	1.3%	8.1%	0.1%	0.0%	3.2%	0.3%	5.9%	0.2%	54.4%
10	US-280 in Cordele	1.1%	1.6%	6.7%	4.2%	0.1%	1.1%	21.1%	0.4%	0.0%	9.0%	0.8%	1.8%	27.1%	24.8%
11	GA-37 in Moultrie	0.5%	0.8%	4.9%	2.1%	0.3%	1.2%	14.5%	0.1%	0.0%	21.9%	1.2%	0.7%	0.8%	50.8%
12	US-1 in Baxley	1.2%	0.3%	9.3%	2.4%	0.1%	0.4%	19.6%	0.5%	0.0%	23.7%	1.4%	2.8%	0.0%	38.3%
13	US-82/US-319 at I-75	3.4%	1.0%	11.0%	4.1%	0.2%	1.7%	16.7%	0.5%	0.0%	10.3%	1.3%	2.8%	13.2%	33.9%

Rank	Bottleneck Name	Automotive	Chemicals & Plastics	Construction	Distribution	Electronics & Electrical	Energy	Food & Agriculture	Furnishings & Clothing	Health	Lumber & Paper	Metals & Machinery	Miscellaneous	Through Trucks	Empty Trucks
14	US-76 in Ellijay	2.7%	2.6%	13.9%	2.3%	0.2%	1.2%	28.9%	4.0%	0.1%	2.9%	3.1%	2.2%	0.3%	35.6%
15	US-441 at I-16	1.3%	0.8%	7.0%	4.6%	0.2%	1.5%	14.8%	2.1%	0.0%	19.7%	1.5%	2.6%	1.3%	42.6%
16	US-27 in Bainbridge	0.4%	0.8%	4.5%	2.3%	0.2%	12.9%	15.6%	0.2%	0.0%	11.6%	0.7%	2.6%	10.9%	37.2%
17	GA-37 at I-75	0.5%	0.8%	6.9%	2.7%	0.1%	0.8%	20.1%	0.2%	0.0%	13.4%	1.0%	1.4%	18.5%	33.7%
18	US-129 BR in Eatonton	1.7%	2.6%	14.9%	4.1%	0.2%	1.2%	22.5%	0.5%	0.1%	13.5%	1.0%	6.8%	3.2%	27.8%
19	US-441 in Dublin	0.4%	0.4%	8.4%	1.4%	0.0%	0.6%	8.4%	0.4%	0.0%	11.8%	0.7%	28.0%		39.5%
20	US-1 in Wrens	0.3%	0.2%	5.3%	0.7%	0.1%	0.6%	9.1%	0.3%	0.0%	14.8%	0.7%	24.0%	0.1%	43.7%

Source: Transearch and NPMRDS

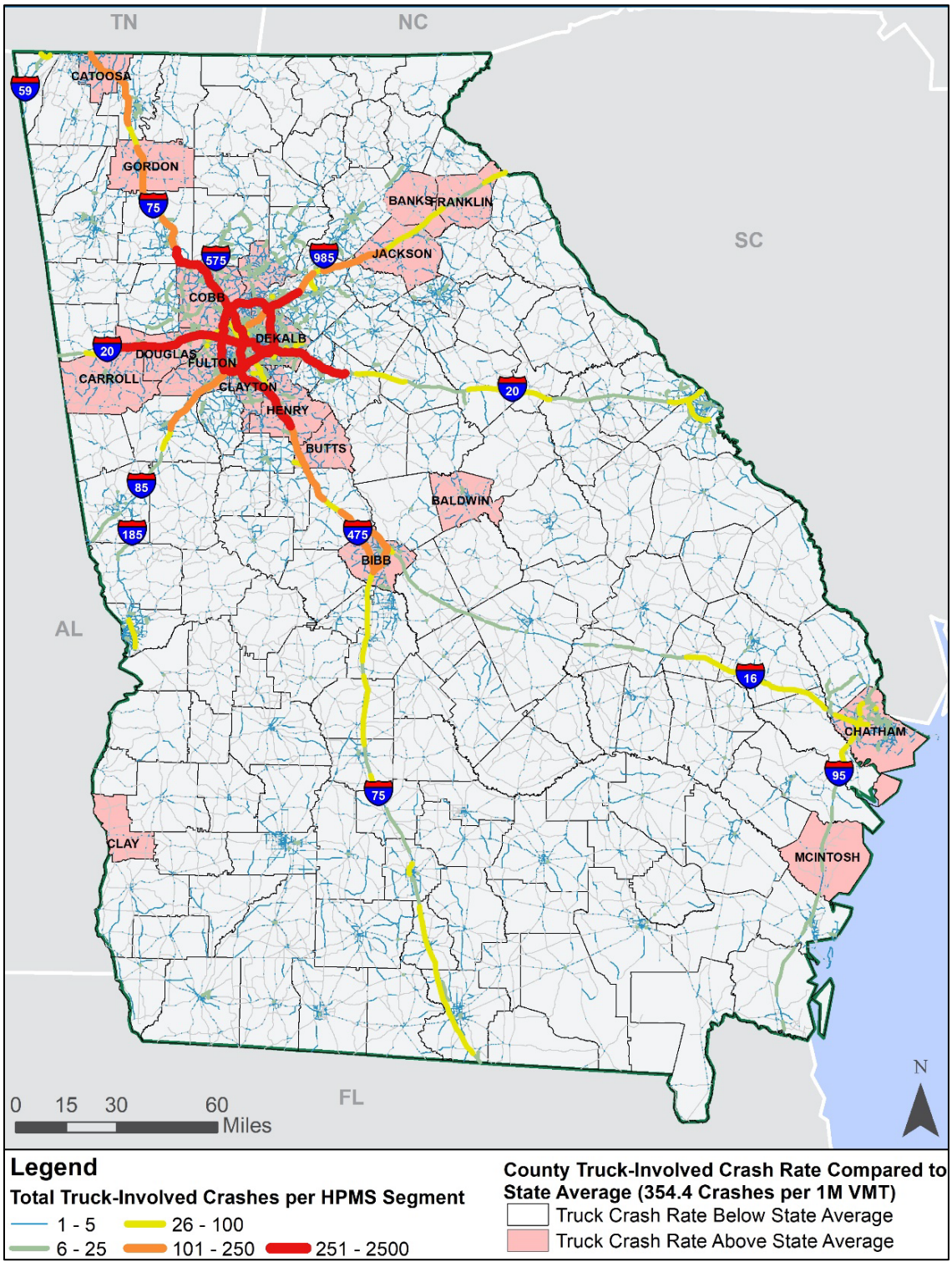
Truck Crash Analysis

An analysis of crashes from 2017-2021 provides insights into specific roadway locations that may be more hazardous to freight and goods movement. Crash data collected from the Georgia Electronic Accident Reporting System (GEARS) shows that the highest volume of truck-involved crashes occurs along Interstates and in metro areas, notably the Atlanta region, and is correlated with higher traffic volumes in **Figure 95**.

Several counties in the Atlanta region exceed the statewide average of approximately 354 truck-involved crashes per one million vehicle miles traveled (VMT) with higher rates of truck-involved crashes along Interstate corridors including I-75, I-475, I-20, and I-985.

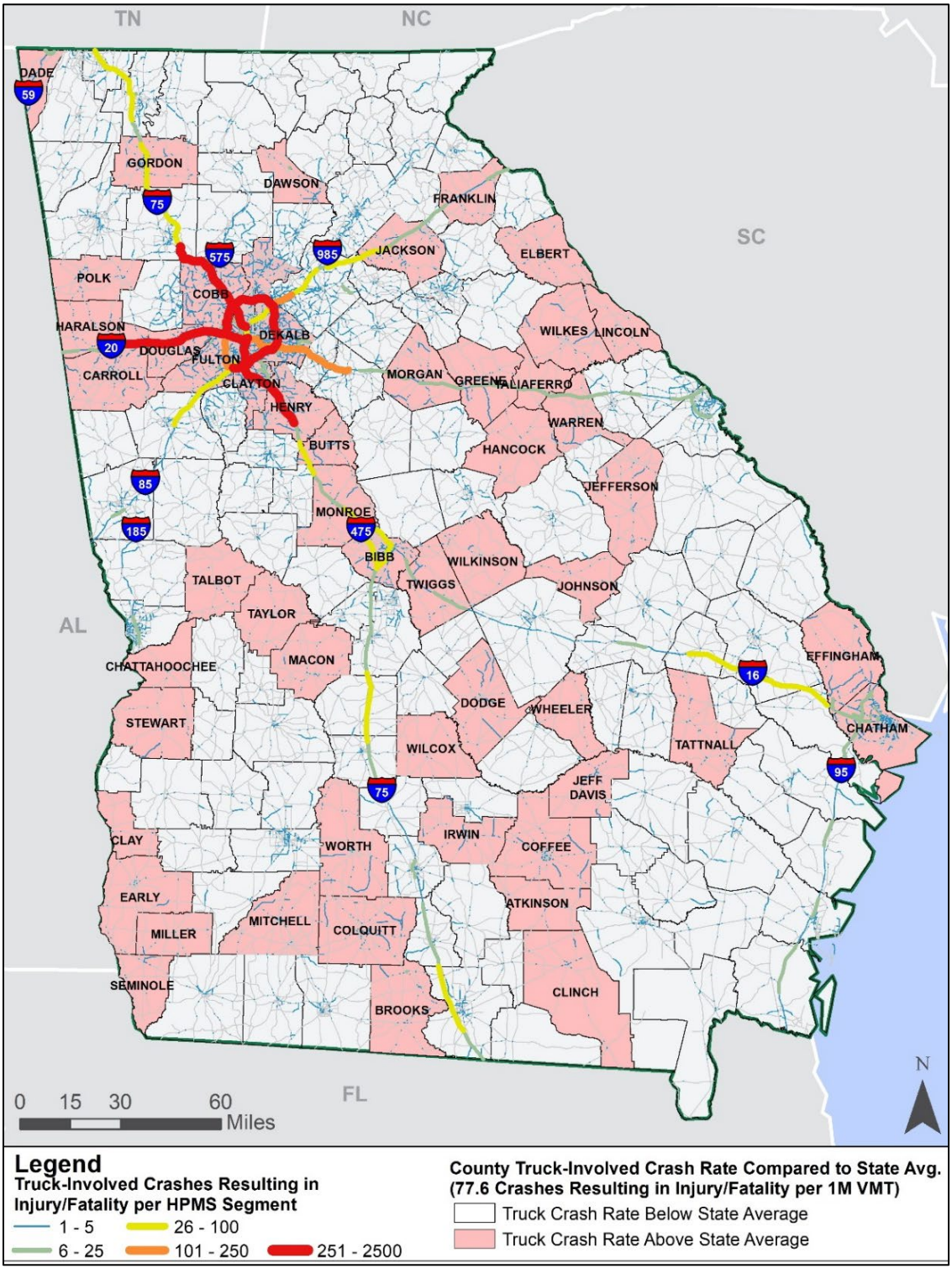
The tables included in this section provide an overview of crash characteristics for all truck-involved crashes, with a detailed breakdown of truck-involved crashes resulting in an injury or fatality in **Figure 96**. Please note that due to gaps in reporting, the tables do not sum to the same number of total crashes.

Figure 95. All Truck-Involved Crashes 2017-2021



Data Source: GEARS data 2017-2021, VMT data GDOT 2019 Form 445, HPMS 2017 road network

Figure 96. Serious* Truck-Involved Crashes 2017-2021



Data Source: Gears data 2017-2021, VMT data GDOT 2019 Form 445, HPMS 2017 road network
**Serious Crashes defined as those resulting in at least one injury or fatality*

Rural areas tend to have higher speed and higher severity crashes, while urban areas typically have a higher volume of less severe crashes. Truck-involved crashes in rural counties across the state are typically more severe.

When analyzing crashes resulting in an injury or fatality (referred to throughout this section as "serious truck-involved crashes," a subset of all truck-involved crashes), several counties in rural areas exceed the statewide average of 77.6 truck-involved crashes per one million VMT, notably Clay County in southwest Georgia and McIntosh County south of Savannah.

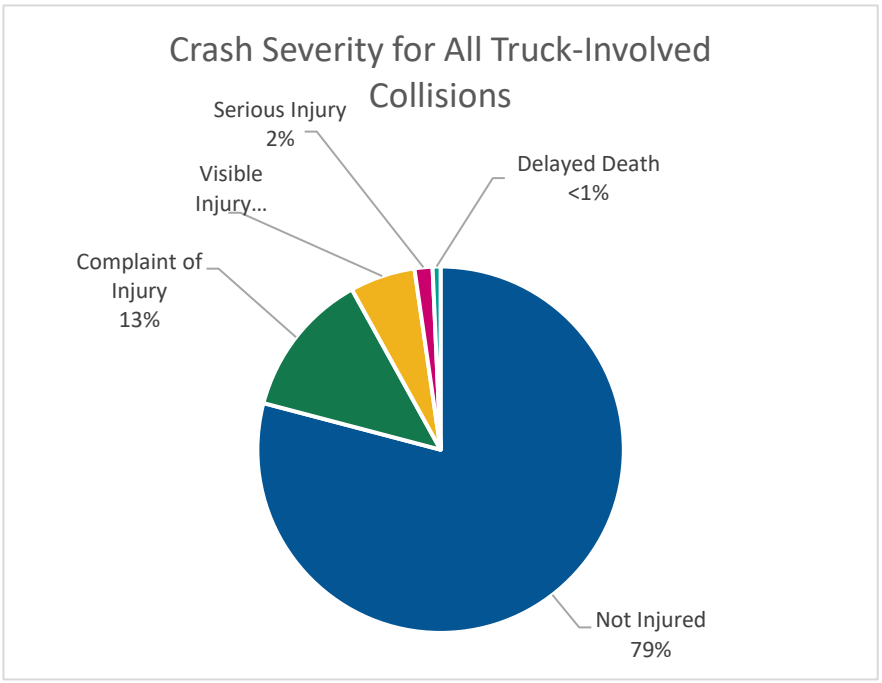
Approximately 130,000 crashes between 2017-2021 involved trucks. Of those, the majority (79 percent, or 101,703 crashes) did not result in an injury or fatality (**Table 90** and **Figure 97**).

Table 90. Truck-Involved Crashes by Severity

Severity	All Truck-Involved Crashes	
Not Injured	101,703	79%
Complaint of Injury	16,533	13%
Visible Injury	7,406	6%
Serious Injury	2,037	2%
Delayed Death	903	<1%
Not Injured	101,703	79%

Source: GEARS Data, 2017-2021

Figure 97. All Truck-Involved Crashes by Severity



Source: GEARS Data 2017-2021

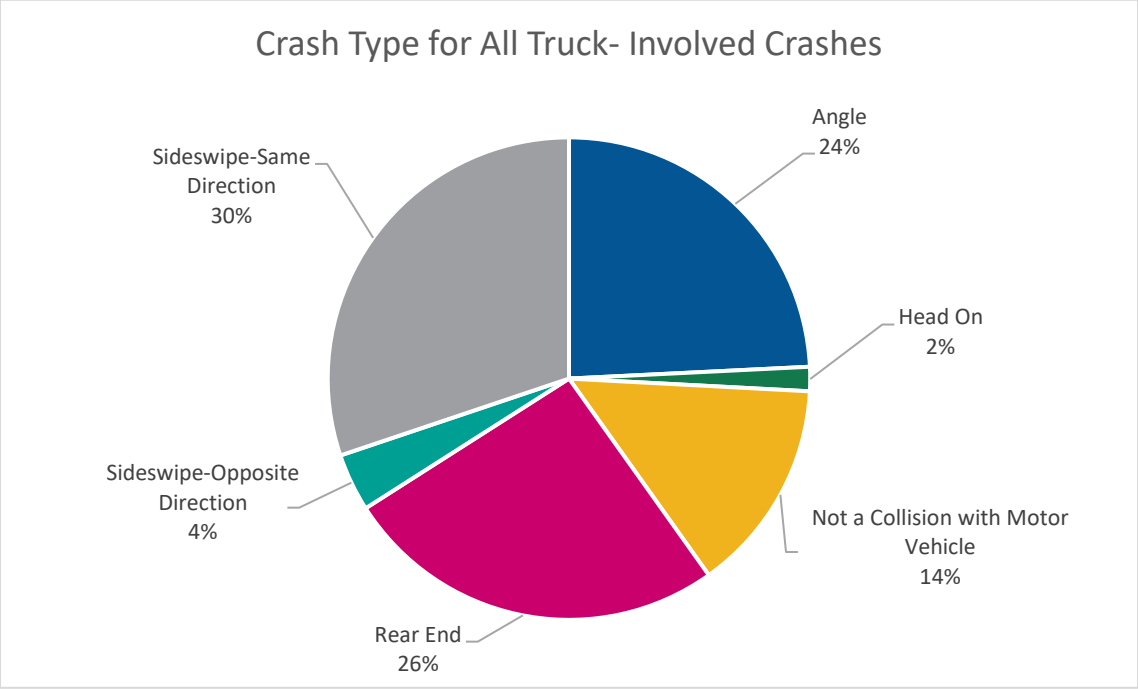
The majority of truck-involved crashes can be classified as either sideswipes (same direction), angle crashes, or rear ends, with rear end and angle crashes making up nearly 65 percent of crashes resulting in an injury or fatality (**Table 91**). While head-on crashes make up a small portion of all truck-involved crashes (2 percent or 2,063), they are typically more severe, with nearly 40 percent (800 crashes) classified as serious (**Figure 98** and **Figure 99**).

Table 91. Truck-Involved Crashes by Type

Crash Type	All Truck-Involved Crashes		Serious Truck-Involved Crashes	
Angle	30,755	24%	7,727	29%
Head On	2,063	2%	800	3%
Not a Crash with Motor Vehicle	18,183	14%	3,251	12%
Rear End	32,773	26%	9,401	35%
Sideswipe-Opposite Direction	4,919	4%	652	2%
Sideswipe-Same Direction	38,305	30%	4,931	18%

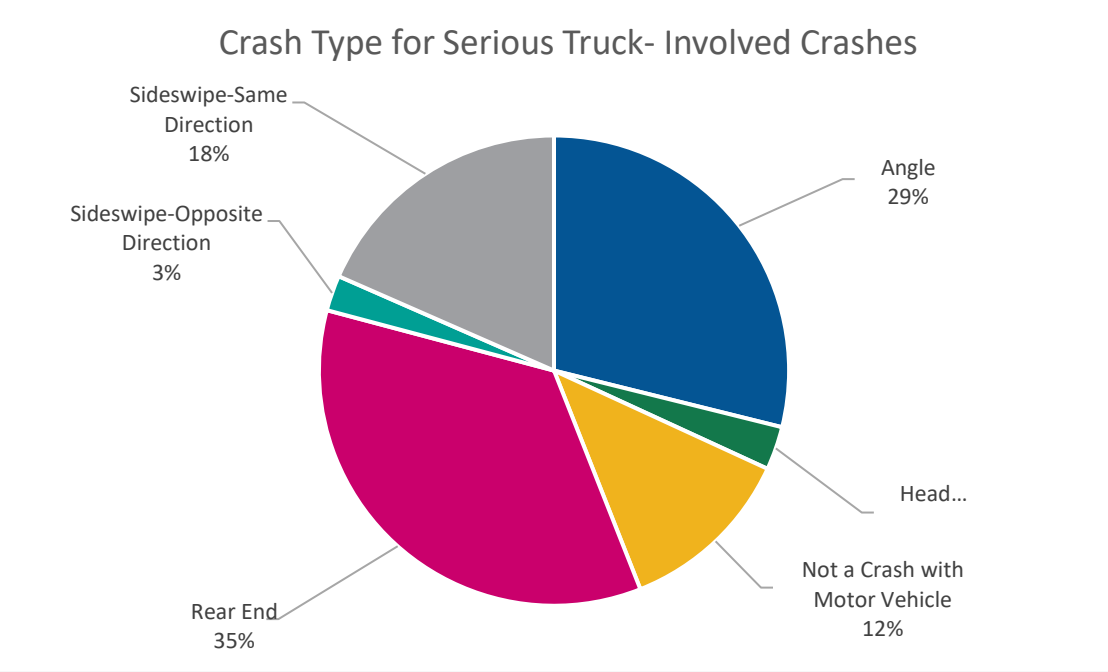
Source: GEARS Data, 2017-2021

Figure 98. All Truck-Involved Crashes by Type and Severity



Source: GEARS Data 2017-2021

Figure 99. Serious Truck-Involved Crashes by Type and Severity



Source: GEARS Data 2017-2021

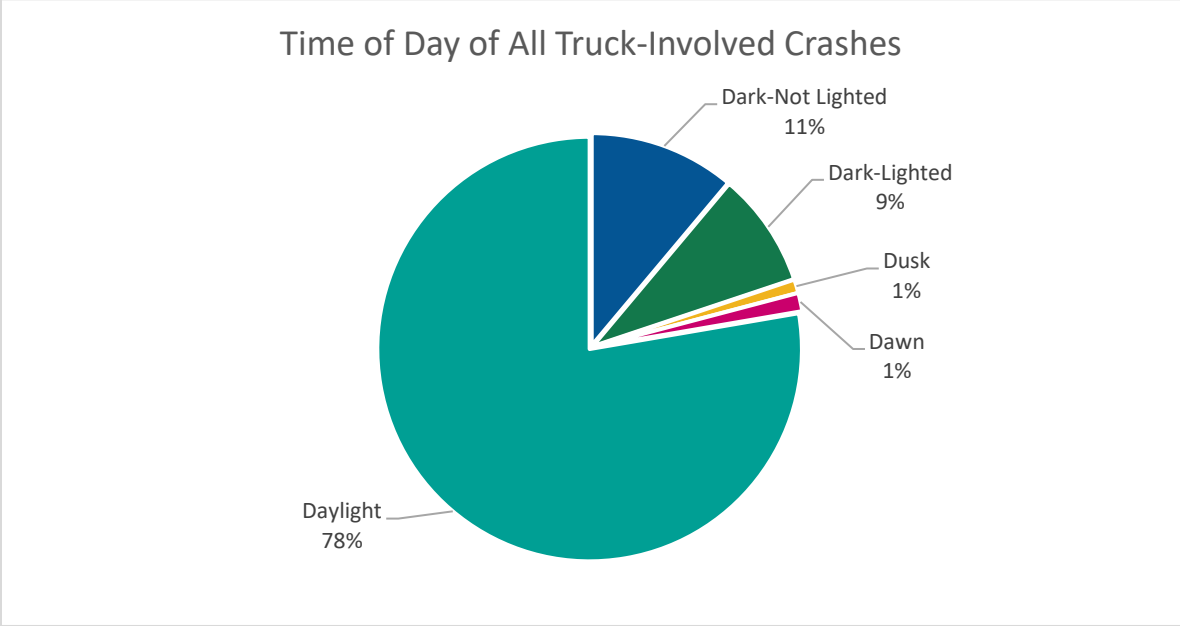
The majority of all truck-involved crashes and serious truck-involved crashes occur in daylight conditions (78 percent). However, unlit dark conditions tend to result in a higher proportion of serious truck-involved crashes, with 15 percent of serious truck-involved crashes taking place in such conditions, compared to 11 percent of all truck-involved crashes (**Table 92**). Approximately 28 percent of all truck-involved crashes (3,953 out of 14,250) taking place in unlit dark conditions resulted in an injury or fatality (**Figure 100** and **Figure 101**).

Table 92. Truck-Involved Crashes by Time of Day and Severity

Time of Day	All Truck-Involved Crashes		Serious Truck-Involved Crashes	
Dark-Not Lighted	14,250	11%	3,953	15%
Dark-Lighted	11,228	9%	2,256	8%
Dusk	1,318	1%	289	1%
Dawn	1,793	1%	403	2%
Daylight	99,617	78%	19,932	74%

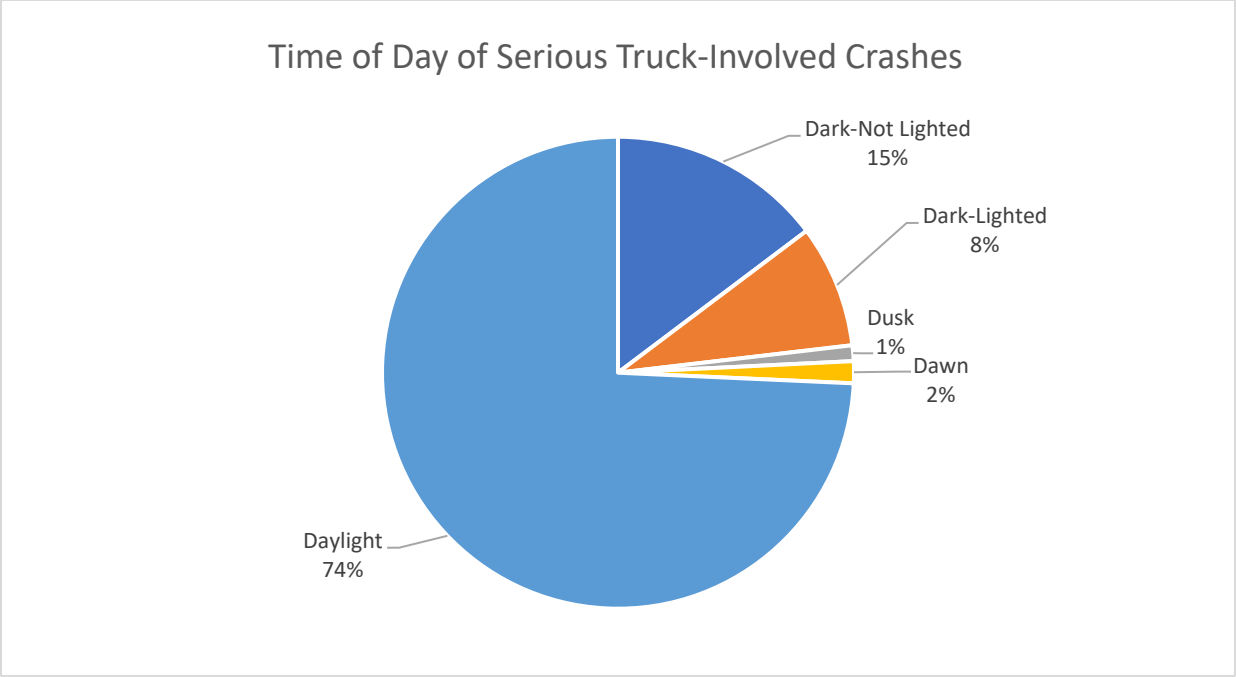
Source: GEARS Data, 2017-2021

Figure 100. All Truck-Involved Crashes by Time of Day and Severity



Source: GEARS Data 2017-2021

Figure 101. Serious Truck-Involved Crashes by Time of Day and Severity



Source: GEARS Data 2017-2021

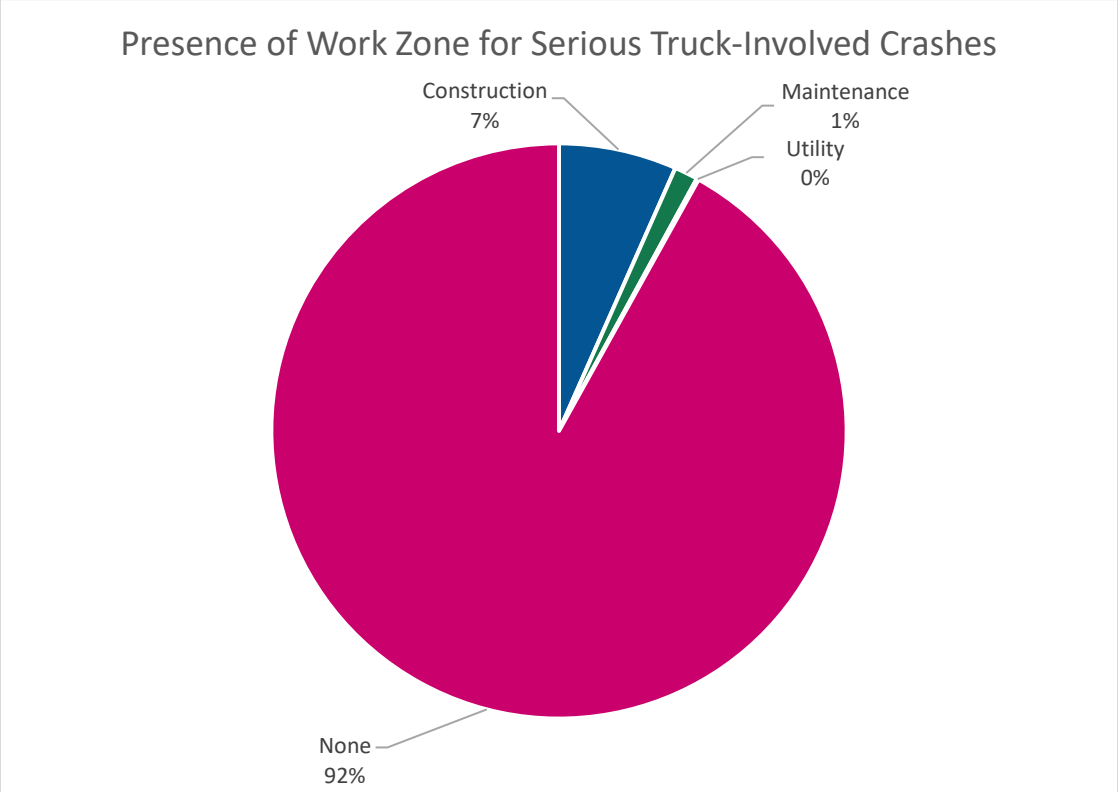
Over 90 percent of all truck-involved crashes occur outside of a work zone (**Table 93**). There is no significant relationship between the presence of a work zone and the severity of crashes (**Figure 102** and **Figure 103**).

Table 93. Truck-Involved Crashes by Presence of Work Zone and Severity

Presence of Work Zone	All Truck-Involved Crashes		Serious Truck-Involved Crashes	
Construction	9,024	7%	1,748	7%
Maintenance	1,588	1%	349	1%
Utility	192	0%	30	0%
None	114,260	92%	24,228	92%

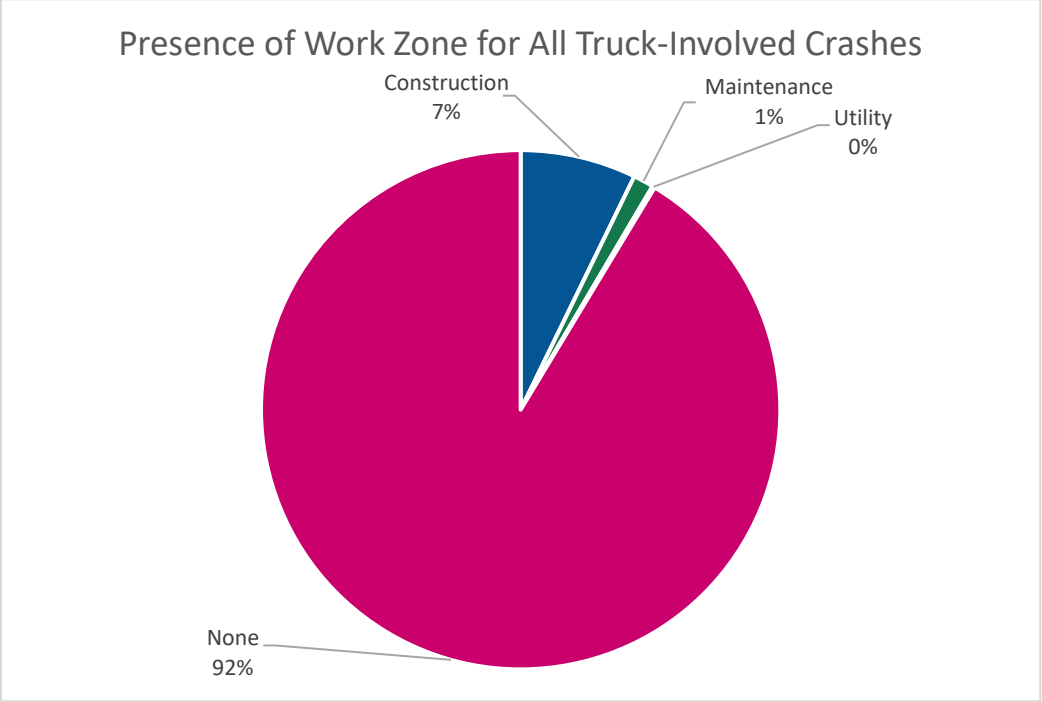
Source: GEARS Data, 2017-2021

Figure 102. Serious Truck-Involved Crashes by Presence of Work Zone



Source: GEARS Data 2017-2021

Figure 103. Serious Truck-Involved Crashes by Presence of Work Zone



Source: GEARS Data 2017-2021

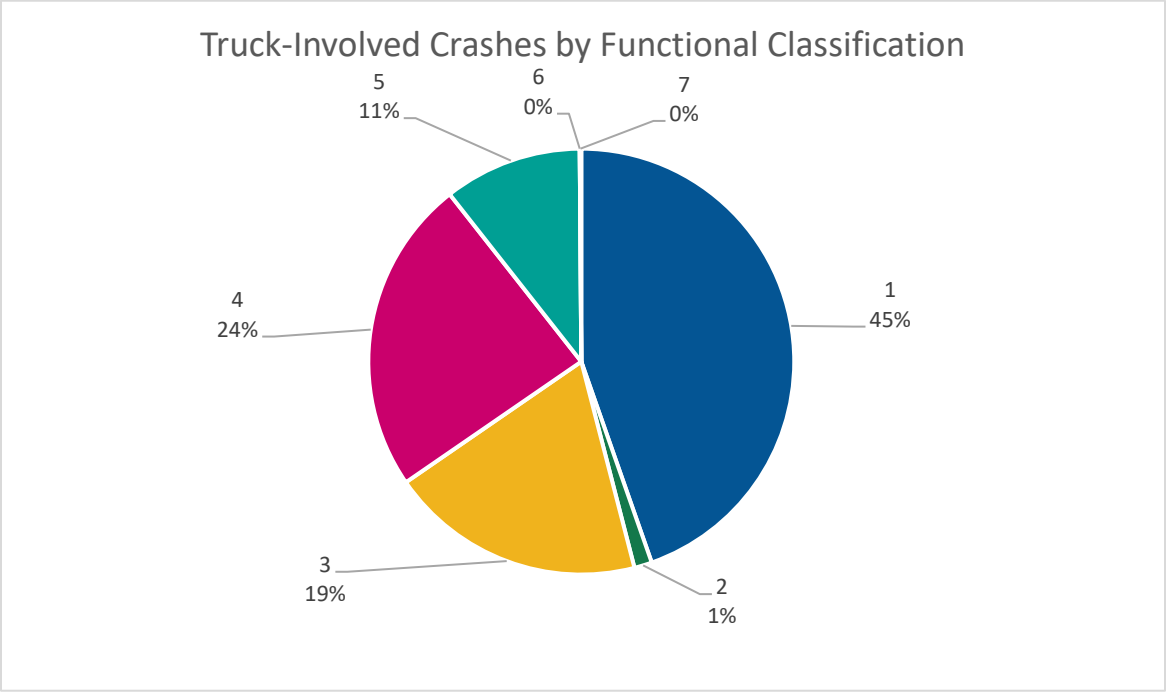
Serious truck-involved crashes make up approximately 25 percent of total truck-involved crashes. A breakdown by functional classification shows that crashes on freeways and expressways are slightly less likely to result in an injury or fatality (261 out of 1,271, or 21 percent), and crashes on major collectors are slightly more likely to result in an injury or fatality (2,661 out of 9,879, or 27 percent). Nearly half (45 percent) of all truck-involved crashes occur on Interstates, reflecting the correlation between traffic volumes and crashes (**Table 94**). The correlation between functional classification and crash severity also reflects the trend of higher severity crashes occurring on rural, less congested roadways (**Figure 104** and **Figure 105**).

Table 94. Truck-Involved Crashes by Functional Classification and Severity

Functional Classification	All Truck-Involved Crashes		Serious Truck-Involved Crashes	
1: Principal Arterial – Interstate	42,041	45%	10,389	44%
2: Principal Arterial – Other Freeway/Expressway	1271	1%	261	1%
3: Principal Arterial – Other	18,297	19%	4,640	20%
4: Minor Arterial	22,593	24%	5,554	24%
5: Major Collector	9,879	10%	2,661	11%
6: Minor Collector	0	0%	0	0%
7: Local	111	0%	24	0%

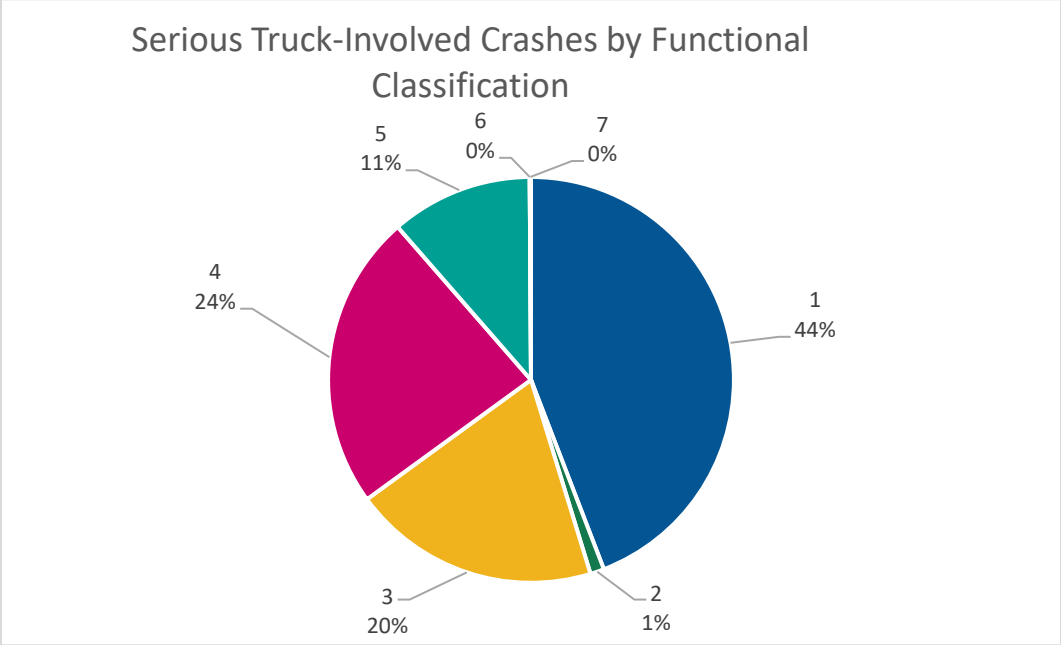
Source: GEARS Data, 2017-2021

Figure 104. All Truck-Involved Crashes by Functional Classification



Source: GEARS Data 2017-2021

Figure 105. Serious Truck-Involved Crashes by Functional Classification and Severity



Source: GEARS Data 2017-2021

4.1.2. Truck Parking

Overview

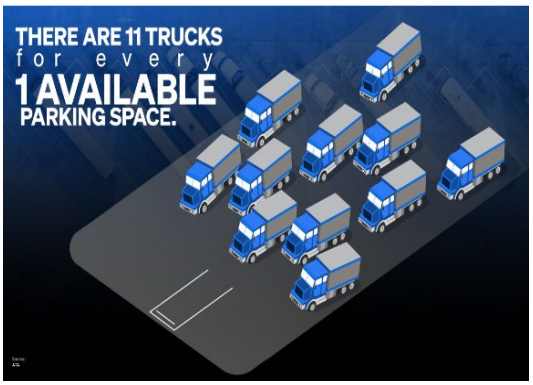
Truck parking remains a national challenge, continuing to impact the United States and Georgia's economy. Even with new truck parking supply, freight demand and corresponding truck volumes continue to expand at faster rates, outstripping new and expanded supply. According to the latest Jason's Law survey (2019), there are about 313,000 truck parking spaces across the nation, including 40,000 at public rest areas and 273,000 at private truck stops, an increase of 6 percent and 11 percent between 2014 and 2019, respectively.

Within Georgia, truck parking supply increased just over 7 percent between 2020-2022, almost exclusively comprised of new private truck parking spaces. Within Georgia, private truck parking, that is parking provided by private facilities, comprises 94 percent of the total supply in the state. The remaining 6% is public truck parking, which includes state-controlled welcome centers, rest areas and weigh stations in Georgia. **Figure 106** shows the private to public truck parking supply within Georgia. Despite these increases, truck parking shortages are still a major problem in every state and region. Major freight corridors and large metro areas, such as within and adjacent to the greater metro Atlanta, have the most acute shortages. Shortages exist at all times of day, week, and year, but mostly overnight and weekdays.

Figure 106. Available Parking Spaces for Trucks

Truck parking remains among the top five (5) challenges reported in the American Transportation Research Institute (ATRI) annual survey of trucking industry concerns. Both ATRI and Jason's Law surveys report nearly all drivers experience regular difficulties finding safe parking. This number increased in dramatically between 2015 and 2019 from 75 percent to 98 percent, respectively. According to the American Trucking Association (ATA), there are 11 drivers competing for each truck parking space with the average driver spending upwards of 56 minutes a day searching for parking. This wasted time amounts to an approximately 12 percent annual pay cut, further impacting the number of truck drivers who choose to remain in the industry. To avoid a route change, late delivery, or trouble with their employer for not resting when they are supposed to, 58 percent of drivers stated they will park illegally at a minimum of three times a week.

As noted previously, Georgia has been successfully increasing its supply of available safe truck parking. According to the 2019 Jason's Law survey, Georgia is ranked in the top tier among states in terms of number of total truck parking spaces per 100 miles of the National Highway System and per 100K Daily Truck Vehicle Miles Traveled, respectively. As of 2019, Georgia remains among the top five states in the nation for total number of public truck parking spaces.



Source: American Trucking Association (ATA)

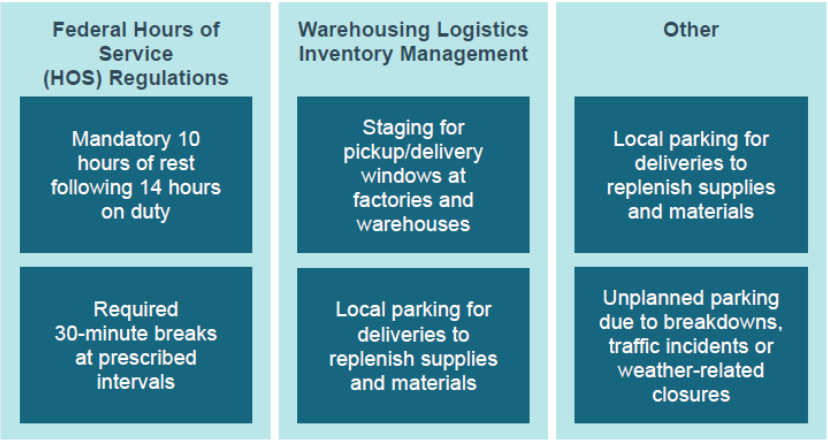
Despite high national rankings, the state has both qualitive and quantitative data indicating that a truck parking shortage exists. Truck drivers traveling within or through the state report difficulties finding safe, adequate parking. Both public and privately-owned truck parking facilities frequently experience demand at or near capacity. Truck parking utilization counts data obtained at Georgia's visitor centers and rest areas in 2020 indicate that several locations are overcapacity at various times of the day. Private truck parking facilities (who provide the greatest number of truck parking spaces) also indicate frequent shortages. A GDOT study conducted in 2019 identified hundreds of unauthorized parking locations throughout the state (detailed further below). Additionally, areas of

unauthorized truck parking locations along ramps have been identified across the state, discussed later in this section.

Contributing Factors

Many varying factors contribute to the truck parking shortage in Georgia, including industrial growth, federal Hours of Service (HOS) regulations, and restrictive delivery and pick-up schedules as shown in **Figure 107**. Additional details on contributing factors were discussed in the Multimodal Assessment Deliverable.

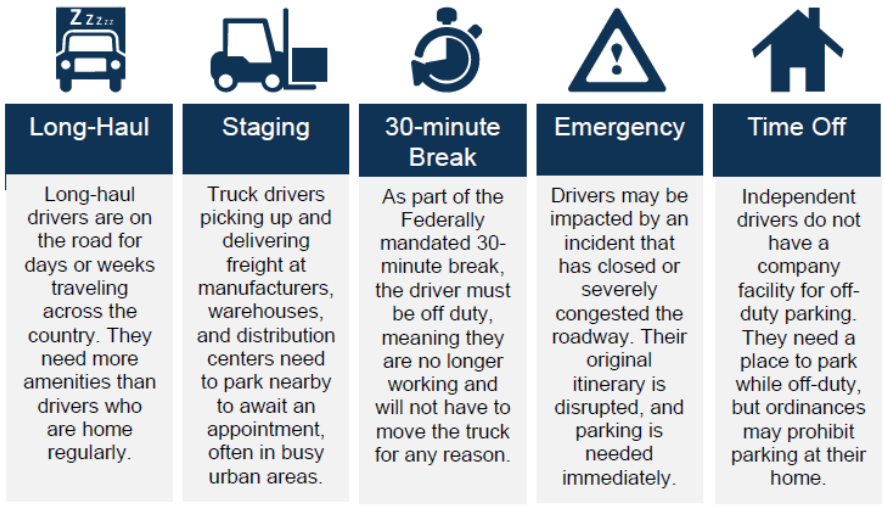
Figure 107. Factors Influencing or Generating Truck Parking Demand



Source: FHWA Truck Parking Handbook (2022)

The factors presented in **Figure 107** can be grouped into five (5) primary reasons for why trucks park, presented as **Figure 108**.

Figure 108. Why Trucks Need to Park



Source: FHWA Truck Parking Handbook (2022)

Truck Parking Opportunities

This section focuses on identifying areas along the National Highway Freight Network (NHFN), Strategic Highway Network (STRAHNET), and Georgia Freight Networks where additional truck parking is or is likely to be needed.

To facilitate the identification of needs across the state, a series of maps have been developed which divide Georgia into a grid index network of 400 square mile (20-mile x 20-mile) squares. Each square is given an alphanumeric label that correlates to its position within the state. Alphabet labels are located along the Y-axis and numeric labels are along the X-axis. The grid system and the labels which will be referenced within this section are identified in **Figure 109**.

The first piece of the needs assessment involved a review of where trucks are parking across the state as well as where unauthorized parking is occurring. Two separate analyses were conducted. The first used a four-month period of ATRI truck parking data from August through November 2021 to identify both overall truck parking locations and unauthorized truck parking locations. Though not a full count of all trucks parking throughout the state, this data has been utilized to identify trends and in conjunction with additional data to assess truck parking needs across the state.

The ATRI data was filtered using the following methodology:

- All truck parking greater than six hours
    - Truck parking at industry locations, parking areas, and unauthorized parking
- Unauthorized truck parking greater than six hours
    - Unauthorized parking areas were defined as areas within 100 ft of roadway ramps where trucks were parked for more than six hours

The second analysis involved two steps. First, Motor Carrier Management Information System (MCMIS) 2017-2019 data and Georgia Electronic Accident Reporting System (GEARS) 2017-2019 data was used to determine the location of accidents involving parked trucks across the state (see **Figure 110**). The crash data was reviewed, to only identify truck related crashes related to a parked vehicle, and to also remove emergency/mechanical failures stopping from the analysis. This analysis identified 77 locations in which parked trucks were involved in an accident without known mechanical failure leading to the parking.

Figure 109. Reference Grid Index

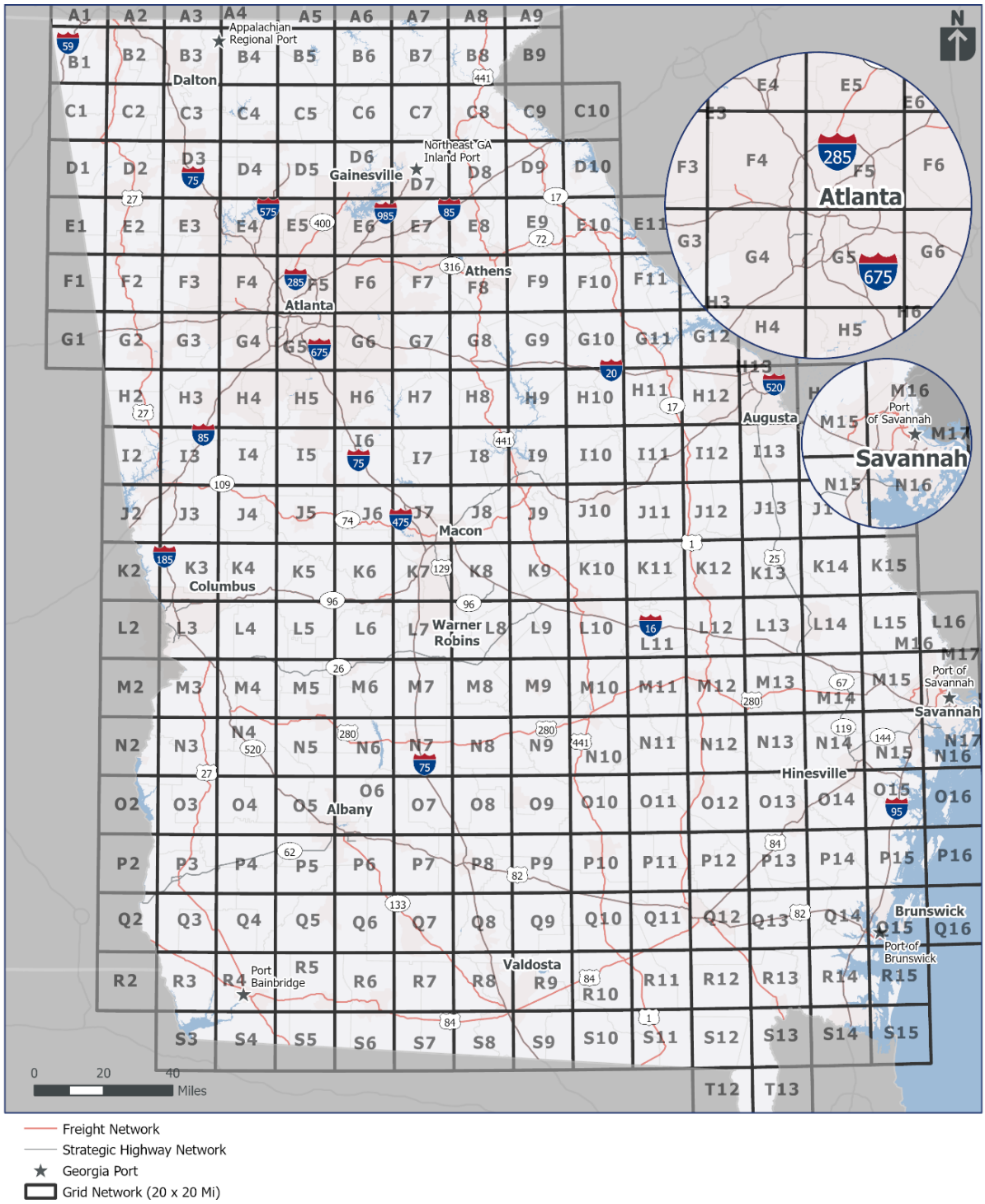
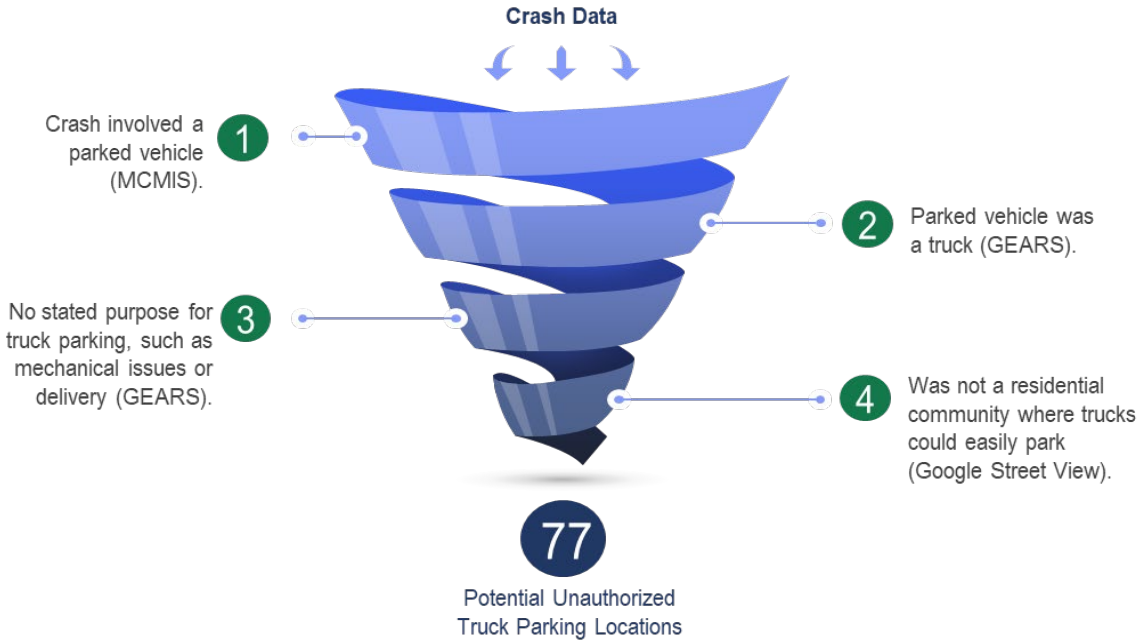


Figure 110. Truck Parking Locations Identified Via Crash Data (2017-2019)



Then National Performance Management Research Data Set (NPMRDS) data was used to identify areas where truck speeds were less than 20 mph between 6 PM and 6 AM. That data was overlaid in GIS with data from the GDOT Road Inventory to identify concrete or asphalt shoulders greater than 8 feet in width (see Figure 111). This analysis helped identify areas where unauthorized parking was and could likely occur along the road network. Combined with the 77 original crash related parking data, a total of 403 individual unauthorized parking locations were identified across the state. Of those 403, 199 were located along the Interstate system as identified within Table 95.

Figure 111. Analysis of Unauthorized Truck Parking Locations

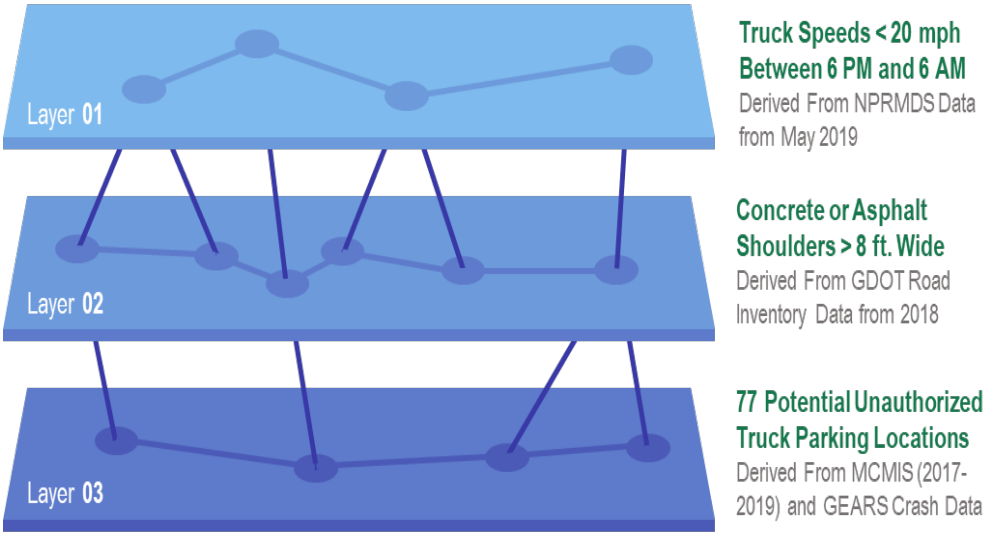


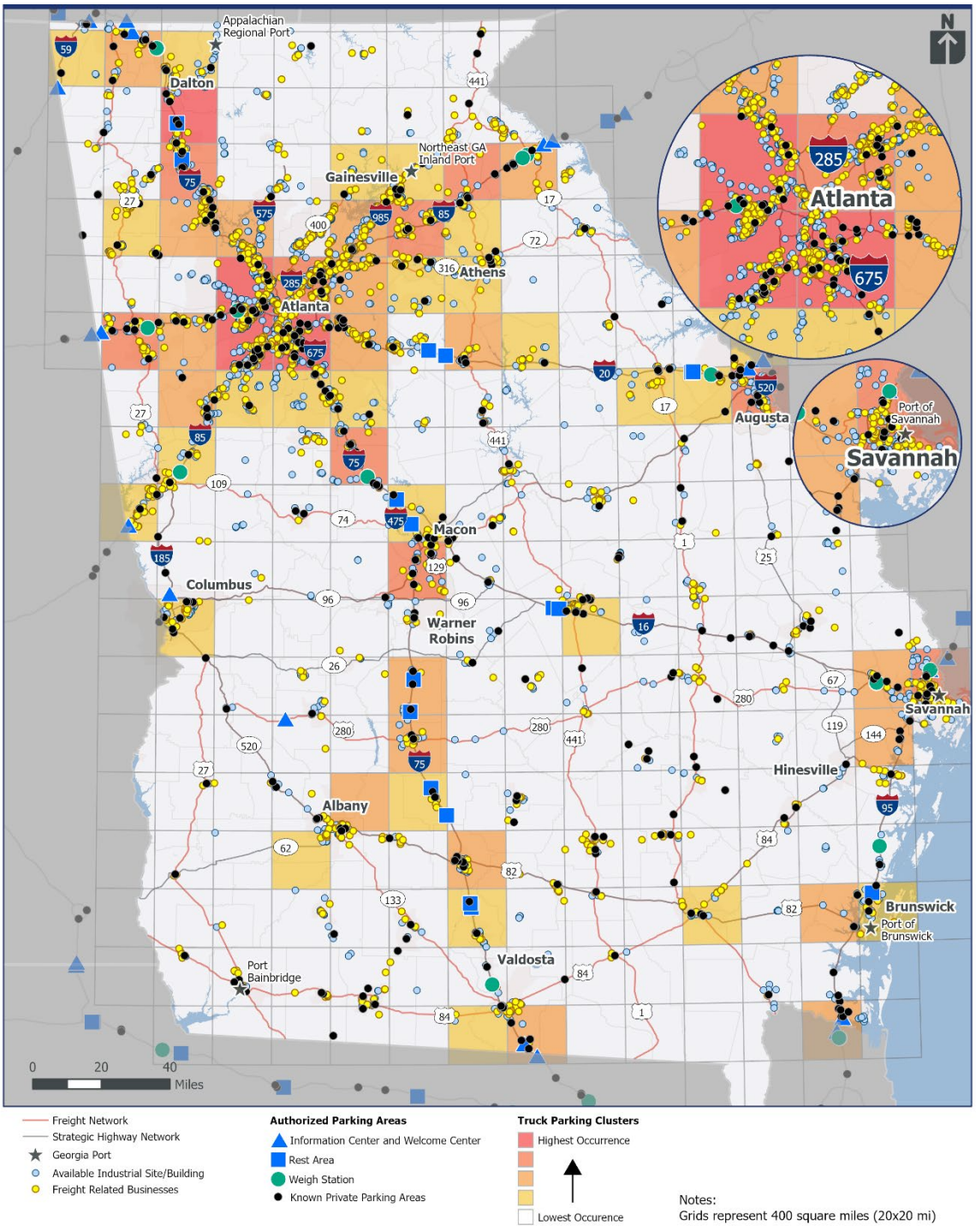
Table 95. Interstate Unauthorized Truck Parking Locations Identified by NPMRDS and Crash Data

Corridor	Unauthorized Parking Locations
I-16	23
I-185	1
I-20	46
I-24	1
I-285	11
I-475	1
I-575	1
I-675	1
I-75	61
I-85	40
I-95	10
I-985	3
Total	**199**

The findings from both analyses were combined to identify all unauthorized parking areas across the state. In total, over 3,000 potential unauthorized truck parking were identified.

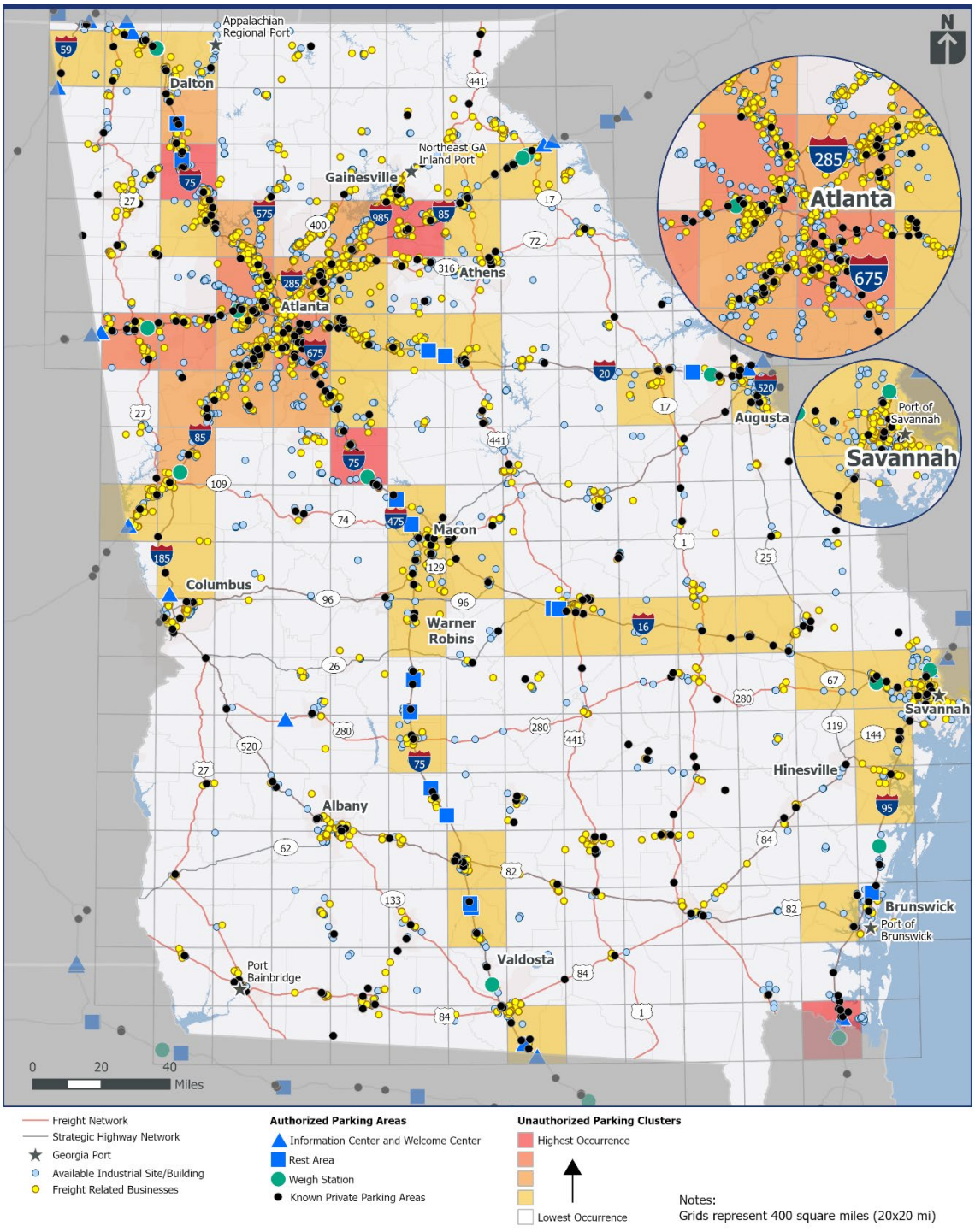
Figure 112 shows overall truck parking trends locations in the state and **Figure 113** shows unauthorized parking locations in the state.

Figure 112. Overall Truck Parking Locations in the State



Source: ATRI (8/21 through 11/21), Georgia Power, local economic development councils, GA DCA DRI website

Figure 113. Unauthorized Truck Parking Locations in the State



Source: ATRI (8/21 through 11/21), GEARS, MCIMS, Georgia Power, local economic development councils, GA DCA DRI website

Overall, truck parking trends align with the Interstate system, with higher densities of truck parking focused in urbanized areas, in proximity to ports, and along state boundaries. The largest (by land area) clustering of the truck parking areas and overall industry locations are located within the Atlanta Metropolitan Area. Outside of the metropolitan area, truck parking is clustered near both Brunswick and Savannah (port cities) and along the freight network, with a primary focus along the Interstate system.

As freight volumes and development continue to increase across the state, it is anticipated that the demand for truck parking in areas with high concentrations of truck parking and high concentrations of unauthorized truck parking will continue to increase. The most prevalent areas of existing truck parking and need are listed below and noted in Table 96 (see **Figure 109** for Grid IDs):

- **Grid ID: F4, G4, G5** - The Atlanta Metropolitan Area (Clayton, Cobb, DeKalb, Douglas, Fayette, Fulton, Henry, Paulding, and Rockdale Counties)
- **Grid ID: C3** - I-75 North of Atlanta (Gordon, Murray, Whitfield Counties)

Table 96. Most Prevalent Areas of Overall Truck Parking

Grid ID	Number of GDOT Public Facilities and (Parking Spaces)	Number of Known Private Facilities and (Parking Spaces)
F4; G4; G5	1 (13)	53 (7,543)
C3	1 (50)	5 (519)

The Atlanta Metropolitan Area has the most significant clustering of unauthorized truck parking in addition to the port cities and state borders. The four most prevalent areas where unauthorized truck parking occurs are listed below and noted in Table 97:

- **Grid ID: S14** -The I-95 area at the border with Florida (Camden County)
- **Grid ID: D3** - I-75 North of Atlanta (Bartow, Floyd, and Gordon Counties)
- **Grid ID: I6** - I-75 South of Atlanta (Butts, Lamar, Monroe, and Spalding Counties)
- **Grid ID: E7** - I-85 North of Atlanta (Barrow, Gwinnett, Hall, and Jackson Counties)

Table 97. Most Prevalent Areas of Unauthorized Truck Parking

Grid ID	Number of GDOT Public Facilities and (Parking Spaces)	Number of Known Private Facilities and (Parking Spaces)
S14	1 (29)	8 (666)
D3	1 (51)	12 (1,050)
I6	2 (28)	9 (746)
E7	0 (0) The closest location is within Franklin County	7 (649)

Areas of projected truck parking growth are anticipated to be in locations with significant growth in industry and overall freight volumes. The Atlanta Metropolitan Area is likely to see the greatest influx of freight-related development, however, both Augusta and Savannah are also anticipated to experience significant growth. Though higher densities of freight related growth are anticipated within the major urban areas, development is expected to continue throughout the state.

Freight Volumes & Freight Generating Industries

Another component of the needs assessment was consideration of existing and anticipated freight volumes and existing and anticipated freight generating industries across the state. Existing (2019) and future (2050) freight volumes were derived from Transearch and applied to the current Georgia Statewide Travel Demand Model (GSTDM). These volumes were used to calculate the percent change in freight volumes along roadways throughout Georgia. **Figure 113** shows the segments with the greatest increases in potential freight development and freight volumes.

The segments with the greatest anticipated percent change in freight volumes are primarily within or near indices where new freight generating industries are anticipated (see **Figure 114**). Many of the roadways with projected increases in freight movement over 500 percent are clustered within the Atlanta Metropolitan Area and the areas closest to Savannah and Augusta.

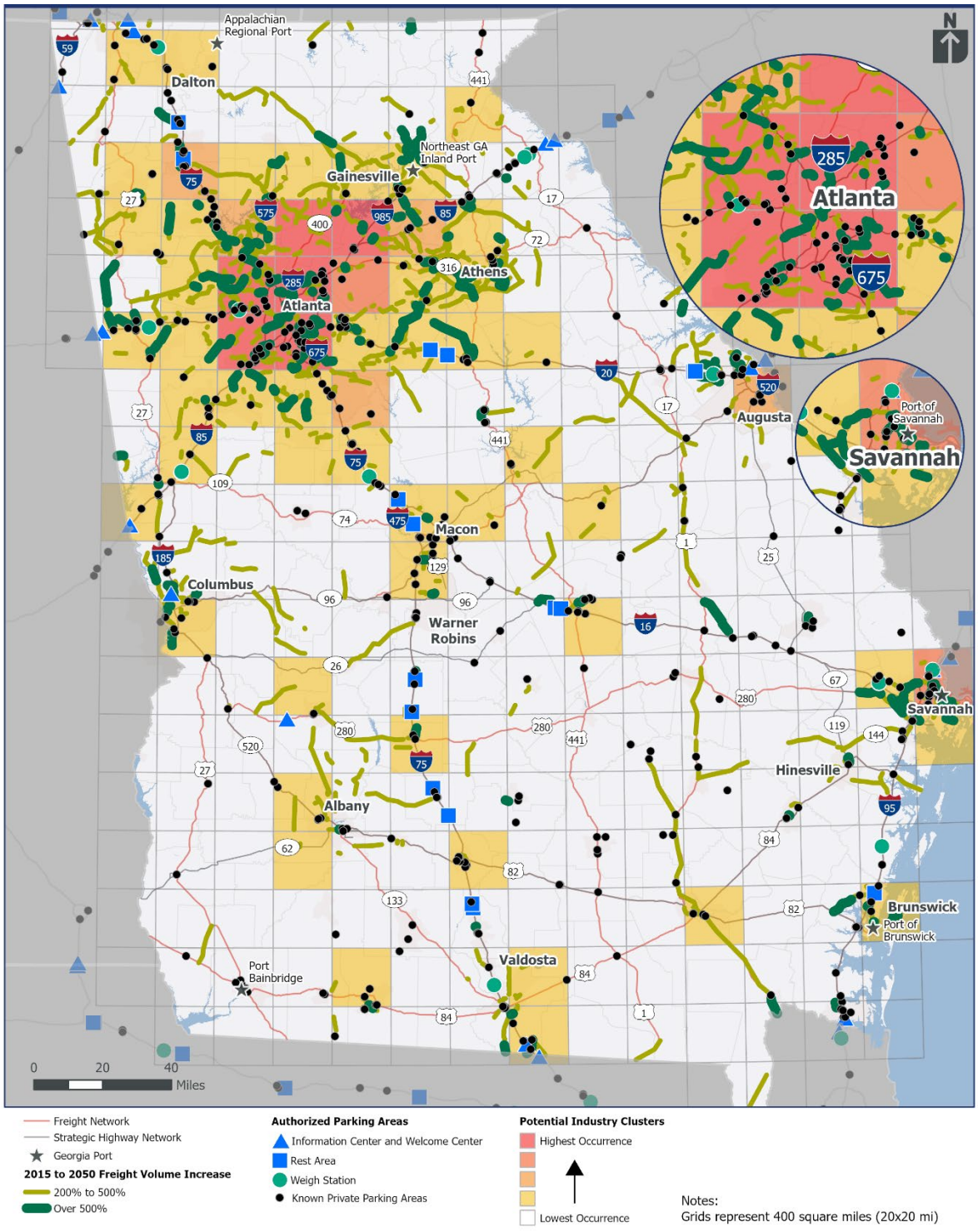
The greatest anticipated need for truck parking due to an increase in development and projected freight traffic volumes is within the Atlanta Metropolitan Area. The six areas with the greatest anticipated freight growth are noted in Table 98 and contain the 13 counties listed below:

- Cherokee
- Clayton
- Cobb
- DeKalb
- Douglas
- Fayette
- Forsyth
- Fulton
- Gwinnett
- Hall
- Henry
- Paulding
- Rockdale

Table 98. Areas with Freight Generating Industries and Significant Increases in Freight Volumes

Grid ID	Number of GDOT Public Facilities and (Parking Spaces)	Number of Known Private Facilities and (Parking Spaces)
F4; F5; G4; G5; E5; E6	1 (13)	66 (7,807)

Figure 114. Freight Intensive Developments and Freight Volumes



Source: GSTDM, Georgia Power, local economic development councils, GA DCA DRI website

Public Facility Parking Utilization

In 2020, a review of 28 GDOT public parking facilities was conducted to estimate truck parking utilization and to understand when the highest demand for truck parking occurred. However, this information was not conducted as a true count of truck parking during this period, as the truck parking stalls were not individually monitored. Assumptions were made based on truck counting stations at the entrance of each facility. This data indicates that there were seven public parking areas where 50 percent or more of the time the number of trucks using the facility exceeded the number of truck parking spaces. The location of these high need facilities is noted in **Table 99**.

Table 99. High Utilization Public Facilities

Grid ID	GDOT Facility Type	Facility Number / Name	Location	Percentage of time interval when truck in-use exceed max truck parking spaces
J7	Open Rest Area	22	I-75, Monroe Co.	99%
Q8	Open Rest Area	5	I-75, Cook Co.	78%
B2	Visitor Information Center	Ringgold	I-75, Catoosa Co.	64%
G1; G2	Visitor Information Center	Tallapoosa	I-20, Haralson Co.	61%
O7; O8	Open Rest Area	9	I-75, Turner Co.	61%
D3	Open Rest Area	34	I-75, Gordon Co.	51%
C3	Open Rest Area	35	I-75, Gordon Co.	50%

Major Port Facilities

The locations of major marine and inland port facilities have also been considered within this analysis. The port facilities are identified within the five Grid IDs depicted in Table 100, (the IDs derive from **Figure 109**). These areas have been specifically identified for their inherent need for truck parking and staging; however, these grids were not identified as having the highest truck parking need as described within the previous sections.

Table 100. Port and Intermodal Facility Locations

Grid ID	Port or Intermodal Facility
B3	Appalachian Regional Port
D7	Northeast Georgia Inland Port
M16	Port of Savannah
Q15	Port of Brunswick
R4	Port Bainbridge

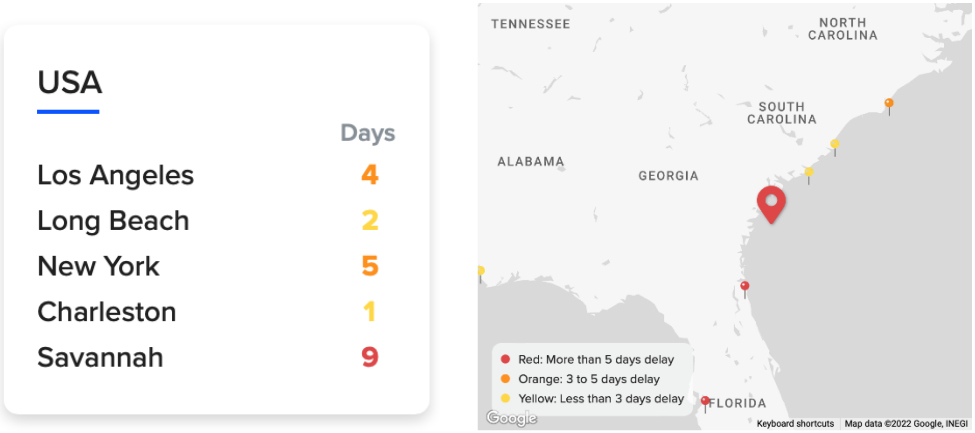
4.1.3. Non-Highway

Ocean shipping, air, rail, and pipeline are the non-highway freight transportation systems in the state of Georgia. This section focuses on system performance for the first three modes.

Port delays are one of the major variables in ocean shipping transit time since vessel sailing times are relatively constant. Port delays are where transit time variability is introduced. Supply chains depend upon reliable delivery. Shippers are highly sensitive to transit time variability and will accept longer transit times for more reliability.

The Port of Savannah is a significant feature of Georgia's freight infrastructure. As the fourth largest container port in the United States, Savannah has experienced both volume growth and increased congestion. A recent snapshot of average delay times, in **Figure 115**, show the Port of Savannah is congested, currently experiencing greater delays than that of other large container ports.

Figure 115. Average Delay Time at Major U.S. Ports, 2022



Source: https://www.gocomet.com/real-time-port-congestion/usa/savannah-ussav

Air system measures are compiled and maintained by the Federal Aviation Administration. The Aviation System Performance Measures[71] (ASPM) system provides detailed aviation performance measures. By its nature, this data is more granular and potentially useful as a planning tool. Performance measures on drayage and long-distance road feeder service routes are not directly tracked and could be as part of regional road performance monitoring.

Rail system performance measures are reported to and made available weekly by the Surface Transportation Board[72]. As with highway and ocean transport, those responsible for planning

[71] Federal Aviation Administration, "Aviation System Performance Metrics" available at https://aspm.faa.gov/aspmhelp/index/Aviation_Performance_Metrics_%28APM%29.html
[72] Surface Transportation Board, "Rail Service Data," available at https://www.stb.gov/reports-data/rail-service-data/#railroads-tab-content-1-7

goods movement are most concerned with transit time reliability. Many of the available measures are higher-level averages and of limited use to supply chain managers.

There are several crossing hotspots throughout the state. According to GDOT's Highway-Rail Grade Crossing Safety Action Plan, between 2017 and 2019, 17 percent of rail crossing crashes in Georgia took place at 21 crossings, representing only 0.4 percent of the state's total number of rail crossings. Crossing hotspots also occur at private rail crossings: nearly a third of private crossing crashes occurred at only three intermodal container yards. These were Garden City in Savannah, Inman Yard in Atlanta, and Whitaker Yard in Austell. GDOT, working in partnership with the Georgia Ports Authority (GPA) and Chatham County, opened a grade separation to address crossing crashes at Garden City in FY2021. The new infrastructure reduces at-grade crossings within the container yard.

4.2. Preparing for Growth

4.2.1. Major Trends Ranked by Importance to FAC Members

The 2050 forecast for Georgia-based freight was presented in the Multimodal Freight Assessment Report. It predicts vigorous growth for every mode. Rail intermodal tonnage is expected to climb 150 percent while truck and total tonnage nearly double. Statewide freight volumes are expected to rise twice as fast as Georgia's already fast-growing population. Container traffic at the Port of Savannah is breaking records and spurring warehouse investment across adjacent territory.

Nine major trends are at work in the supply chain world. The Georgia Freight Advisory Committee (FAC) rank ordered these trends according to importance for the members' operations in the state. The results are shown in **Figure 116**. These trends are assessed in greater detail in the following sub-sections.

What is most remarkable about this list is how different the elements and priorities are from what they would have been just a few years ago – as Georgia FAC members acknowledged. The pandemic accelerated e-commerce demand, disrupted freight operations and exposed risks with a cumulative effect to which supply chains are continuing to adjust.

Figure 116. Trends Identified by the Freight Advisory Committee

4.2.2. Workforce Capacity

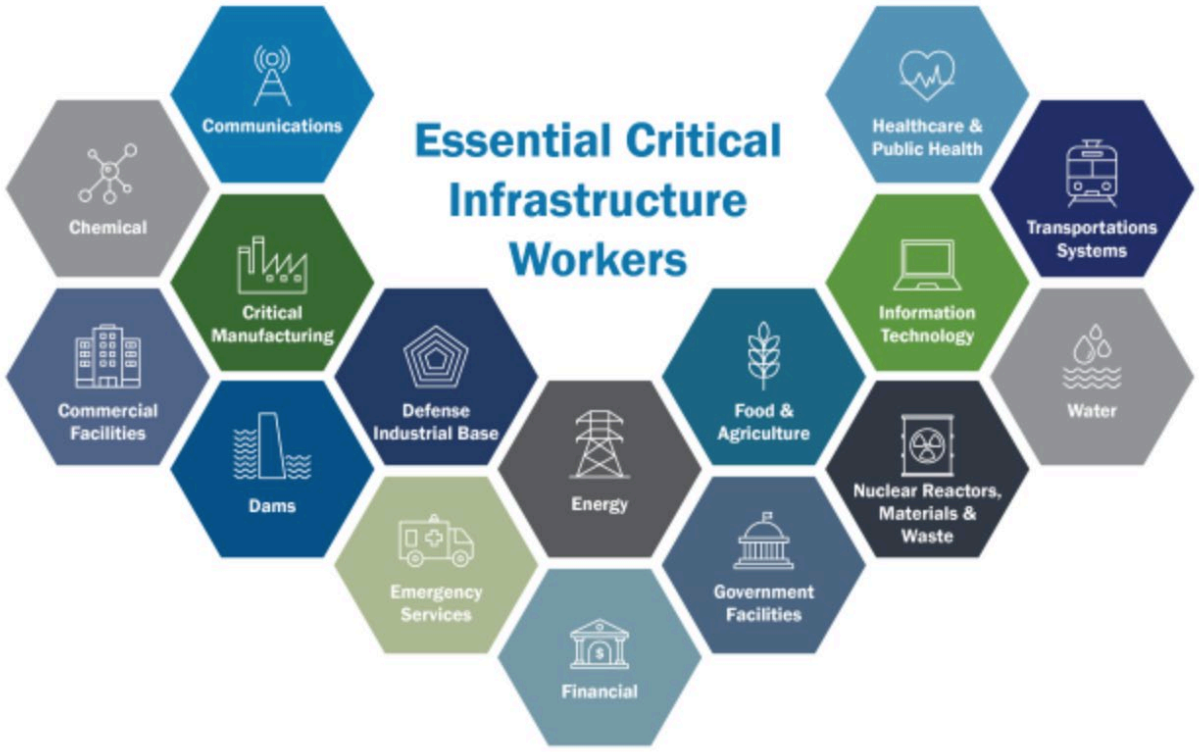
Workforce Capacity issues range from shortages of truck drivers and other carrier personnel to availability of warehouse and factory workers, skill and wage levels, training, location and housing, and transportation access to workplaces. Facility locations that are optimal in terms of an operating efficiency perspective may be impractical in workforce terms. While most of these topics fall outside the direct scope of GDOT responsibilities, they affect KPIs such as cost, safety, and reliability.

The COVID pandemic introduced a new class of labor known as essential workers, those whose work delivers critical "must have" services to society. The definition of essential workers encompasses rail, airline and trucking companies, but also "maintenance, repair and overhaul facilities (MROs), ground handling companies, fixed based operators (FBOs), delivery companies that move freight and cargo out of airports and rail yards."[73] Workers in the transportation system

[73] Fafinski Mark & Johnson, "Is Your Business an Essential Business During Covid-19?" published by fmjlaw.com. Accessed December 22, 2022 at https://www.fmjlaw.com/essential-business-transportation-industry

are considered essential critical infrastructure workers by the Cybersecurity and Infrastructure Security Agency (CISA).

Figure 117. Essential Critical Infrastructure Workers



Source: https://www.cisa.gov/identifying-critical-infrastructure-during-covid-19

According to Bureau of Labor Statistics (BLS) data, 3.9 percent of the national workforce in 2021 were employed in transportation and warehousing jobs. Demand is projected to increase for transportation and warehouse workers over the coming decade at about the same rate as labor demand overall. Many of the current workforce, particularly drivers, are aging out and creating gaps. The nature of these jobs is physically challenging and has been shrinking in number of new entrants into the labor pool due to fertility rates and immigration changes. Thus, attracting and retaining people to perform essential tasks like stocking and picking in warehouses and transporting goods will remain difficult. Industry will continue to face the difficult challenge of maintaining the desired level of employment in supply chain systems work.

Workforce issues impact GDOT and related organizations. The demographic trends of lower birth and immigration rates also mean a shrinking pool of new talent for state transportation

departments. A National Academies of Science study revealed the following key findings regarding transportation department workforce needs:[74]

- Departments of transportation are facing many of the same opportunities and challenges as the larger U.S. workforce.
- The primary focus remains on traditional highway/roadway planning and programming, but there is a shift to reflect a more multimodal nature of transportation.
- The skills required in transportation departments today and in the future go beyond the traditional construction, maintenance, and operations missions of agencies.
- There is no standard definition or understanding about workforce development.
- A range of options for funding workforce development exist.

4.2.3. Supply Chain Disruption and Risk Management

Supply Chain Disruption and Risk Management pertains to interference with supply chain operations caused by external events and the efforts to prevent or reduce those effects. The causes can be separated into two broad categories:

Human

- Terrorism, sabotage, cyber-attacks
- Labor strife/strike
- Pandemics
- Congestion and pollution
- Warfare

Environment

- Shifting weather patterns and extreme weather events
- Natural disasters

The following table (**Table 101**) presents an analysis of the above issues, with a view towards understanding the impact on the supply chain and GDOT's role to address these issues and minimize their impact on the supply chain.

[74] National Academies of Sciences, Engineering, and Medicine 2019. Transportation Workforce Planning and Development Strategies. Washington, DC: The National Academies Press. https://doi.org/10.17226/25624.

Table 101. Human and Environmental-Related Supply Chain Disruption and Risk Management Practices

Category	Issue or Event	Description + Example	Impact on Supply Chain
Human	Terrorist / Sabotage / Cyber	Cyber, sabotage, and ransomware attacks are deliberate actions that disrupt and damage functions and/or equipment. A recent attack at a NC power grid substation brought down power to over 30K customers in the state.	Without services such as power and broadband, warehouse operations are impaired; certain transportation systems would be offline; an increase in fuel prices or lack of availability could cause damage to infrastructure, interrupting operations.
Human	Labor Strife / Strikes	Without safety, efficiency, sustainability, and quality of work systems, labor strikes or disputes can arise. As rail, ports, airports, and other modes of freight have the possibility to go on strike for inadequate working standards. In December 2022, railroad workers threatened to strike for sick pay.	Systems gets backed up; goods cannot move; increased congestion at major nodes (ports, terminals, etc.); essential products cannot be moved (i.e. chlorine which is required for water system).
Human	Pandemics	Global COVID-19 pandemic leads to increased consumer demand and global supply chain crisis (i.e. bottlenecks across supply chain, backups at ports, etc.).	Companies involved in production, distribution, and transportation of goods were impacted in the pandemic by labor shortages, disruption in global sourcing and increased demand for domestic production of essential products.
Human	Congestion & Pollution	Rapid population and industrial expansion overload transportation infrastructure causing congestion and in turn, emissions & pollution.	Companies involved with supply chain processes are motivated to make improvements in their environmental practices for both their own corporate governance and due to increasing public pressure.
Human	Conflicts & War	Aspects of conflict create shortages of supply in different parts of the world. For example, the War in Ukraine has caused an increase in fuel prices in the U.S. as well as a global disruption in food supply.	Supply chain impacts vary depending on the location and scale of the conflict. Currently the rising price of fuel in the U.S. due to supply/demand dynamics. There is often a need to change sourcing locations and supply chain routing to provide goods and materials.
Environmental	Extreme weather events	Regional extreme weather events including heat/droughts, tropical and winter storms, landslides, flooding, extreme cold, freezing of roads/ice roads, snowstorms etc.	Disruption of service results in higher costs, delay, and congestion. Normal components of the infrastructure and equipment may not hold up over time. Disruptions occur and there is a need for recovery actions within the supply chain.

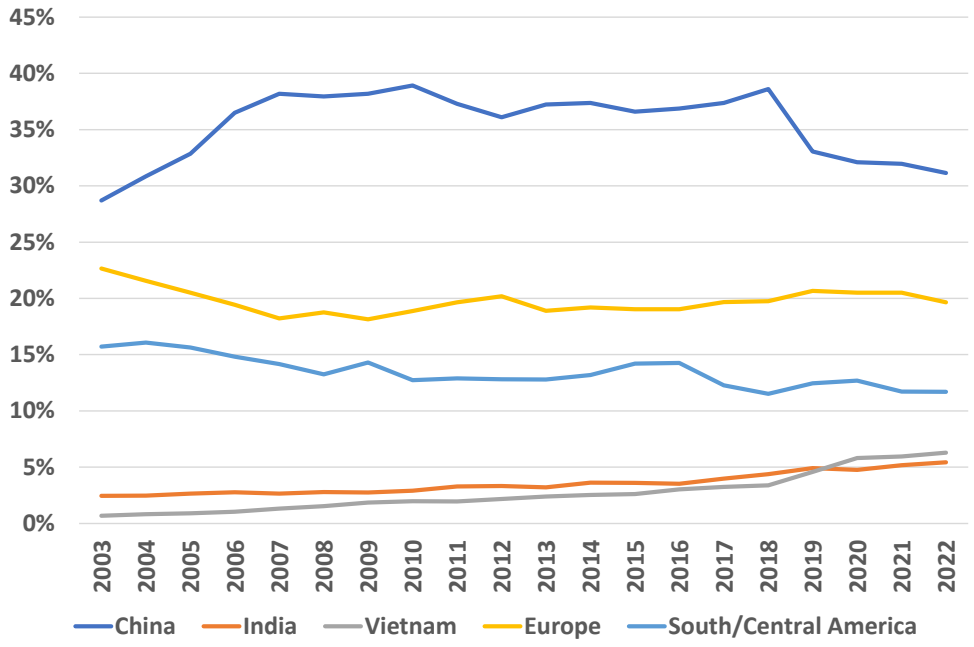
Category	Issue or Event	Description + Example	Impact on Supply Chain
Environmental	Natural disasters	Hurricanes/storms, tropical storms, tornadoes, wildfires, floods, landslides, and power outages.	Disruption of service which results in higher costs and congestion. Increased demand for humanitarian aid and support.

4.2.4. Global Supply Chain Dynamics & Diversification

International trade volumes represent a minority of the freight volumes moving to and through Georgia but are the fastest growing segment, particularly containerized trade. International volumes of containerized freight exported from origins and imported to destinations in Georgia are mostly handled by the Georgia Ports Authority, at its container terminal in Garden City near Savannah. However, other ports also handle containerized volumes moving to/from and through Georgia's road and rail network. These include ports in the Southeast as well as Southern California. These larger US container ports' volumes consist of 50 percent imported goods, 25 percent exported goods, and 25 percent net empty container exports (the US imports a small amount of containers to use for exporting).

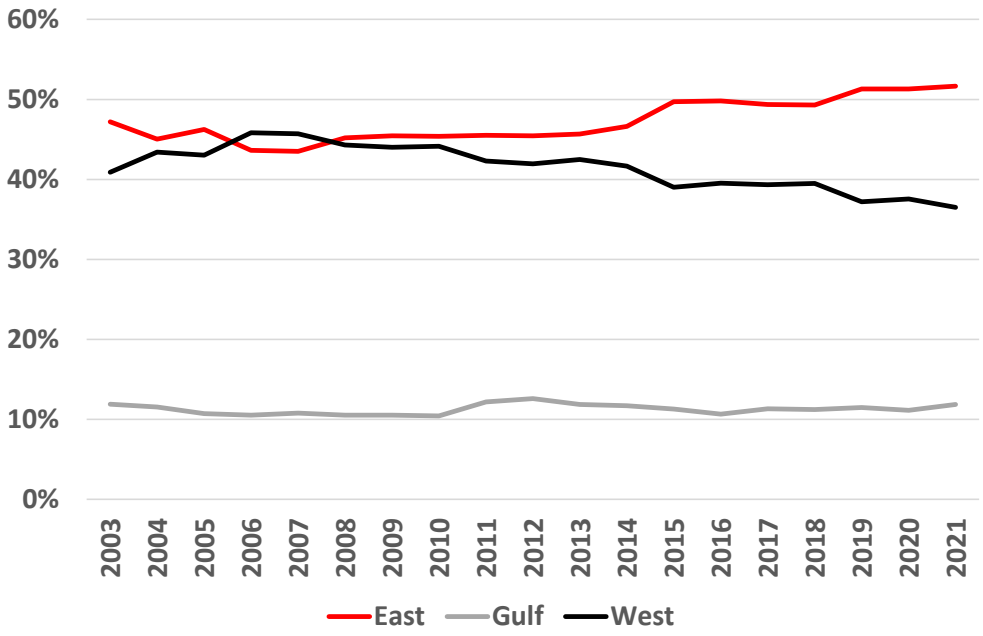
The pattern of international freight flows in the US and in particular Georgia have been continually shifting for decades. Asia has had a dominant share of US containerized trade for decades but the shares of individual Asian country shares have shifted over time. This is shown in the chart below where the shares are estimated using the weight of the commodities in containers. The chart is focused on the dominant freight flow – imports.

Figure 118. Share of U.S. Imports, 2003 to 2022



Source: Analysis of National Ports Data from The Kemmsies Group

Figure 119. Share of U.S. Port Traffic, 2003 to 2021



Source: Analysis of National Ports Data from The Kemmsies Group

The following table shows the connectivity ranking of 22 of the nation's largest container ports as calculated by the United Nations Committee for Trade and Development (UNCTAD). The index is based on five components, collected annually:

1. The number of companies that provide direct services
2. The number of port or country pairs with direct connections
3. The size of the largest container ship
4. The number of services
5. The total deployed carrying capacity

A low rank number means the port is better connected than one with a high rank number. The index shows that the four largest East Coast ports are ranked lower than any other U.S. ports except for the Port of Long Beach. The Port of Savannah has the second lowest ranking of any port in the nation.

An importer that shifts its sourcing location from China to locations west of China, such as India and Vietnam, is mostly going to ship its goods to the US via the Suez Canal. The East Coast ports would be best positioned to benefit from this shift in sourcing location because of their strong connectivity.

Table 102: Port Connectivity Ranking

East Coast Port	Rank	Gulf Coast Port	Rank	West Coast Port	Rank
NT/New Jersey	37	**Houston**	94	**Long Beach**	58
Savannah	45	**New Orleans**	151	**Los Angeles**	61
Norfolk	53	**Mobile**	180	**Oakland**	66
Charleston	59	**Tampa**	196	**Seattle**	114
Baltimore	98	**Gulfport**	417	**Tacoma**	127
Wilmington, NC	123			**San Diego**	608
Miami	138				
Port Everglades	145				
Philadelphia	160				
Boston	200				
Wilmington, DE	415				

Source: UNCTAD

In the last several years a number of other factors have contributed to the East Coast and Georgia's gain of US containerized trade volumes. These include:

- **Trade Policy**. The Trump Administration's policies regarding China have been continued by the Biden Administration. These include tariffs on imports from China, technology export restrictions to China, and subsidies to motivate US companies in national security-sensitive industries to produce the goods they intend to sell in the US in domestic locations (policy-induced reshoring). These industries include information and communication equipment such as chips, pharmaceutical ingredients, advanced medical devices, and other healthcare related commodities.
- **Supply Chain Restructuring.** Various factors that either began or started to be accelerated during the pandemic. These are discussed in the next subsection.

Supply Chain Restructuring

Supply Chain Restructuring alters operating methods, staging sequences, and facility and supplier location in response to disruption risk and market developments. Cost, speed, reliability, and risk are KPIs prominently influenced when changes are made to the network. Connecting facilities to suppliers, resources, and markets, and anticipating capacity and performance requirements are aspects within GDOT's purview.

The COVID-19 pandemic created a challenging situation for global supply chains. The situation was described in the "State of Logistics 2022" report published by the Council of Supply Chain Management Professionals (CSCMP) as follows:[75]

> *As services spending gave way further to the purchase of goods by consumers adjusting to new norms of work and social life, clogged ports and paltry capacity failed to meet surging and often desperate demand. Inventory-to-sales ratios dropped to near-record lows and capacity adds from carriers were in no way near the levels required by shippers.*
>
> *Disruptions in all logistics networks effectively destroyed capacity, as ships loitered at ports; equipment waited to be unloaded; and trucks rushed out half-empty, dashing off to the next high-paying load with little regard for backhauls.*
>
> *Even as companies furiously added capacity in trucking, parcel, air freight and warehousing, it was just as quickly snapped up… United States business logistics costs rose by 22.4 percent and came to represent 8 percent of the nation's entire GDP, a level not seen since GDP.*

These conditions have caused shippers and transportation service providers to rethink their networks and operations in ways that will mitigate the risk from future disruptions of this type. These changes to the shippers' supply chains include these factors:

Replacing Trucking with Intermodal. On both U.S. coasts, rail has been integral to moving containers off congested ports and towards inland hubs and distribution points. Coming off the early 2020 facility closures and the lean operations of precision scheduled railroading (PSR), the railroad industry had to reconfigure its operations to accommodate changed inventory practices along with record cargo volumes. The reconfiguration took time and effort to implement, and rail's importance to the supply chain was evidenced by the container backlogs that occurred while the industry was ramping up capacity.

Intermodal transportation plays a key role in Georgia. As one of five mega intermodal truck-rail hubs across the United States, Atlanta is the Southeastern U.S. distribution hub for both domestic and international intermodal freight. Metro Atlanta is served by two Class I railroads, CSX and Norfolk Southern. With four intermodal terminals and direct service to the Port of Savannah, Atlanta is where shipments transfer between highway and rail. Georgia's short line railroads also play a role in supporting connectivity across the network.

Intermodal rail shipments offer a lower-cost alternative to purely highway transportation services. The trade-off is that intermodal shipments are slower, often adding one to two days to shipment durations. Two factors that make the trade-offs associated with intermodal transportation a winning proposition are 1) workforce capacity and 2) cost, including diesel fuel prices.

As driver shortages persist and worsen, intermodal service offers needed shipping capacity to supply chain managers. One intermodal train can replace as many as 200 trucks. Similarly, the fuel consumption for the typical intermodal shipment is one-half of the highway move. As fuel prices

[75] Kearney, "CSCMP's Annual State of Logistics Report," published in 2022 by CSCMP.

increase, the cost advantages of intermodal shipping increase and it can be effective over a shorter distance.

Holding More Inventory. Prior to 2020, 'just-in-time' (JIT) delivery was a leading phrase in logistics. Rolling shortages of various goods occurred between 2020 through 2022 and businesses started focusing on a 'just-in-case' (JIC) model. JIC is an inventory management strategy used to mitigate risk and uncertainty in the supply chain and/or the anticipation of emergencies or sudden increases in demand. The U.S. shipping industry spent the previous decades perfecting JIT, managing lean inventories based on insights from machine learning, artificial intelligence, and big data. But the COVID-19 pandemic spurred unforeseen surges in demand, compounded by shortages caused by worldwide closures of factories and ports as well as changes to trade policies. Businesses had to pivot to JIC, building up inventories to prepare for potential future shortages of key goods, and ordering well ahead of seasonal demands due to delays across the supply chain.

Import distribution centers have been challenged to pull containers from marine terminals, contributing to significant and widespread port congestion. While container volumes were on the rise before the COVID-19 pandemic, imports across all sectors have since skyrocketed- partially for JIC inventory planning, but mostly because retailers' sales jumped around 20 percent once the stimulus payments were received by households between Q2-2020 and Q1-2021.

Four Corner Port Strategy. Prior to the pandemic the majority of US retail goods importers brought over 90 percent of their goods to the US via US and Canadian West Coast ports, the majority coming through Southern California. The incoming volumes, along with labor shortages due to various factors such as illness, overwhelmed the Southern California ports.

Figure 120. Ships Waiting for A Berth in Southern California December 22, 2020

Source: MarineTraffic.Com

Some retailers learned some time ago to diversify their port gateway entry points to the US in order to minimize risks such as local labor problems, bad weather, etc. This strategy is often referred to as a four or five corner port strategy. A four corner strategy might include using ports in Los Angeles, Seattle, New York, and Savannah. Houston could be a fifth for some.

The news story on the retail sector has had a significant amount of announcements regarding importers using more imports, usually accompanied by investments in new distribution centers in the new ports.

The Southeast was already home to five of the nation's top ten seaports by twenty-foot equivalent units (TEU) handled. Altered consumer buying habits, COVID-19 related closures, labor and chassis shortages, and other factors led to large increases in both container volumes and port congestion. The Port of Savannah saw a 7.5 percent increase in TEUs between 2018 and 2020. and the resulting congestion pushed the port into innovative solutions. In 2021, Georgia Ports Authority opened four additional inland yards, including one in Atlanta, to ease congestion from Savannah.

Table 103. Container Volumes in Savannah for Fiscal Years (July 1 to June 30) 2018 and 2021

	Import	Export	Total
2018	1,291,757	847,814	2,139,571
2021	1,732,824	862,794	2,596,618
Percent (%) Change	34%	2%	21%

Source: Georgia Ports Authority

Since most of the retail goods sold in the US are imported, it is not surprising that warehouse and distribution center vacancy rates fell significantly more in port cities than in the US (those all declined but not as much). In 2022, Savannah's vacancy rate, at 0.1 percent, was the lowest of any real estate market in the US. Savannah has added about 30 million square of distribution center space in the last three years, more than in Atlanta, which has ten times the Savannah population. The real estate industry press has been reporting that Savannah is the fastest growing industrial real estate market in the US.

The supply chain restructuring process is ongoing. Some firms are still researching and planning, while others are already implementing their supply chain changes. Besides adding nodes to their distribution networks (more ports for example), using more intermodal, holding more inventory, etc., another strategic element is reshoring at least some and potentially all of foreign-based production back to the US, or near-shoring some of that to Latin America. These actions would increase domestic freight movement more than international freight movement in Georgia.

Re-shoring. The global management consulting company, AT Kearney (ATK) publishes a Reshoring Index that tracks trends in manufacturing returning to the US from low-cost countries (LCC) in Asia where sourcing, production, and assembly have historically been offshored to. This is a good indicator of the reshoring trends. The index is based on their survey of CEOs of manufacturing companies around the world. Their latest report indicates US companies relied more on manufacturing operations in the LCC in 2021 than they did in 2020, and more in 2020 than in 2019. The report indicates that this is likely caused by the pandemic-driven issues.

The survey of CEOs, conducted in March 2022, indicates that corporate attitudes and strategies are changing. In the 2021 report, 78 percent of the executives answered "maybe" or "yes" when asked about reshoring and in the 2022 report, 92 percent answered maybe or yes.

Yeti tests Port Houston in bid to avoid congestion

Published March 12, 2021

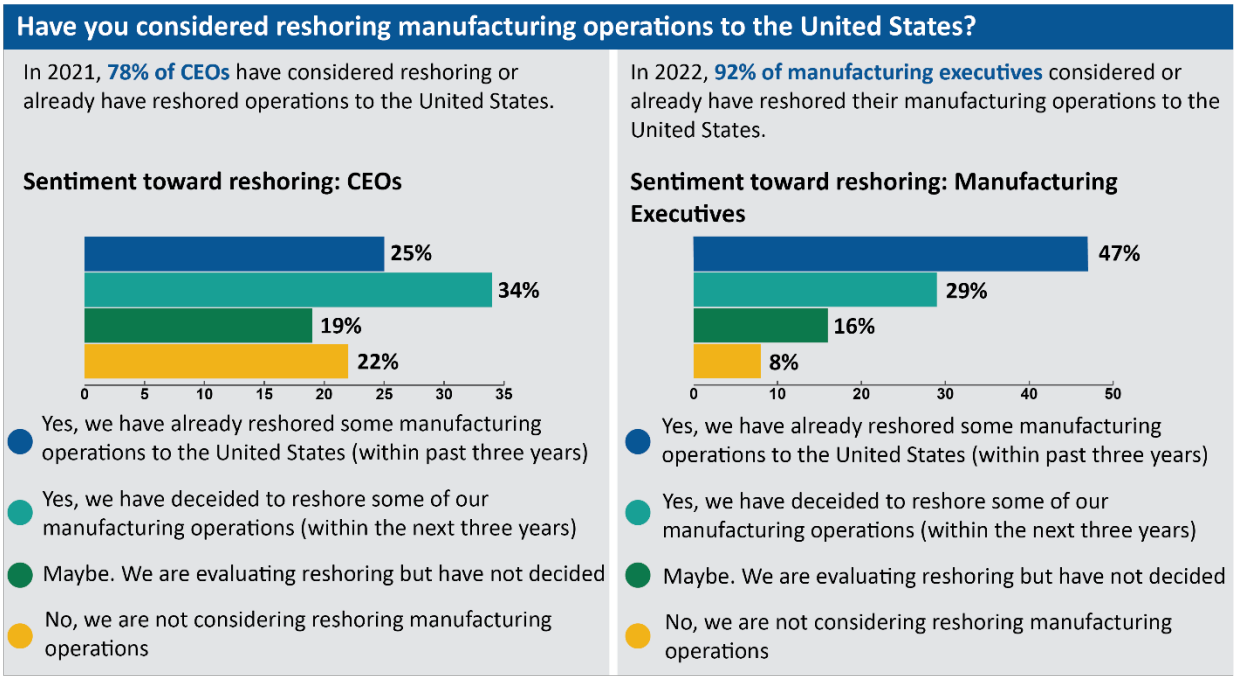
Yeti has been able to "secure ample capacity" for its ocean shipping needs as some in the industry struggle with accessing containers, but the brand did say it is testing the use of Port Houston to avoid congestion, CFO Paul Carbone said during the Bank of America 2021 Consumer & Retail Technology Conference on Tuesday.

"We're seeing some elongated times coming through the port," Carbone said. Multiple ports have reported congestion issues in recent months — including Los Angeles, Long Beach and New York/New Jersey — but Carbone didn't specify where they're seeing difficulties.

Source: https://www.supplychaindive.com/

Figure 121. Manufacturing Executives and CEOs Attitude about Reshoring Outlook

Manufacturing executives and CEOs are more positive about the reshoring outlook than they have been in the past



Source: Kearney analysis

The 2021 Reshoring Index also reveals a positive trend in domestic manufacturing activity: since Q2-2021, quarterly manufacturing gross output levels have been back above pre-pandemic levels. The National Factory Activity index hovered between 58 and 64 in 2021, with any number above 50 meaning expansion.

Five factors underlying the rising interest in reshoring were identified in the report. The report notes that the prioritization of these factors are different depending on the size of the company, as shown in **Figure 122**.

Figure 122. Top Five Factors by Company Size Influencing Reshoring

	Small companies	Medium-size companies	Large companies
1	Quality of goods	Quality of goods	Labor costs
2	Delivery lead times	Labor costs	Logistics costs
3	Logistics costs	Reduced carbon footprint	Labor availability
4	Ease of conducting business	Delivery lead times	Delivery lead times
5	Quality of goods	Logistics costs	Reduced carbon footprint

Factor appears once in top five factors across company sizes
Factor appears twice in top five factors across company sizes
Factor appears three times in top five factors across company sizes

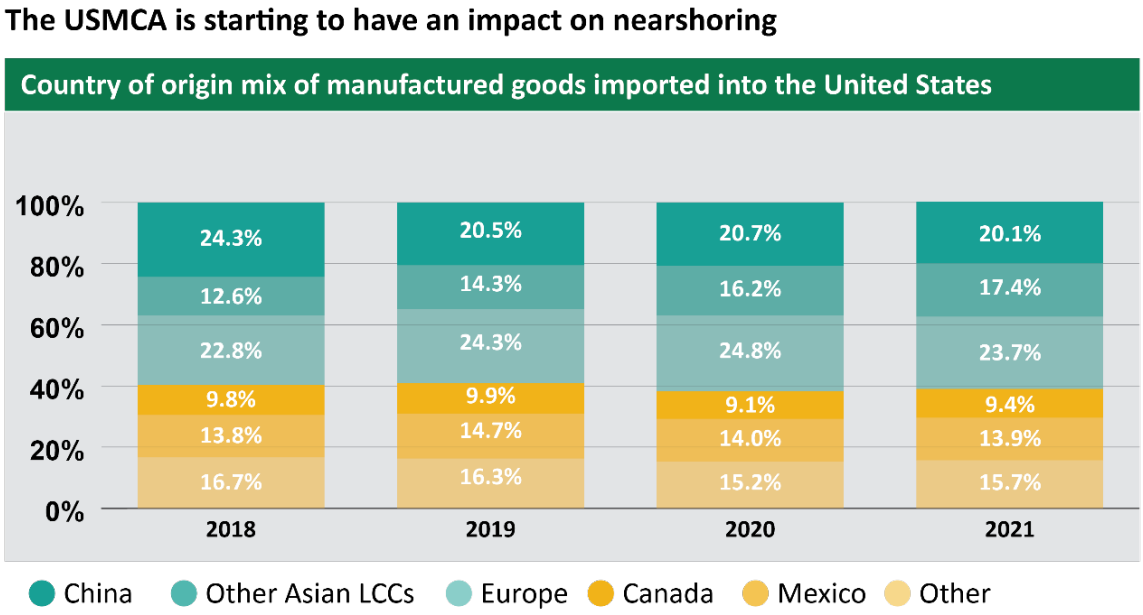
Note: Small= less than $250 million, Medium= $250 million to $5 billion, Large= more than $5billion
Source: Kearney analysis

Besides the factors listed above, the report notes that 45 percent of the CEOs say they have been approached to consider reshoring by their employees, followed by the board of directors (36 percent), industry organizations (31 percent), family and friends (25 percent), and local or state-level officials (18 percent). Seeing other companies reshore their operations has also instigated interest in reshoring among the surveyed executives and CEOs.

The survey states that 79 percent of the manufacturing executives who have operations in China have either already moved some of their operations to the US or plan to do so in the next three years. **Figure 123** shows the shares of the value of US imports from various regions and countries. It is clear that China has lost share.

Imported container data for the US shows that China has been losing share to other Asian countries, corroborating the conclusions of the ATK report. These trends are also true for the port in Savannah, given the incentives that the state and many of its counties and cities offer, it is likely that at least some of the reshoring manufacturing that the ATK reports is likely to end up in Georgia. A good example of such efforts is the siting of electric vehicle and lithium battery manufacturing plants in Georgia.

Figure 123. Value of US Imports from Various Regions



Note: USMCA is the United States-Mexico-Canada Agreement; LCC is low-cost country.
Source: United States International Trade Commission; Kearney analysis

It Is Still About the Gateway of the Future – Savannah

Reshoring production back to the US would have a minimal impact on aggregate freight volumes handled by US ports. To some extent near-shoring to Mexico would a larger negative immediate impact on US port volumes, but in the long run, larger volumes are likely to prompt more short sea shipping to US ports. For now, what matters is that East Coast ports, particularly in Savannah invest to continue to be ahead of the curve.

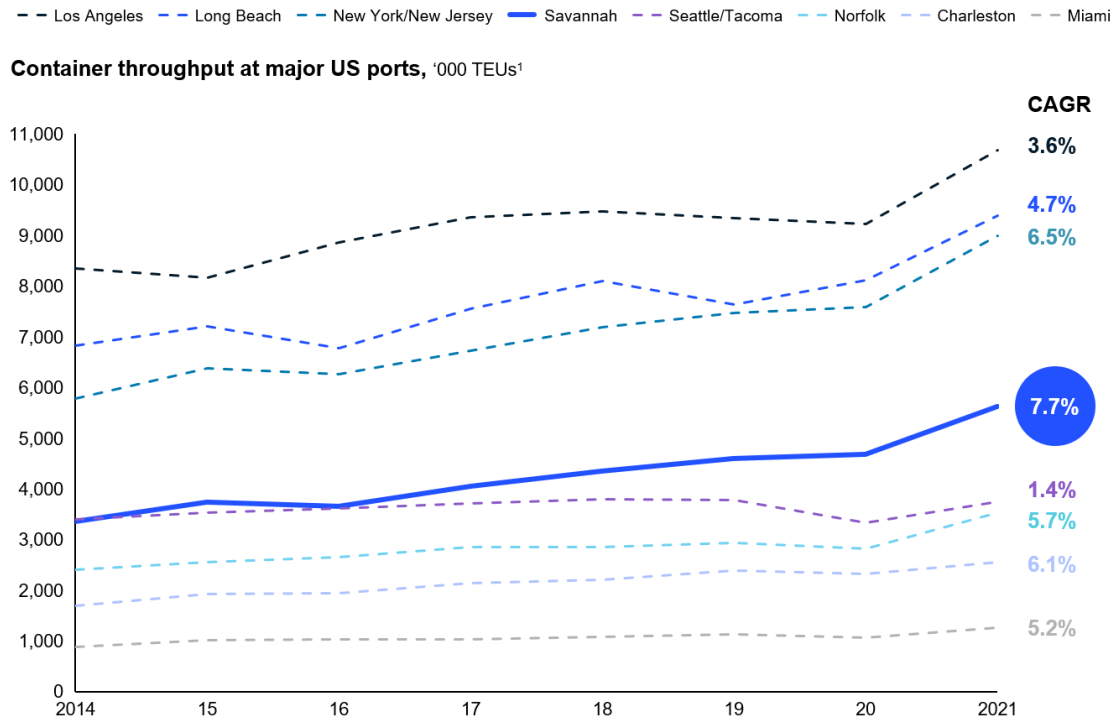
- Port of Savannah has undertaken strategic infrastructure investments to meet short and long term challenges. In progress are:
- Infra-structure upgrades: Investing in berth renovations and new STS cranes that will improve berth capacity and improve productivity
- Capacity expansion: Ongoing Phased capacity expansion to add 1.6 Mn TEU[76] capacity across the terminal

Additionally, Georgia Port Authority (GPA) has made previous strategic investments in port infrastructure which enabled them to keep up with surging demand. and the GPA will now need to continue making broader investments to remain on the growth trajectory and be the premier gateway on the east coast. In the future, Port of Savannah's throughput and hinterland reach will determine future freight flows to meet Georgia's consumption and economic productivity

[76] Source: BTS; CTS; Port Websites; Press Search

opportunities. In short, GPA's investment programs over 25 years have positioned it as the port Gateway of the Future. It is critical for GDOT to invest in a corresponding way alongside GPA.

Figure 124. Port Competitiveness



1. TEU: Twenty-foot equivalent unit

Source: The Georgia Department of Transportation (The Georgia Advantage); ports websites

Intermodal

Intermodal transportation plays a key role in Georgia. As one of five mega intermodal truck-rail hubs across the United States, Atlanta is the Southeastern U.S. distribution hub for both domestic and international intermodal freight. Metro Atlanta is served by two Class I railroads, CSX and Norfolk Southern. With four intermodal terminals and direct service to the Port of Savannah, Atlanta is where shipments transfer between highway and rail. Georgia's short line railroads also play a role in supporting connectivity across the network.

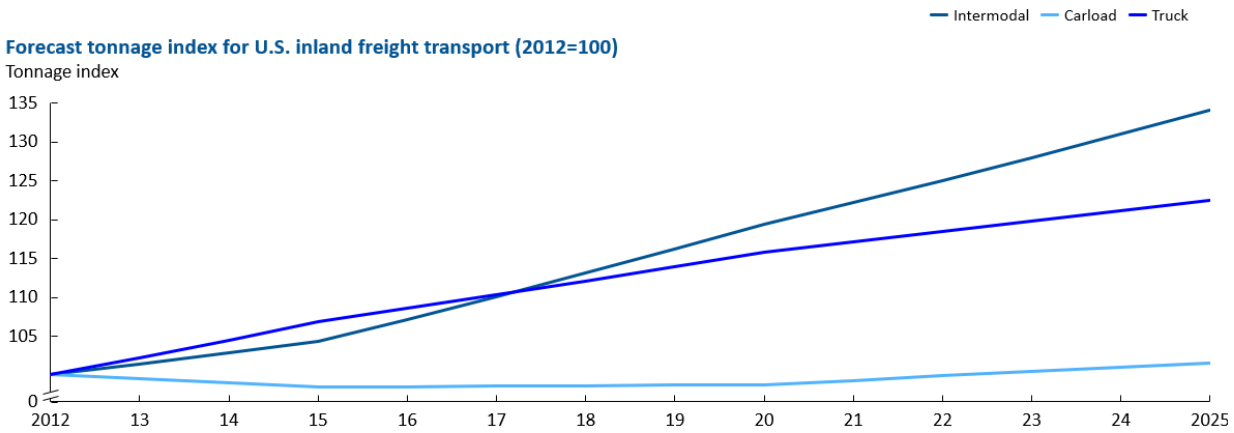
Businesses will continue to make decisions about modal share between intermodal, air, and truck based on a variety of factors. There are four main challenges which will continue affect modal share in the future: business performance, technology, regulation, and structural changes such as emissions reporting requirements.

Rail carries <10 percent[77] of cargo in Georgia, and its share has been decreasing steadily in the past decade within the state and across nation. Rail's modal share loss to truck has been

[77] Source: Freight Analysis Framework; GDOT

consistent for some of the top commodities in Georgia such as cereal grains, basic chemicals, and minerals. One major cause of this share loss and resulting increase in trucking is inconsistent access to rail by key economic engines of Georgia: manufacturing and agricultural.

However, although traditional rail has seen a sharp decline, adoption of intermodal growth is likely to accelerate by 2025. Nationally, intermodal and coal are the largest rail commodity segments, with intermodal showing strong growth while coal has concurrently seen a sharp decline. Intermodal has become a growth engine for the Class I railroads - improvements to infrastructure, transit times, and reliability has made intermodal a viable alternative to long-haul trucking.



Inconsistent access to rail by key economic engines of Georgia have contributed to truck cargo share increase. GA's top manufacturing counties are concentrated around the Atlanta area and have good rail access, but several mid-sized contributors are outside the 60-minute drive time: Clarke County, Habersham County, and Evans County. 3 out of GA's top 10 agriculture producing counties are outside a 60-minute drive from a major railyard or terminal: Franklin County, Early County, and Hart County.

Intermodal rail shipments offer a lower-cost alternative to purely highway transportation services. The trade-off is that intermodal shipments are slower, often adding one to two days to shipment durations. Two factors that make the trade-offs associated with intermodal transportation a winning proposition are 1) workforce capacity and 2) cost, including diesel fuel prices.

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Just-in-Time vs Just-in-Case

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the supply chain and/or the anticipation of emergencies or sudden increases in demand. The U.S. shipping industry spent the previous decades perfecting JIT, managing lean inventories based on insights from machine learning, artificial intelligence, and big data. But the COVID-19 pandemic spurred unforeseen surges in demand, compounded by shortages caused by worldwide closures of factories and ports as well as changes to trade policies. Businesses had to pivot to JIC, building up inventories to prepare for potential future shortages of key goods, and ordering well ahead of seasonal demands due to delays across the supply chain.

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The Southeast was already home to five of the nation's top ten seaports by twenty-foot equivalent units (TEU) handled. Altered consumer buying habits, COVID-19 related closures, labor and chassis shortages, and other factors led to large increases in both container volumes and port congestion. The Port of Savannah saw a 7.5 percent increase in TEUs between 2018 and 2020. and the resulting congestion pushed the port into innovative solutions. In 2021, Georgia Ports Authority opened four additional inland yards, including one in Atlanta, to ease congestion from Savannah.

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Source: Georgia Ports Authority

On both U.S. coasts, rail has been integral to moving containers off congested ports and towards inland hubs and distribution points. Coming off the early 2020 facility closures and the lean operations of precision scheduled railroading (PSR), the railroad industry had to reconfigure its operations to move from JIT to JIC and accommodate the record cargo volumes. The reconfiguration took time and effort to implement, and rail's importance to the supply chain was evidenced by the container backlogs that occurred while the industry was ramping up capacity.

4.2.5. Technology and Automation

Technology and Automation encompasses a range of issues from robotic, optical, and materials handling equipment that reduces labor and increases freight volumes per square foot to alternative fuels and autonomous vehicles that change the methods of transportation.

Technology applied to the infrastructure such as flexible signage also apply as do changes in supply chain operations systems like shipment tracking. Although different aspects of technology affect different KPIs, cost, reliability and safety are leading types, and GDOT interests include

capacity, broadband and intelligent transportation systems, air quality, and safety assurance. Technology advancements are creating an emerging transportation infrastructure that is digital in nature and key to the physical infrastructure's performance and reliability. These technologies change both how transportation users engage and operate with the transportation systems in the state and how the Georgia DOT delivers on its mission.

Technology and automation will be discussed in this section from the perspective of both the users of the Georgia transportation network and systems and from the viewpoint of GDOT's role as the provider of state-wide transportation infrastructure. Take the case of new technologies like automated or autonomous driving systems (ADS) and connected driving systems (CDS) that promise improvements in safety, efficiency, and service. Transportation and logistics firms are pursuing, evaluating, and adopting these new technologies. With this deployment of new goods movement methods, transportation infrastructure needs will change.

In the case of ADS/CDS technologies, road markings will remain crucial for all types of guidance systems in the age of mixed-level autonomous driving. Digitizing and sharing roadway geographic information system (GIS) data will be a new service offering using both private and public sector input. Sensor-based and connected technologies will generate large amounts of new and complex data. Public agencies like Georgia's DOT will plan how to leverage and govern emerging data sources to improve the management and operations of transportation infrastructure.

Broadband

Since the Georgia Broadband Deployment Initiative (GBDI) legislation was passed in 2018, the need for broadband services has become an increasingly important asset needed for both existing and unserved businesses and consumers in the State. To preserve Georgia's competitive market and to grow future markets in unserved areas, the following transportation technologies will rely on new or improved broadband infrastructure: real-time travel information, connected vehicle systems, traffic management systems, and signal operations. These technologies assist private-sector industries improve advancements in fleet management, modernized supply chains, and automation at ports and warehouses.

The Georgia Department of Community Affairs (DCA) has supported GBDI in developing the Broadband Ready Community Designation (BRCR) grant program to support broadband expansion. The goal of the grant program is to provide a mechanism to tweak the economics for providers and to encourage them to expand broadband service to unserved areas. Forty-seven local governments, most of which are in rural areas, have committed to facilitating broadband deployment in their communities after receiving the BRCR grant by DCA. This designation signifies that local governments have adopted comprehensive plan language and a model ordinance to promote broadband deployment in their communities.

Additionally, GBDI is working closely with USDA and other federal entities to access all available resources to aid unserved Georgians. USDA's ReConnect Program allocates $600 million in grant and loan funds for rural broadband implementation. GBDI has worked with several active

deployment projects to encourage and facilitate USDA funding applications in addition to DCA's BRCR grant program78.

Broadband availability and the need for information has become more important after the recent pandemic because of increases in residents working from home and purchasing household goods online. The federal government in November 2021 enacted the Bipartisan Infrastructure Law (BIL) that allocates $65 billion for broadband improvements. GDOT is supporting the expansion effort by installing broadband along Interstate corridors. The first phase of GDOT's broadband program will install broadband along I-75, I-16 (PI No. 0019550) and I-20, I-75, I-85, I-285, and SR 400 (PI No. 0019551).

GDOT is preparing for emerging technologies and has implemented the installation of equipment to support Vehicle-to Anything (V2X) communications throughout the state. This will allow GDOT to share data such as wrong-way driving information, Signal Phase and Timing (SPaT), work-zone information, freeway speed and road condition. These potential applications can be built upon the high-tech infrastructure and prioritized based on the deployment of broadband.

Emerging Freight Technologies

Given the wide array of technologies and the imprecise definitions inherent in new and evolving work, it is helpful to group like technologies together for analysis and discussion purposes. Various such frameworks for classifying emerging freight technologies exist. One framework example is from a recent academic study[79] by Dong, et al summarizing a systematic literature review of the current and future trends in freight technologies. This study identified nine emerging technologies grouped into three categories:

1. New Automation Systems - 3D Printing, Automated Robots, Autonomous Vehicles, and Drones.
2. New Information Systems - Artificial Intelligence, Big Data Analytics, Internet of Things, and Blockchain.
3. New Energy Systems - Electric Vehicles.

Another framework was developed by the Mid-America Regional Council (MARC) in 2020 to monitor and prepare regional governments in the Midwest for technological change in freight movement practices. That work identified the following eight freight technology categories.

[78] *"Georgia Broadband Deployment Initiative | The Georgia Broadband Plan." Georgia Broadband Program | Georgia Broadband Program, The Georgia Department of Community Affairs (DCA), 29 May 2019, https://broadband.georgia.gov/.*

[79] Dong, Chuanwen & Akram, Asif & Andersson, Dan & Arnäs, Per Olof & Stefánsson, Gunnar. (2021). The impact of emerging and disruptive technologies on freight transportation in the digital era: current state and future trends. The International Journal of Logistics Management. ahead-of-print. 10.1108/IJLM-01-2020-0043.

Table 105. Major Freight Technology Categories

Freight Technology	Description
Automation	Technologies that allow for greater productivity per labor hour.
Big Data	Information technologies specifically for the processing of large, disparate data sets.
Data, Information, and Communication	Technologies to connect, collect, communicate, and analyze data.
Digital Supply Chain	Information and decision technologies to improve supply chain operations and planning.
Energy	Technologies producing alternative forms of energy to power the transportation of goods.
Enforcement and Inspection	Technologies to improve and enhance equipment inspection and traffic enforcement.
Intermodalism	Technologies that facilitate the linking of transportation modes.
Safety	Technologies that reduce the risk of injury, death and damage to vehicles, occupants, and payload.

Source: Mid-America Regional Council

Finally, a recent study by Comi and Russo focused on a subset of Intelligent Transportation Systems (ITS)[80]. It highlighted the same new information technologies as Dong, et al did. Comi and Russo referred to these technologies as emerging information and communication technologies (e-ICTs): Internet of Things (IoT), Block Chain (BC), Big Bata (BD), and Artificial Intelligence (AI).

Together, these frameworks show both the commonality and disparity in how technologies are viewed, discussed, and thus understood. The three consistent framework categories of information systems, automation, and energy will be used to analyze and discuss freight technology and automation considerations.

Information Systems

Big Data, Artificial Intelligence, Blockchain, and the Internet of Things have been identified as emerging technologies in the field of Information Systems.

- Big Data refers to the ability to capture vast amounts of data regarding a myriad of subjects ranging from traffic counts to road temperatures to engine data. Big Data technologies harvest valuable information from these large datasets and support new models, algorithms, and applications.

[80] Paper - Comi A and Russo F (2022) Emerging Information and Communication Technologies: The Challenges for the Dynamic Freight Management in City Logistics. Front. Future Transp. 3:887307. doi: 10.3389/ffutr.2022.887307N. Sourced at https://www.marc.org/transportation/plans-and-studies/heartland-freight-technology-plan

- Artificial Intelligence (AI) provides a different, machine perspective to both obtain information from and to act on data.
- The Internet of Things (IoT) is a compilation of embedded and connected sensors (like RFID tags, vehicle telematics, and cell phones) that collect, process, and transmit data. IoT creates an interface between data and the actual transportation activities.
- Blockchain, or distributed ledger processing, is a novel approach to create trust among actors sharing data. This is especially important for the transportation sector because freight flows often involve multiple stakeholders from around the globe.

Together, these transportation information systems technologies are being leveraged by both industry and government to improve transportation system performance.

Sound data management is core to all these information technologies and will therefore be a key competency for the effective use of them. Both private and public sector systems can gather and share real-time situational data to improve transportation decisions at vehicle, route, and system levels. In the private sector, data-driven innovations in real-time routing and planning in urban transportation operations like navigation, vehicle routing, and courier delivery scheduling are occurring. Public sector opportunities for more responsive intelligent transportation systems will develop in advanced traveler information and infrastructure and operations management systems.

Automation Systems

The purpose of all automation technologies is improving or enhancing the efficiency of operations, often by replacing human labor with machinery. Supply chain automation is present within factories and warehouses, automating manufacturing steps and material handling activity. 3D printing and automated robots' impact is mostly inside the factory or warehouse. For example, as land becomes scarcer in desirable warehouse locations, building up occurs. Known as high cube warehouses, they are typically built for a specific use and highly automated. These high cube warehouses often use Automated Storage and Retrieval Systems (ASRS) to maximize storage space availability and to store and pick goods with less labor input.

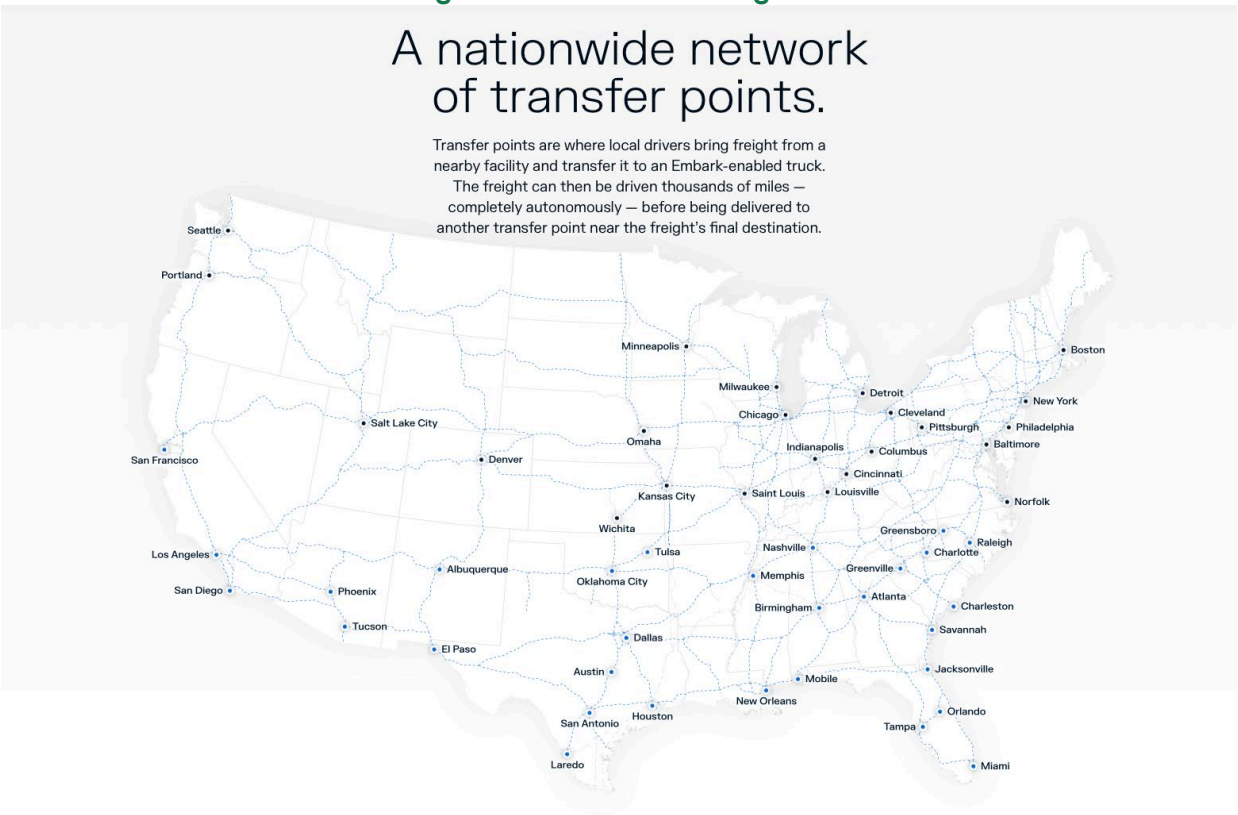
In transportation, the automation opportunity is the driving task. Given the ever-present shortage of commercial drivers and the accidents caused by human error, there is much interest in and motivation to automate the driving task with autonomous vehicles. It is a more challenging automation task than factory or warehouse automation. It will require both automation and connectivity and rely on the information systems technologies discussed earlier.

Automated driving systems (ADS) can be defined as hardware and software that are collectively capable of performing without any intervention or supervision by a human operator. Connected driving systems (CDS) are hardware and software that enable vehicles to receive and share mobility and safety information with other vehicles and information systems. A short list of ADS/CDS vendors include Kodiak, Embark, TuSimple, Gatik, and Aurora. Leading firms active in Georgia like UPS, Ryder and Walmart are actively testing ADS/CDS technology in their operations.

ADS/CDS technology will be implemented slowly and incrementally in controlled operating conditions, or operational design domains (ODDs), specifically structured to safely leverage the benefits of ADS/CDS technology. A likely first implementation of the technology will involve a hub-

and-spoke model where the ADS/CDS power units will do the linehaul between transfer hubs. At the hub, the outbound (pickup) and inbound (delivery) loads will be switched from and to a local delivery power unit with a driver as depicted in this graphic produced by ADS/CDS technology provider, Embark.

Figure 125. Hub Model Diagram

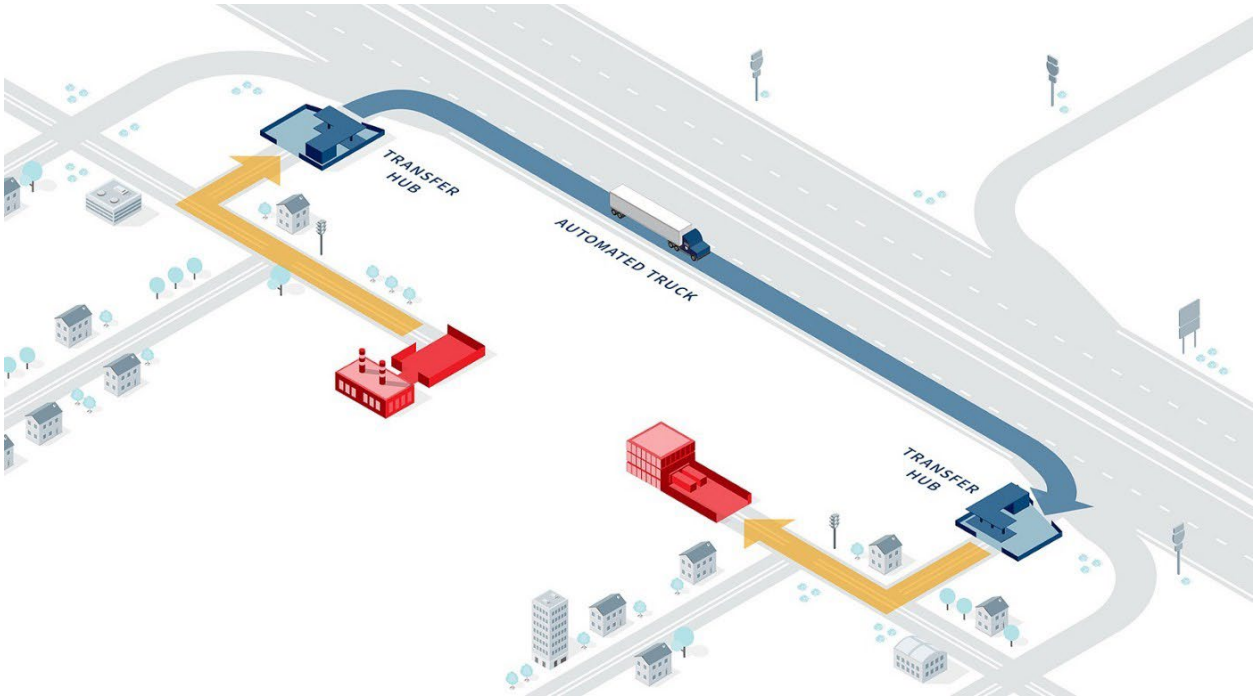


Source: embarktrucks.com

In this hub-and-spoke model use case, the automated driverless truck operates between hubs on the same route. These hub-to-hub linehaul routes will be mapped in detail with repeated test runs to develop and fine tune the algorithms to support the ADS operating the vehicle along each linehaul route. Human drivers will make the initial pickups and final deliveries to customers. This way, the variety and randomness of freight goods movement from one customer location to the next is left to the human driver while the automated driving system always transits a known hub-to-hub route.

The transfer hub operating model leaves the human driver in place to deal directly with customers at shipping and receiving yards and docks while leveraging the ADS/CDS technology to move freight between the transfer hubs with no customer interaction required. The autonomous power units stay in highly controlled ODDs and out of the ever-changing last mile environments. As a primary freight hub, Atlanta will certainly be a major transfer point for automated trucking operations.

Figure 126. Automated Trucking Model



Source: Ike/Medium - https://medium.com/ike-blog/how-automated-trucks-could-create-better-truck-driving-jobs-e817b524c5fd

Embark announced in late 2021 an agreement with Ryder aimed at launching a nationwide network of up to 100 transfer hubs where Ryder will provide yard operations, maintenance, and fleet management to support an autonomous network where freight is moved from driverless long-haul trucks to human-driven driver-enabled trucks for shipment pickup and delivery. Ryder plans to serve as the transfer point operator, managing the logistical operations throughout the yard, performing pre- and post-trip inspections, and providing maintenance services for the vehicles as well as the autonomous hardware.

Platooning is a variation of ADS/CDS technology deployment and will likely be a bridge leading to fully autonomous operation. Locomation, based in Pittsburgh, PA, is an example of a technology provider following this approach. First-generation platooning technology, which keeps an active driver in each vehicle, has been tested and could be deployed more broadly in the mid-term, with a marginal reduction fuel costs and emissions if deployed.

Remotely assisted and/or controlled trucks are another technology that could impact freight operations. The operational design domains most suitable for remote operations have yet to be defined, but it is possible that they might operate within urban areas, along Interstates, or in confined locations, such as ports or even rest areas. Strong, low latency (latency refers to time delay) communication to the vehicle is expected to be needed to enable remote operations, so rural use cases are less likely.

Drones, or unmanned aerial vehicles (UAVs), are more likely to fill a niche in inspection roles or local delivery of certain goods like pharmaceuticals and other medical supplies or to remote areas with few roads. UPS has a new division, Flight Forward, focused on drone delivery solutions. Both Walmart and Amazon also are piloting drone delivery service. Given the drone payload limits

(typically 5 to 1,400 pounds), drone deliveries will not significantly impact highway freight transportation volumes.

A final note on automation technology regards the level of public acceptance for sharing the roadways with driverless vehicles. A recent Pew Research Center study found that most Americans have reservations about automating other kinds of transit beyond personal vehicles[81]. Nearly six-in-ten (59 percent) said they opposed the use of technology to operate driverless 18-wheelers. People were somewhat more favorable regarding its use in buses, taxis, ride-sharing and delivery vehicles. In no case were most people in favor of driverless operations. If the traveling public acts on these expressed concerns, the implementation of these automation technologies will certainly be slowed and limited in public spaces.

Energy Systems

Transportation is undergoing two major changes simultaneously – the adoption of ADS/CDS technologies and the electrification of vehicle powertrains. Electric vehicles (EVs) can be defined as vehicles fueled by electricity that can be charged from an off-board electric power source. EVs are often discussed in conjunction with ADS and CDS. According to the Center for Automotive Research[82], "automated, connected, and electric (ACE) automotive technologies can exist as stand-alone advancements, but when combined, this set of advancements may fulfill the loftiest technology expectations. In a few decades, it is likely that people will no longer make the distinction between the three areas and will see ACE technologies as one thing."

Today, electrification implementations are ahead of higher levels of ADS/CDS technology deployment. According to an article on SAE.org[83], three factors have altered industry's journey toward full self-driving systems. One factor cited was the COVID pandemic and the resulting "touchless economy" that curtailed at least temporarily the growing enthusiasm for robotaxis and ride sharing. The other two factors were economic constraint across the industry combined with strong regulatory pushes for electrification, particularly in Europe and China. The last point, it was noted, has made electrification a necessary focus for OEMS.

The International Energy Agency's 2021 Global EV Outlook Report[84] states that around 370 electric car models were available worldwide in 2020, a 40 percent increase from 2019. Battery electric vehicle (BEV) models are offered in most vehicle segments in all regions; plug-in electric hybrid vehicles (PHEVs) are skewed towards larger vehicle segments. Sport utility vehicle (SUV) models account for half of the available electric car models in all markets.

- The report further states that in the commercial vehicle market, electric bus, and electric heavy-duty truck (HDT) registrations increased in 2020 in China, Europe, and North

[81] Nadeem, Reem. "4. Americans Cautious about the Deployment of Driverless Cars." Pew Research Center: Internet, Science & Tech, Pew Research Center, 18 Mar. 2022, https://www.pewresearch.org/internet/2022/03/17/americans-cautious-about-the-deployment-of-driverless-cars/.
[82] Car Group "Automated, Connected, Electric, and Shared Vehicles: Are Aces Leading to Unprecedented Change?" Center for Automotive Research, 27 Nov. 2017, https://www.cargroup.org/automated-connected-electric-shared-vehicles-aces-leading-unprecedented-change/.
[83] https://www.sae.org/news/2020/12/rise-of-sae-level-2 – Accessed May 19, 2022
[84] IEA (2021), Global EV Outlook 2021, IEA, Paris https://www.iea.org/reports/global-ev-outlook-2021

America. The global electric bus stock was 600,000 in 2020 and the electric HDT stock was 31,000. In the United States, electric bus deployment primarily reflects polices in California, which is the location of most of the current e-bus stock. Global electric HDT registrations were 7,400 in 2020, up 10 percent on the previous year. The global stock of electric HDTs numbers 31,000. China continues to dominate the category, with 6,000 new registrations in 2020, up 10 percent though much lower than the fourfold increase in 2019. Electric HDT registrations in Europe rose 23 percent to about 450 vehicles and in the United States increased to 240 vehicles. Electric trucks are still below 1 percent of sales in Europe and the United States.

While vehicle electrification adoption is leading fully autonomous ADS/CDS implementation, these two technology transformations will certainly converge. One leading automotive manufacturer, General Motors (GM), states that autonomous vehicles[85] should also be electric vehicles for several reasons:

- Environment - All-electric shared autonomous vehicles will be ideal for dense cities that need solutions for congestion and noise pollution.
- Power - The advanced sensing and computing hardware on an autonomous vehicle needs a lot of electric power. Compared to an internal combustion engine, an all-electric battery pack acts as a more stable power source that can enable higher-powered ADS/CDS components.
- Latency - When driving, reaction time matters. Electric propulsion systems have lower latency and more consistent response when accelerating. As a result, when compared to internal combustion counterparts, an all-electric automated and connected vehicle will have a lower delay between the time it decides to make and the time it completes a maneuver.

General Motors (GM) believes electric vehicles allow for simpler integration of the advanced technologies required for the cleanest and safest operation of autonomous vehicles. Other industry players have raised concerns about the ability of current battery technology to satisfy ADS/CDS power needs. A study by Carnegie Mellon researchers Mohan, et al[86] found that ADS/CDS technology energy demand will likely reduce electric vehicle range by 5–10 percent for suburban driving and by 10–15 percent for city driving with negligible impact on battery life. These results suggest that BEVs can provide acceptable range if manufacturers implement energy-efficient computing and aerodynamic sensor stacks for the ADS/CDS technology.

As GM has noted, vehicles that are autonomous, connected, electric, and shared offer many benefits. They can reduce congestion, decrease accidents, ease urban travel, reduce fuel consumption, and lower emissions. Often referred to as shared autonomous electric vehicles (SAEVs), several studies have shown they can dramatically reduce operating costs as well.

For example, a report by Berkeley National Laboratory researchers found that electrification for fleets of automated taxis would reduce GHG emissions by 73 percent and energy consumption by

[85] https://www.gm.com/stories/all-avs-should-be-evs
[86] Mohan, A., Sripad, S., Vaishnav, P. et al. Trade-offs between automation and light vehicle electrification. Nat Energy 5, 543–549 (2020). https://doi.org/10.1038/s41560-020-0644-3

58 percent compared to a fleet using internal combustion engines in Manhattan[87] Operating costs were estimated to range from a low of $0.29 per mile to as much as $0.61 per mile, an order of magnitude lower than traditional taxi operations. A similar study using data from the Capital Metropolitan Transportation Authority's bus fleet in Austin, Texas by Quarles, et al found that adopting both automation and electrification technology simultaneously offers cost savings and other benefits.[88] While the initial cost of adopting both ADS/CDS technology and electrification is higher, over the long term the co-adoption strategy is more economically feasible.

Autonomous and electric vehicle operations share a dependency on connected operations. Both electrification and automation technologies require real-time connectivity with a variety of entities and systems, ranging from central operations centers, roadway infrastructure, or emergency personnel.

A key part of vehicle electrification is charging infrastructure and management. As BEVs replace internal combustion engines, charging station networks will emerge. Fuel gauges will be replaced by battery power monitors, and "smart charging" to maximize battery life and minimize energy cost will be common practice in both passenger and commercial vehicle operations. Connectivity will be needed for EV fleet operators to remotely monitor real-time vehicle conditions, routes, traffic, and weather to inform and predict when each vehicle will need to be recharged and by how much. Passenger vehicles will likely connect to similar systems to optimize their own charging practices.

The synergistic benefits from SAEVs in passenger and transit vehicles are less clear in freight transportation. Like ADS/CDS technology adoption, electric vehicles are in the very initial stages of adoption in trucking. A May 2022 report by the North American Council for Freight Efficiency (NACFE), found that many medium and heavy-duty trucks can be electrified and continue to perform similarly to internal combustion engine (ICE) trucks.[89] Using operational data from California and New York, 65 percent of medium-duty trucks and 49 percent heavy-duty trucks in those regions are considered electrifiable today.

The study also found that electric trucks offer significant greenhouse gas emissions reductions per mile compared with diesel vehicles. Given utility demand charges and high infrastructure costs, fleets will be encouraged to recharge at lower power levels over longer periods of time. Charging at lower power levels outside of peak grid demand times is the best strategy for minimizing both capital and operational expenses related to charging.

One benefit of an automated truck is that it can operate nearly non-stop, but an extended operating day of 20 hours or more leaves no opportunity for recharging an EV truck over longer periods of time as suggested by the NACFE study. This does not mean the linehaul tractors cannot be SAEVs. Carriers will evaluate the cost and benefits of investing in more tractors operating less hours per day that could be electrified versus those of investing in fewer ICE tractors operating more hours each day. Electrification will make more sense for the local pickup and delivery truck

[87] Gordon S. Bauer, Jeffery B. Greenblatt, and Brian F. Gerke, Environmental Science & Technology 2018 52 (8), 4920-4928 DOI: 10.1021/acs.est.7b04732
[88] Quarles N, Kockelman KM, Mohamed M. Costs and Benefits of Electrifying and Automating Bus Transit Fleets. Sustainability. 2020; 12(10):3977. https://doi.org/10.3390/su12103977Que
[89] https://nacfe.org/charting-the-course-for-early-truck-electrification

moves that will be human driven. Transfer hubs will also make ideal charging locations for BEVs, and the emission and noise reductions from BEV operations will benefit urban environments where they matter most.

Automotive vehicles are a durable good. Both passenger and commercial vehicles are being kept in operation longer than before. Fleet average ages are around 12 years old.[90] Fleet replacement strategies will dictate when both automation and electrification technology is adopted. The cost to retrofit a vehicle in the middle or latter stages of its useful life will preclude most retrofits. Only those with compelling business cases and short payback periods are likely to be considered. In addition, the operational cost, and the difficulties of managing the retrofit work make large-scale mid-life vehicle technology adoption unlikely.

Thus, many fleets will only adopt new technologies like ADS/CDS technology and electrification when they replenish their fleet. Since electrification technology is ahead, fleets will likely adopt electrification coupled with the latest proven SAE level of ADS/CDS technology available. Because ADS/CDS technology is supplied by some firms as an OEM-independent kit, mid-life adoption of these technologies is possible if perhaps unlikely.

Key Insights

While the framework used to discuss the emerging freight technologies separated them into distinct and separate groups, it is apparent that the technologies operate in a synergistic and symbiotic manner. Automation requires sensing, sensing requires connectivity, connectivity requires information sharing, electrification enhances automation, and so on. Understanding the component technologies that will drive future transportation systems and how they support and complement each other is vital. Focusing on one component will not provide the perspective or insight needed to plan, design, construct, maintain, and improve Georgia's emerging digital and physical transportation infrastructure. Last, the increasing importance of information in transportation systems means that data management must be part of GDOT's core competencies.

GDOT Opportunities

Georgia's already enhanced management of traffic operations across the state will help to support the vision for Georgia's Freight Plan. Current and future technology deployments will be essential to support Georgia's position as the global gateway of choice, providing reduced time to market, superior supply-chain efficiency, and reliability from destination to end customer. Efficient traffic operations will also be essential to the safe and efficient movement of goods throughout the freight network.

[90]The Association for the Work Truck Industry. "AGING TRUCKS CREATE MORE SERVICE OPPORTUNITIES." Edited by Dawn Brusseau, Aging Trucks Create More Service Opportunities, Nov. 2019, https://www.ntea.com/NTEA/NTEA/Member_benefits/Industry_leading_news/NTEANewsarticles/Aging_trucks_create_more_service_opportunities.aspx.

4.2.6. Population and Economic Growth

Population and Economic Growth are demographic dynamics underlying the freight system. They affect the demand for goods and labor, and they are affected in turn by the influence of the freight system on business attraction, business retention, cost of living and quality of life.

The size and concentration of demand impacts freight cost, while reliability, speed and safety are subject to the implications of demographic growth on infrastructure requirements and conditions. GDOT has a comprehensive interest in these dynamics.

Population

Georgia's population in 2021 was roughly 10.8 million, an increase of almost 74,000 residents, or about 0.7 percent, over 2020. Only four states (Texas, Florida, Arizona, and North Carolina) grew more than Georgia over the same period. Georgia is the nation's eighth most populous state, just behind Ohio's 11.8 million residents.[91]

The state's median age rose from 37.3 in 2020 to 37.5 in 2021. The fastest-growing age group in Georgia was the 65 and older population, increasing by 3.2 percent over the one-year period from 2020 to 2021.[92] The Census Bureau estimates that more than 20 percent of Georgia's population will be 60 or older by 2030, an increase of almost 34 percent from 2012.[93]

Metro Atlanta added 64,940 new residents in the past year, or 1.3 percent, pushing the region's 11-county population to 5.1 million (nearly 47 percent of the state's population). The concentration of population in the Metro Atlanta area can help businesses be more efficient by serving a larger customer base at lower cost, although it can also result in additional congestion which has implications for transportation system performance (in terms of reducing efficiency and safety) as well as environmental impacts.

The smaller metropolitan areas of Gainesville, Hinesville, Warner Robins, Savannah, and Athens each saw population increases of 1 percent or more over the same period. Albany's population decreased by 644 and Columbus's 1,605 people between 2020 and 2021. The Jefferson metro population increased by about 3,500 residents to reach 80,000 people by 2021.[94]

Population growth through 2050 will likely be concentrated in urban areas, emphasizing the need for urban-rural connectivity. Essentially all population growth will be in urban areas with ~39 percent[95] more Georgians by 2050, while rural Georgia maintains its current population levels. Population growth in urban communities will continue to increase freight flows and congestion

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[91] Dave Williams, "Georgia population growth outstrips most states," published December 21, 2021 by albanyherald.com. Accessed December 6, 2022 at https://www.albanyherald.com/news/georgia-population-growth-outstrips-most-states/article_0b566ef6-6284-11ec-a3ea-53af9a085859.html

[92] Rebecca Grapevine, "New Census Data Shows How Georgia Changed from 2020 to 2021," published July 1, 2022 by GPB.org. Accessed December 6, 2022 at https://www.gpb.org/news/2022/07/01/new-census-data-shows-how-georgia-changed-2020-2021

[93] Department of Human Services, "Demand for professionals in aging field increasing," published April 19, 2021 by dhs.georgia.gov. Accessed December 6, 2022 at https://dhs.georgia.gov/spotlight/2021-04-19/demand-professionals-aging-field-increasing

[94] Ibid.

[95] Source: Georgia Governor's Office Data Series 2020

along routes connecting Georgia's rural production with urban centers of consumption. Urban centers like Atlanta can drive growth across the state, but only with sufficient infrastructure connections to facilitate urban-rural symbiosis.

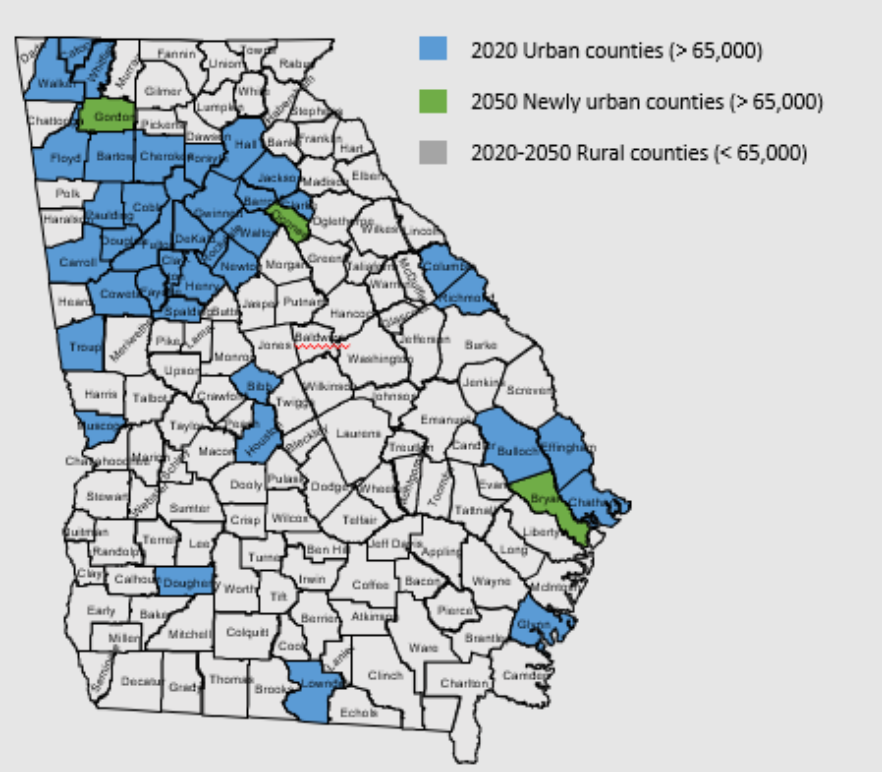
Table 106. Georgia's Population Growth Forecast, 2020 to 2050

Counties	2020 Population	2050 Population	2020-2050 Growth	CAGR
Urban	8,322,027	11,555,567	38.9%	1.1%
Rural	2,385,176	2,388,997	0.2%	0.01%
Total	**10,707,203**	**13,944,564**	**30.2%**	**0.88%**

Source: Georgia Governor's Office Data Series 2020

Georgia's population growth over the next 30 years is projected to be almost exclusively focused in the current 38 urban counties, with the addition 3 new urban counties by 2050.

Figure 127. Projected Change in Urban Counties from 2020-2050



Source: Georgia Governor's Office Data Series 2020

With a large, growing, and diverse population, Georgia offers a strong base of demand for a wide range of industries in addition to a robust and well-trained employment base for the businesses that are serving customers across the nation and world.

Economic Growth

Georgia is home to a diverse range of industries and this economic base has helped the state navigate the economic downturn associated with the COVID-19 pandemic. While other states experienced significant declines in GDP and employment, Georgia's GDP grew by nearly $51 billion. Some of the state's achievements over the past two years include:[96]

- Since 2018, over 1,400 manufacturers, logistics, and agricultural businesses have relocated to the state, with estimated creation of 137,000 new jobs and nearly $50 billion in investments
- Manufacturing employment is near a 20-year high at 289,000 workers, with output of nearly $60 billion in 2021
- Agricultural exports continue to increase on an annual basis, with agribusiness contributing an estimated $74 billion in economic impact each year
- Over 350 film and entertainment productions spent $4.4 billion in the state in FY2021
- Bioscience saw a 147 percent increase in job creation in FY2022 compared to FY2021 thanks to companies such as Boston Scientific and Boehringer Ingelheim
- FinTech projects created $32 million in investment and 1,215 new jobs in FY2022
- Record growth in port traffic, with a 24 percent increase in FY2020, 20 percent increase in FY2021, and an 18.5 percent increase in FY2023 to date

Additionally, the state continues to see a tremendous increase in foreign direct investment, totaling $8 billion in FY2022 with the top five sources of South Korea, Germany, Japan, France, and the Netherlands.[97] Georgia continues to be a leader in workforce development, education and training programs which have facilitated these investments from foreign companies.

4.2.7. E-commerce Scale and Penetration

This section describes the size and scope of the sea change in the retail market and the manner and speed by which goods reach consumers. E-commerce requires three times the warehouse space of traditional retail plus proximity of some facilities to consumers. Cost, speed, and reliability are KPIs substantially affected, as well as safety in neighborhoods. The expectations for level of service from GDOT can rise because freight delivery to homes is personal and visible, and greater coordination of service between GDOT and local agencies may be necessary.

[96] Chris Clark, "Georgia Is Making the Business Case," published November 3, 2022 by the Georgia Chamber. Accessed December 6, 2022 at https://www.gachamber.com/georgia-is-making-the-business-case/

[97] Andrew Isenhour, Carter Chapman and Marie Gordon, "Georgia Shatters Investment and Job Records in FY22," published August 10, 2022 by Georgia.org. Accessed December 6, 2022 at https://www.georgia.org/press-release/georgia-shatters-investment-and-job-records-fy22

Definition of E-commerce

E-commerce is broadly defined as any commercial transaction involving the internet. The U.S. Census Bureau defines e-commerce to include online manufacturing orders, services, and wholesale business conducted online. This discussion narrows the focus to goods bought and sold online, as in the case where a consumer makes a retail purchase using the internet.

E-commerce has similarities and differences to traditional retail. The primary differences involve how the product is ordered and delivered: for e-commerce, the transaction occurs over the internet and the product is delivered to the customer at their residence, business, a retail location, or another location of their choice; for traditional retail, the product is chosen, purchased, and taken by the customer at the retailer's location.

E-commerce companies use a variety of operational models. Some sell their own products directly, while others pass orders on to a supplier. E-commerce sellers may be "pure players" operating entirely online, or "brick and click" businesses that sell online while maintaining physical stores, where customers can also opt to pick up online orders.

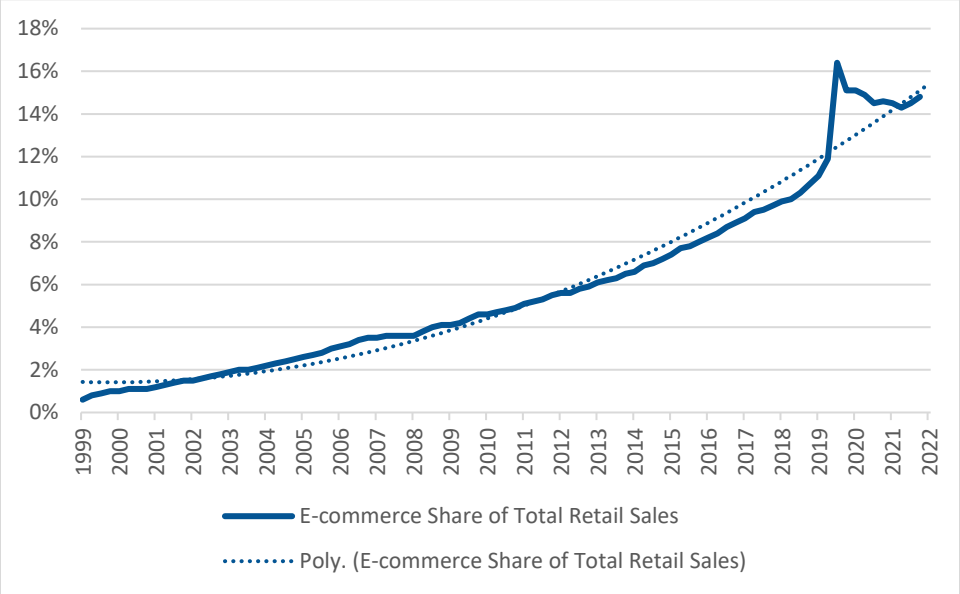
E-commerce has had a significant impact on the transportation sector. It has brought new retailers into the market while traditional retailers have expanded into providing online shopping options for their customers. These retailers have invested in additional warehousing capacity as well as new and additional transportation assets to meet the growing demand for their products.

E-commerce Share of Retail Sales

As shown in **Figure 128**, e-commerce's share of retail sales grew steadily and consistently from 2000 through the first quarter of 2020, then jumped dramatically during the COVID-19 pandemic, from 11.8 percent in the first quarter of 2020 to 16.1 percent in the second quarter, before reverting to trend at 14.3 percent (both seasonally and non-seasonally adjusted) in the second quarter of 2021.

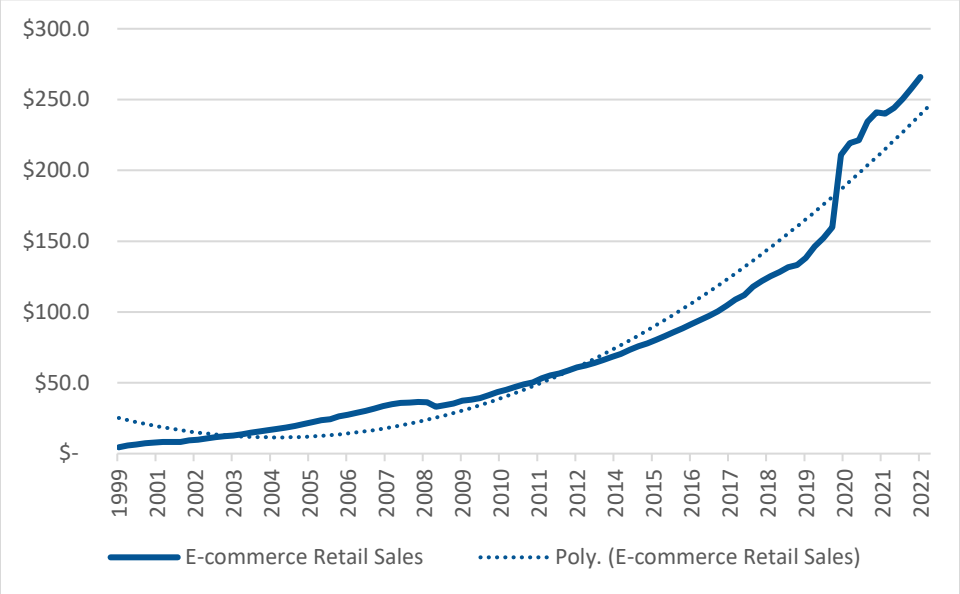
E-commerce share of retail sales has been following a polynomial trend line. In the middle of 2020, e-commerce sales surged because physical stores were closed. In the middle of 2022, as stores reopened, the e-commerce share of retail sales fell. But while e-commerce sales have continued to increase, e-commerce's share of total retail sales has declined because in-store retail sales grew faster than e-commerce sales did. The e-commerce share of retail sales has returned to the trend line.

Figure 128. E-commerce Share of Retail Sales



Source: U.S. Census Bureau, The Kemmsies Group

Figure 129. E-commerce Retail Sales (Billion Dollars)



Source: US Bureau of the Census, The Kemmsies Group

E-commerce share of retail sales is expected to reach 30 percent over the next 10 years. Beyond the early 2030's, the e-commerce share is expected to grow more slowly and could flatten out in the 35 percent to 40percent range. The exact level where it will flatten out depends on too many factors for a credible forecast to be produced.

Trends and Developments in E-commerce

One of the fastest growing segments within e-commerce is online grocery, which tends to be same day/next day delivery and involves perishables. As of Spring 2021, approximately 3 percent of all American groceries were purchased online, a market value of approximately 30 billion dollars. Online grocery shopping services typically offer several options for consumers including curbside pickup or at-home delivery.

The rise in direct-to-consumer (D2C) e-commerce is having significant repercussions for product distribution and delivery, with shipments increasingly going directly to individual residences replacing pick up at brick-and-mortar storefronts. Many retailers are using package delivery companies such as UPS, FedEx, and USPS to handle these deliveries, significantly altering the business model for such companies. Consumers are also purchasing larger items such as furniture and appliances via the internet. This trend is causing larger trucks to move into residential areas to complete these deliveries.

Selling merchandise via e-commerce also requires retailers to use more warehouse space because they are not storing their goods on store shelves or backrooms. Other factors impacting trip generation from e-commerce include returns of wrong-sized or otherwise unwanted merchandise purchased electronically; failed delivery attempts requiring multiple trips; and replacement of damaged, lost, or stolen items.

A similar shift is occurring in the B2B (business to business) space. Companies like Ali Baba are growing by bringing the same quality of delivery service to businesses, most of whom are still ordering from catalogs, that Amazon and other 3PL companies deliver to consumers.

E-commerce Impacts on and Implications for Freight

Retailer Supply Chain Expansion

Amazon is looking to grow its last mile delivery network through regional delivery service partners (essentially transportation franchisees) and its Amazon Lockers program. Walmart, the nation's largest retailer, is also using e-commerce to drive its revenue growth. Both retailers have their own fleet of trucks and are now allowing third party vendors to use their long haul and last mile delivery capacities. Different types and sizes of vehicles are being introduced in this market.

Last-Mile Delivery

North America's last mile delivery market generated revenue of more than $31 billion in 2018 and the market is expected to increase to $51 billion in 2022. The total transportation sector is 3 to 5 percent comprised of last mile delivery. This last mile transportation includes various delivery services which have become familiar sights. The effects are so widespread that they create a significant opportunity for businesses and authorities to have far-reaching influence through improved management of this flow of goods. However, according to a recent meta-analysis of

research on the traffic demand for personal shopping, evidence does not overwhelmingly suggest that online shopping will replace the traditional shopping trip.[98]

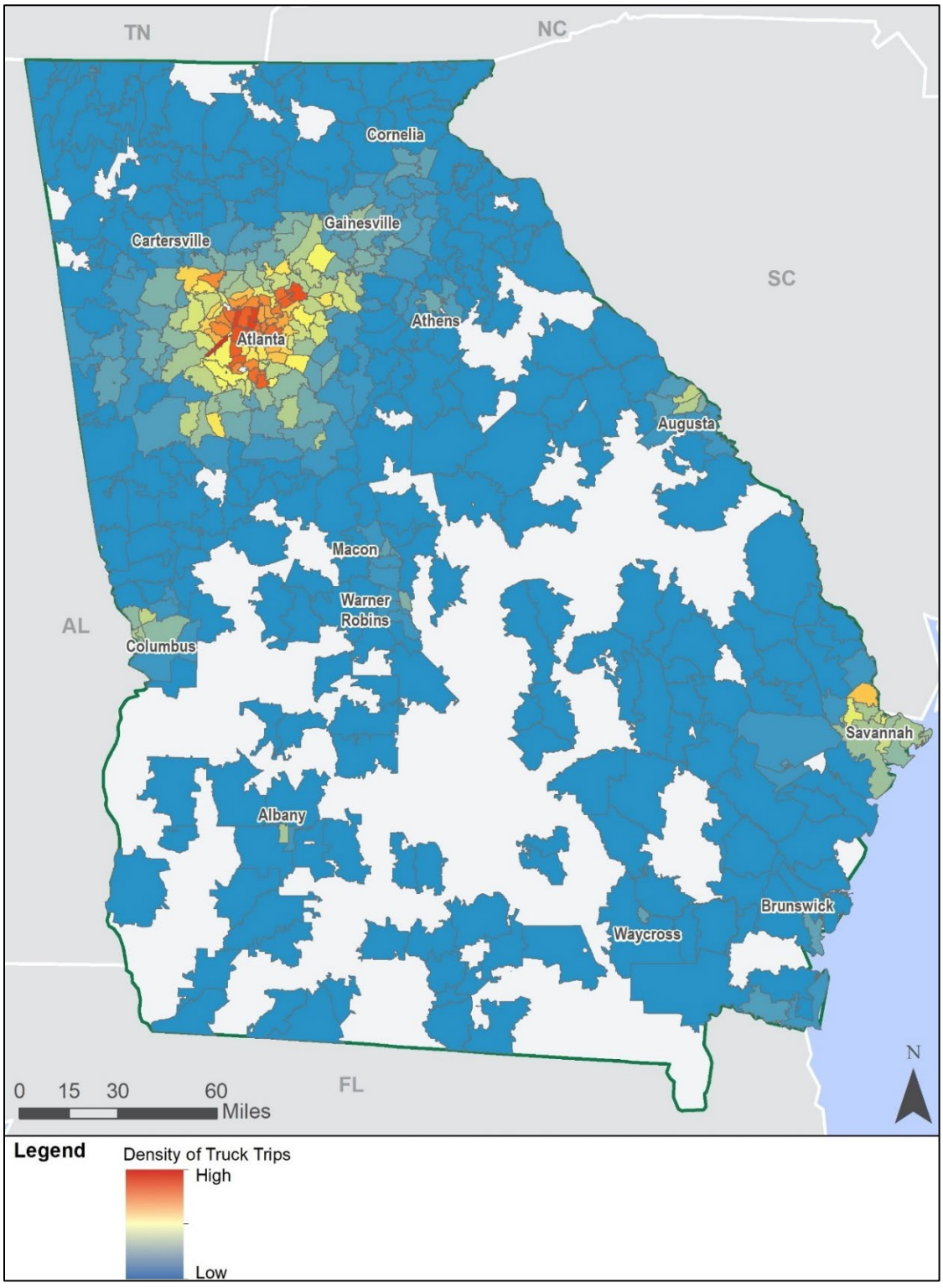
The fastest growing trucking segment is the delivery of goods purchased online. The COVID-19 pandemic accelerated the long-standing trend where Americans spend a growing share of income online. This has significant implications for the logistics system and trucking sector, as these goods must be delivered to people's homes, often within hours of purchase.

The Geotab data, which comes from 4 months in the second half of 2021, was used to better understand the geographic patterns of e-commerce related to trucking. **Figure 130** and **Figure 131** show the destinations of e-commerce related trucking, including courier trucks. These maps show the density of trucking activity per acre, to control for zip codes having a wide range of sizes. As expected, this trucking activity concentrates in urban areas, particularly those with high household incomes.[99]

Nevertheless, the outstanding feature of this map is the pervasiveness of e-commerce around the state, and while the gaps lie in rural areas, there is activity in rural Georgia as well. The absence of e-commerce traffic corresponds well with limitations in broadband service. The implication is that expansion of broadband coverage is likely to bring e-commerce into more parts of the state.

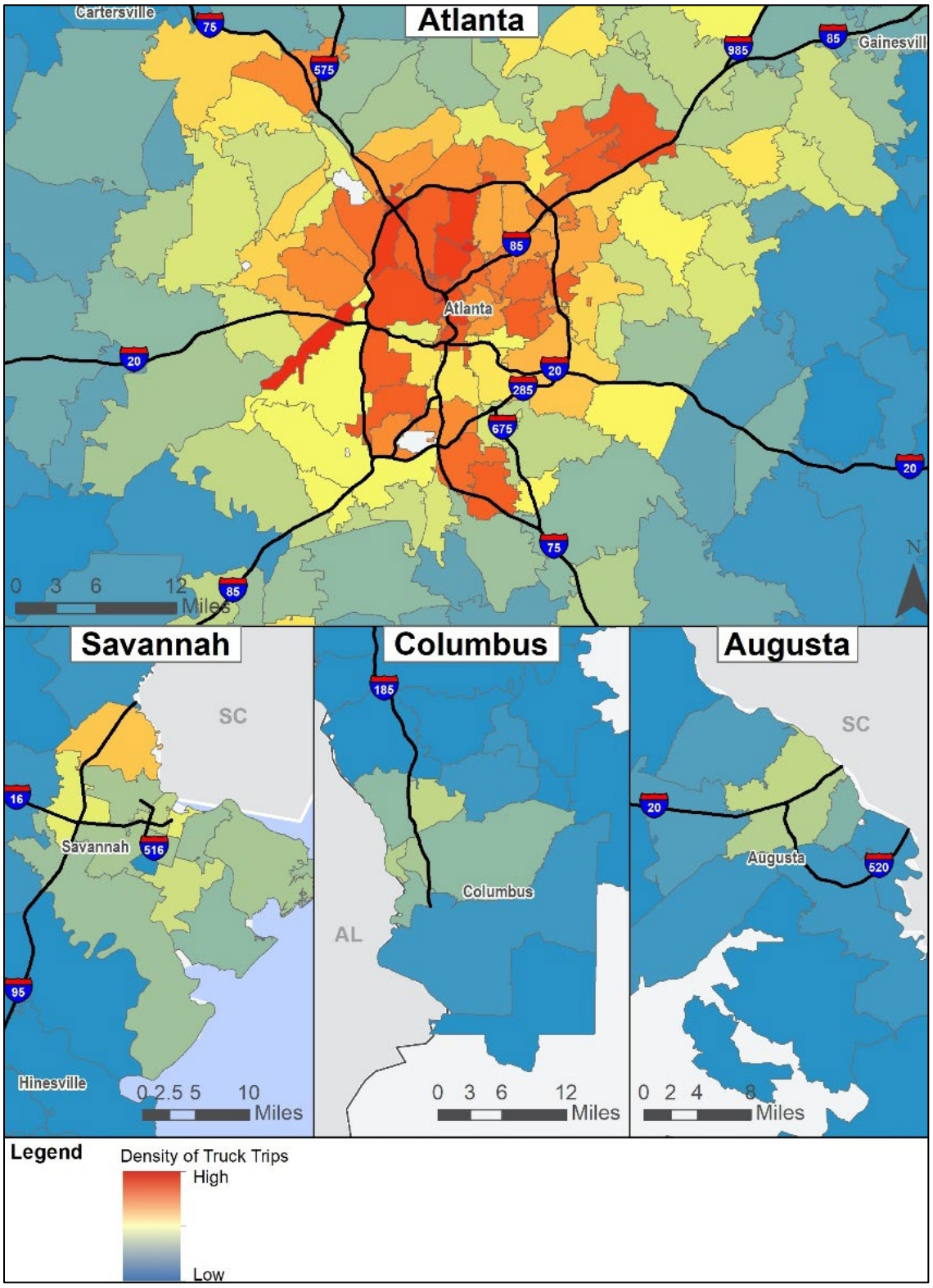
[98] Huyen T. K. Le, Andre L. Carrel & Harsh Shah (2022) Impacts of online shopping on travel demand: a systematic review, Transport Reviews, 42:3, 273-295, DOI: 10.1080/01441647.2021.1961917
[99] 2020 USPS Household Diary

Figure 130. Destinations of Courier and E-commerce related Truck Trips



Source: WSP Analysis of GeoTab Data

Figure 131. Destinations of Courier and E-commerce related Truck Trips in Metro areas



Source: WSP Analysis of Geotab data

Warehouse Expansion

CBRE, a leader in global commercial real estate, estimates that every additional $1 billion of e-commerce requires 1.25 million square feet of new distribution and warehouse space. If the e-commerce sales growth rate slows from growing to three times as fast as overall retail sales to two times as fast over the next 10 years to 2032, its share will increase from 14.3 percent to almost 25 percent. That implies that e-commerce sales will have increased by $437 billion. Given the CBRE estimates, an additional 546 million square feet of distribution and warehouse space will be needed nationally. Georgia is likely to be home to a significant amount of this growth.

E-commerce is steadily changing the Georgia freight distribution network, with a high demand for land for facility expansion. While e-commerce will continue to grow rapidly in the US, physical stores and warehouses remain critical in an omnichannel retail world. Physical retail stores are serving two purposes: as omnichannel storefronts and as warehousing capacity for online orders, given that only 12 percent of purchases across all categories are tied to purchases that are researched and purchased entirely online[100]. Movement away from brick-and-mortar-only retail experiences to omnichannel and online shopping has been spurred by changing consumer expectations and digitization of payments and shopping.

As a result, logistics providers have been moving closer to consumers and increasing the frequency of trips. Until 2019, e-commerce related warehouses under construction had been increasing in frequency but decreasing in size. However, the pandemic accelerated distribution center and warehousing infrastructure, leading to larger warehouse spaces: new warehouses under construction have increased in size by 45.2 percent after COVID[101].

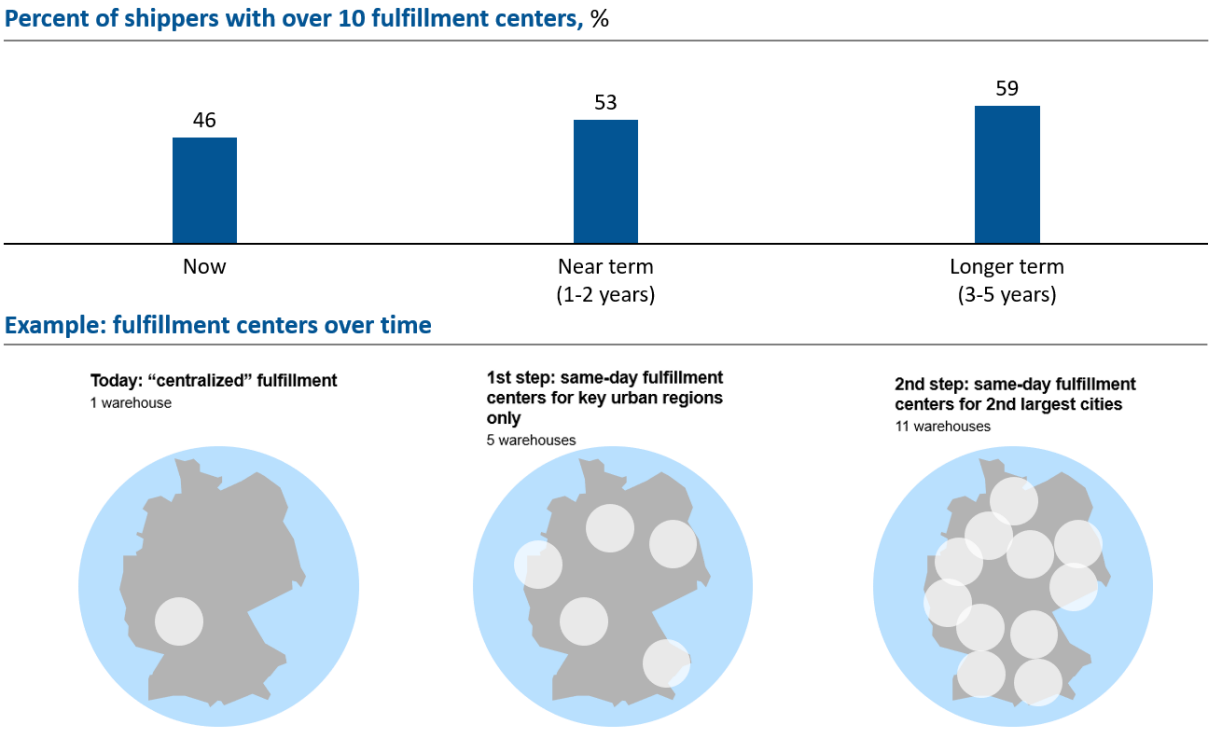
To add to this, reverse logistics is a large and important component of the e-commerce supply chain with unique challenges and complexities for e-tailers and supply chain partners. For example, reverse logistics requires on average up to 20 percent[102] more space. Hence, e-commerce requires 3 times[103] the warehouse space to move the same volume as traditional retail, resulting in additional warehouse and real-estate requirements.

Due to same day and next day delivery commitments, most of the logistics real estate needed is likely to be near population/consumption centers as opposed to traditional remote sites, which creates competition with passenger traffic flow. Local and regional trips increased from 56 percent to 69 percent of all trips, and the proportion of smaller shipments has grown by 5 percent[104], when comparing tonnage by shipment across the same segments. Logistics players are also increasingly

[100] McKinsey & Company COVID-19 US Consumer Pulse Survey; Forrester consumer spend data
[101] Source: Commodity Flow Survey, American Transportation Research Institute - An Analysis of the Operational Costs of Trucking, CoStar
[102] Source: Freight Waves
[103] Source: Department of Commerce; Prologis
[104] Source: Commodity Flow Survey, American Transportation Research Institute - An Analysis of the Operational Costs of Trucking, CoStar

investing in expansion of their fulfilment center networks: 95 percent of shippers expect to increase their number of fulfillment centers within the next 5 years[105].

Figure 132. Fulfillment Center Trends



Source: McKinsey Voice of Shipper Survey – PRELIMINARY – Based on results from 2,331 respondents that sell electronics products in US, Canada and Germany; CNBC

Returns

Returns are an essential component of e-commerce. Part of the industry's growth has been its ability to convince consumers that they could return products without penalty and for any reason within a specified time. This provided assurance to customers that ordering online was essentially the same as buying in stores. By some estimates, 15 percent to 30 percent of e-commerce orders are returned- which is a much higher return rate than for brick-and-mortar sales[106].

In recent years, much of the B2C industry's efforts have been to simplify the reverse logistics process. These efforts have resulted in a variety of options for customers who seek to return products, such as dropping off products at stores, post offices and UPS or FedEx locations, and even at third-party locations (such as a different retailer from where the purchase was made).

[105] Source: McKinsey Voice of Shipper Survey – PRELIMINARY – Based on results from 2,331 respondents that sell electronics products in US, Canada and Germany; CNBC
[106] Patrick Burnson: "Reverse Logistics Rides High on the Wave of E-Commerce." Published by Logistics Management on March 2, 2020. Accessed November 9, 2020 at https://www.logisticsmgmt.com/article/reverse_logistics_rides_high_on_the_wave_of_e_commerce

However, the process of returning an item to inventory is still complicated because there are several factors for the retailer to consider, including: the condition and nature (including size, weight and expected depreciation) of the product; seller's requirements (if the seller is different from the retailer); and location of purchase and delivery. Although technology such as Artificial Intelligence can help with routing decisions, human intervention is necessary at some point in the reverse logistics chain.

Consequently, several 3PLs have inserted themselves more prominently into the reverse logistics supply chain, offering to use up some of their capacity and manpower to handle the transportation and storage of returned products. Some have established facilities where goods are directly recycled and not returned to the vendor at all. Additionally, large online retailers have been acquiring more Class B warehouse space to prepare for the increased volume of both shipments and returns[107].

Sustainability

Every year, more than two billion tons of waste end up in landfills globally. The enormous volume of waste produced by the e-commerce supply-chain network and its impact on the environment, along with growing consumer interest in and demand for sustainable practices, has forced e-commerce companies to rethink their practices and find solutions.

One of these solutions is eco-friendly packaging. TOMS, for example, an internationally known retailer of footwear, apparel, and other consumer products, uses packaging made from 80 percent recycled waste material and printed with soy ink. Some of TOMS' shoes are made of natural hemp, organic cotton, and recycled polyester[108]. Such practices may not reduce the number of packages being delivered but they could reduce the volume of material being discarded or returned, thereby easing pressure on the reverse logistics supply chain.

Another solution is to consolidate products closer to the actual points of delivery. While this may result in additional trips (and emissions) between large distribution hubs and smaller urban delivery stations, the vehicles transporting products between delivery stations and delivery addresses may be more environmentally friendly than those transporting products between large delivery hubs and delivery addresses. In other words, this movement would theoretically generate fewer truck trips and more van, car, bicycle and even drone trips. These solution ideas are geared toward urban distribution. Deliveries in rural areas over longer distance still rely on traditional service types.

Advancements in transportation and energy also hold promise for the sustainability of e-commerce. In 2019, Amazon placed an order for 100,000 Rivian battery-electric vans to be delivered over the next few years (with the first 10,000 making deliveries by 2022). UPS and FedEx are considering electric battery as well as hydrogen fuel cell technology for their medium to long haul trucks[109]. Any

[107] Ibid.
[108] Byrd: "THE RISE OF SUSTAINABLE ECOMMERCE." Published by Byrd. Accessed November 9, 2020 at https://getbyrd.com/en/blog/rise-of-sustainable-ecommerce
[109] David Ferris: "How the pandemic is delivering the electric truck." Published by E&E News on September 25, 2020. Accessed November 9, 2020 at https://www.eenews.net/stories/1063714673

combination of these technologies will help reduce the emissions impacts associated with e-commerce package delivery.

Figure 133. Walmart Electric Delivery Van

Source: Freight Insights

Ocean shipping remains a major contributor to total e-commerce supply chain emissions; by some estimates, a single large containership can emit as much pollution as 50 million cars[110]. The International Maritime Organization, a United Nations agency, has set ambitious sulfur and Greenhouse Gas emissions targets for 2020 and 2050 for which shipping lines have begun adopting strategies to reach compliance.

4.2.8. Real-Time Optimization

Real-Time Optimization reflects the potential for logistics systems and operating plans – already optimized through software on a daily and longer-term basis – to optimize immediate, on-the-ground route choices, timing and functional sequences using real time information feeds about operating conditions. Cost, reliability, and speed are the KPIs that benefit. GDOT participates through its intelligent transportation systems, 5G broadband availability and coordination with local agencies providing technology services to the freight community.

The focus for the port is supply chain efficiency and optimization. Providing and analyzing data is important for real time information and reporting. Data from various sources allows the freight networks to get a clear picture of the transportation and port networks. These data-sharing

[110] The Guardian: "Health risks of shipping pollution have been 'underestimated." Published by The Guardian on April 9, 2009. Accessed November 9, 2020 at https://www.theguardian.com/environment/2009/apr/09/shipping-pollution

opportunities could produce applications that could track the cargo, the vehicle it's tied to, the route and the delivery time anywhere in the state. They may also provide automatic notifications about any delays and reroutes around the state. The combined data sources can produce real-time dashboards that aid in managing freight. These dashboards can be used by port terminal operators, railroads, truckers, and warehouse operators.

Supply chain managers and freight operators plan and create routes based on the best information available to them. This includes historical information, inputs from different sources, such as the information that GDOT provides to its stakeholders on planned projects and closures. The risk with such plans is that things may not go as expected on the road due to an unplanned event, closure, traffic incident, or other change of conditions.

Real-time data reduces risk by informing freight operators and supply chain managers as they adapt their daily operating plans to the immediate roadway conditions. Coordination of real-time data will support Georgia's Freight Plan objectives by identifying public-sector improvements for broadcasting real-time traffic and operational conditions, and enhancing the resilience of freight infrastructure – whether under routine conditions or during disruptions such as those from extreme weather events. The employment of technology and processes that allow information to be "pushed" out to users rather than requiring a "look up" process is desirable.

Traffic signal optimization improves the flow of traffic and safety through a corridor or network. Traffic signal optimization is also an important traffic engineering strategy for reducing congestion. It minimizes vehicular delays and stops, arrivals on red and bottlenecks. Traffic signal timing needs to conform to the operational and safety goals established by GDOT for each corridor, such as the priority of arterial through traffic progression over local side street traffic delays. Signal retiming projects typically include extensive traffic data collection, data processing, optimization of signal phasing, splits and cycle lengths and computer simulation to develop initial signal timings.

GDOT uses the University of Maryland's Regional Integrated Transportation Information System (RITIS) to identify system bottlenecks, speed, congestion, and travel times, both historically and in real-time. On the arterial network, GDOT uses Automated Traffic Signal Performance Measures (ATSPM) to review split failures, arrivals on green, or arrivals on red. ATSPM metrics, RITIS outputs and field observations are used to fine-tune and adjust signal timing for real world conditions and citizen complaints.

ATSPMs can be used to support other technologies and operational strategies, such as adaptive signal control and emerging connected vehicle applications. It can be used to adjust signal timing to address recurring traffic demands, along with non-recurring incidents, construction, weather conditions, equipment failures and other events. The increase of automation of operations will provide greater data reliability, accuracy, and the level of service on transportation facilities. ATSPMs allow for continuous performance monitoring of the system and proactive identification of problems.

Georgia has multiple deployment Vehicle-to-Everything (V2X) technologies across the state to support the development of connected vehicle environments and related applications to support transportation operations. These deployments include equipment installations on infrastructure such as Interstates, state highways, and intersections across the state.

Trucks and other vehicles have equipment installed in them to share information with the infrastructure. This can help to enable applications to improve safety and operations for all partners. The supporting data is the key when evaluating existing traffic conditions and determining the primary sources of traffic problems, such as high accident rates, recurring congestion, and driveway access/egress for connected or autonomous vehicles. Messages from infrastructure can be used to confirm the position and orientation of the roadway geometry for connected vehicles.

GDOT and the truck/automobile original equipment manufacturers (OEMs) are also exploring ways to leverage emerging vehicle-based telematics-focused data platforms such as Wego and Sibros. Additionally, third party data providers such as Waze, INRIX and Streetlight are expected to continue to be a reliable source of real-time and historical data sets.

Data exchanges between partners are essential to enable operational solutions such as Freight signal priority (FSP), Transit Signal Priority (TSP), Emergency Vehicle Preemption (EVP), work zones, special events and signal timing failures. The MaxTime software and ATSPM are being used statewide. In addition to receiving the information, Georgia also shares data with the RITIS program, as well as with Waze and Streetlight.

GDOT's Road Weather Information System (RWIS) is another tool that provides real-time information to help freight operations. This system includes roadway sensors in 55 locations across the state that improve the ability to predict weather conditions on roads such as ice, temperature, precipitation, and wind. An expanded network of RWIS capabilities will include Georgia airports, and will feature real-time capability to view all surrounding states' weather conditions (AL, TN, NC, SC, North FL, and MS). Paired with the 511 Navigator system, this information can be used to see roadways that have been treated for ice/snow, monitor incidents, and obtain real-time roadway condition information.

Community Systems

Freight Community Systems are cooperative programs to establish a comprehensive foundation for real-time optimization in complex logistical environments with many interdependent players - seaports and airports being prominent examples. They make use of shared software platforms and exchange vital information (such as equipment location and condition) so that all participants have visibility into the factors that affect their decisions. This information may be in private hands, and the challenge is to bring participants to share proprietary data for the common benefit. Community systems exist at Georgia ports and HJAIA, yet the systems are voluntary and lack of participation limits their effectiveness. Following the supply chain breakdowns of 2021, the federal government initiated the Freight Logistics Optimization Works (FLOW) program[111] in 2022 to bring attention to the issue and push for participation from many players across the logistics ecosystem. FLOW is established as a private initiative with public backing, including engagement of the Bureau of Transportation Statistics because of its ability to serve as a confidential steward of data with statutory protections. The program is being designed, negotiated and piloted at a small number of

111 https://www.transportation.gov/briefing-room/dot-supply-chain-companies-collaborate-speed-movement-goods-cut-costs-consumers

seaports to begin with – among them the Port of Savannah – but its ambition is to expand to other multimodal environments, including airports, inland ports and distribution hubs. KPI benefits are in cost, reliability, speed and risk, and with Georgia and Georgia companies involved from the outset, the lessons from the pilot and the opportunities from the program will be known in the state as they evolve. Community systems thus promise to be one way that real time optimization can be promulgated at key locations in Georgia, adding to the state's competitive advantage.

Smart Work Zones

Work zones cause negative roadway conditions for emergency responders, motor carriers, traveling motorists and construction workers.[112] In work zones, bottlenecks and congestion may occur due to lane closures. Studies have shown increased accidents in work zones, which include rear-end collisions and fatal incidents. Work zones also add additional risk for construction workers and motorists as lane volumes increase due to closure. Data-sharing helps with safety and decreases driver frustration by providing real-time information.

Smart work zones utilize real-time information to provide accurate travel time for freight and the traveling public and enable optimal operating plans. The smart work zone could be a part of high-tech infrastructure for connected vehicles. Information can be provided from the Transportation Management Center (TMC), probe data and data warehouse services, and can be a part of high-tech infrastructure for connected vehicles. Safety is GDOT's number one goal and smart work zones increase safety for truck drivers, motorists and construction workers.

Work Zone Data Exchange

Work zone delays can significantly impact travel times and route of truck traffic. These work zones and other roadway closures are often planned weeks, if not months, in advance. High level information is sometimes shared with the public and other partners, but real-time information on openings, closures, and detour/alternate routes is a common challenge for carriers.

To address this challenge, GDOT is working with USDOT and other partners to make reliable and consistent real-time work zone information available for freight and other uses via the Work Zone Data Exchange (WZDx) Specification (https://www.transportation.gov/av/data/wzdx). The objective of the project is to make travel on public roads safer and more efficient through access to data on work zone activity, which can significantly enhance freight operations, both in terms of route planning and real-time decisions. The information made available in the specifications is intended to be embedded in Advanced Drive Assistance Systems (ADAS).

In 2020, USDOT put out a call for demonstration projects with the goal of using these projects to advance the WZDx specification at multiple sites across the U.S. GDOT was awarded one of the WZDx demonstration grants in early 2021. The project will extend the existing lane closure system to include new data capture and exchange capabilities to produce WZDx feeds, which is intended to be used by third party providers, such as freight dispatch units and related applications.

[112] https://ops.fhwa.dot.gov/wz/workshops/accessible/pant_paper.htm

The top causes for fatal work zone crashes are often associated with distraction, driving too fast for conditions and driver impairment. GDOT is also using technology to improve work zones and address these issues in other ways. Work zone safety is important to the freight plan to maintain truck safety as they travel through work zones and top reduce delays due to incidents within work zones.

Freight Priority

The implementation of an additional freight signal priority (FSP) for heavy commercial vehicles allows the vehicles to extend the green light's timing to make it through an intersection without stopping. This will increase safety by allowing intersections to clear and reducing the incentive for trucks to run red lights. The technology could also reduce truck delays and congestion at major freight centers such as ports. With broadband connection and connected commercial vehicles, the trucks can be remotely monitored and progress followed in real time.

The FSP system will help reduce congestion by giving freight vehicles longer green time. It takes trucks more time to startup after stopping at traffic signals which contributes to longer queues and traffic delays. Keeping the trucks moving reduces delay and improves. The system will help with travel time reliability for trucks. The implementation of the system should increase travel time reliability by 10 to 15 percent. GDOT is currently using FSP for railroad crossings near the port, where trains sit on the tracks. The system gives the truck priority at the traffic signals on an alternate route around the track. Priority treatment for freight will incentivize operators to use specific routes.

4.2.9. Electrification and Decarbonization

Electrification and Decarbonization relate to efforts by supply chains to reduce their carbon footprint, and the potential for lower net costs of ownership for freight vehicles not using internal combustion engines. Cost and risks to cost are the principal KPIs affected, with air quality and the availability and capacity of charging networks among GDOT's concerns.

Alternative Fuel Vehicles

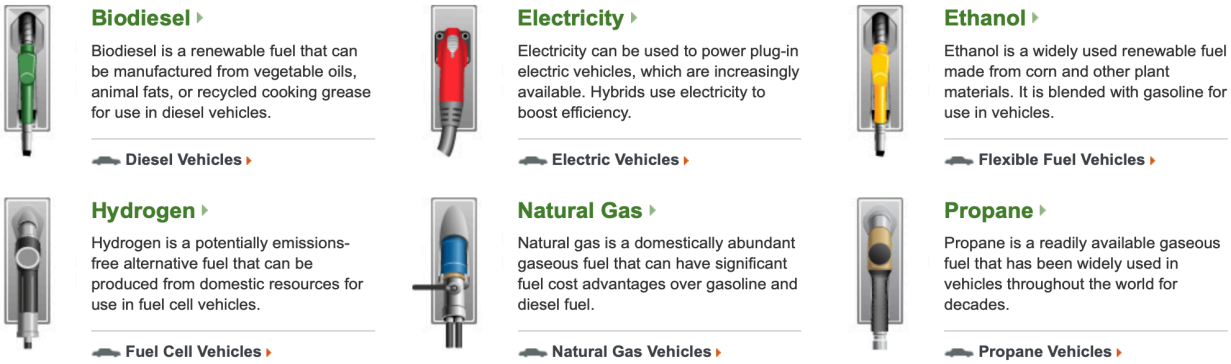
Most transportation requires an onboard energy source, making petroleum products (gasoline and diesel fuel) ideal fuel to power transportation vehicles. Petroleum is portable and energy dense. It is no surprise then that the U.S. Energy Information Administration (EIA) reports that petroleum is the main source of energy for transportation. In 2021, petroleum products accounted for about 90 percent of the total U.S. transportation sector energy use[113].

But current social, financial, and environmental concerns are shifting transportation energy fuel choices away from gasoline and diesel to alternative fuels. Recent legislation like the CHIPS and Science Act[114] and the Infrastructure Investment and Jobs Act[115] put the United States on a path to

[113] U.S. EIA, "Use of Energy Explained," published June 17, 2022 by U.S. Energy Information Administration. Accessed https://www.eia.gov/energyexplained/use-of-energy/transportation.php
[114] https://science.house.gov/chipsandscienceact
[115] https://www.congress.gov/bill/117th-congress/house-bill/3684

a decarbonized economy. Transportation will be transformed in the coming years as fossil fuel use wanes and alternative energy choices emerge. The U.S. Department of Energy identifies the following six categories of alternative transportation fuels making up the remaining 10 percent of transportation energy sources in 2021:

Figure 134. Categories of Alternative Transportation Fuels



Source: U.S Energy Information Administration - https://afdc.energy.gov/fuels/

Biofuels represented about 6 percent of 2021's transportation fuel. Natural gas accounted for about 4 percent, most of which was used in natural gas pipeline compressors. Electricity use by mass transit systems provided less than 1 percent of total transportation sector energy use. Natural gas, both compressed natural gas (CNG) and liquefied natural gas (LNG), are being used by carriers as diesel alternatives today. Renewable fuels like ethanol and biodiesel have limited use and are mostly blended with gasoline or diesel fuel. While each alternative fuel source listed above has a unique set of benefits and drawbacks, electricity is emerging as the most likely dominant transportation energy source.

Electric vehicles are expected to make a significant impact on the trucking industry. Electrification applies to all vehicle types, including light duty vehicles, shuttles and utility carts, delivery trucks and vans, material handling, ground service equipment and terminal tractor, refrigerated trucking, airport and seaports, and delivery trucks and vans. Today, electric vehicle (EV) technology is in the field-testing stage of development and is anticipated to move into adoption within the next five years. Long-standing barriers to widespread adoption are beginning to fall as the market expands and grows.

EVs appeal to motor carriers for a variety of reasons: increasing customer focus on decarbonizing the supply chain, the potential lower total cost of ownership (TCO), and insulation from energy cost volatility. EVs are suited to drayage in port, rail-truck, barge-truck and air-truck operations, making them both an intermodal and energy technology.

Current research indicates the total cost of ownership favors electric vehicles (EVs) as compared to traditional internal combustion engine (ICEs) trucks no later than 2030 for local and regional length-of-haul operations while long-haul (500 mile and greater) operations become less expensive

by 2035[116]. The transition to electric vehicles will begin with light and medium duty fleets, then progress to the class 8 heavy duty local (< 75-mile) and regional (< 300-mile) markets.

Battery electric vehicles (BEVs) will dominate the local and regional hauls. Fuel cell electric vehicles (FCEVs) will likely find a place in the long-haul market. Like BEVs, fuel cell electric vehicles (FCEVs) use electricity to power an electric motor. In contrast, rather than drawing electricity from only a battery, FCEVs produce electricity using an onboard fuel cell powered by hydrogen. In the EV market, hydrogen-fueled electric trucks are three to five years behind battery powered trucks (or more specifically, tractors, which is the industry term for the power unit where the driver sits in a combination vehicle pulling a semi-trailer).

The EV vs. ICE TCO tipping point is dependent upon several key items. Government policies supporting EV adoption is one. Regions with such incentives reach parity sooner than those without them. The price of diesel fuel is also a major factor in the TCO calculation. Independent of energy commodity prices, the lower maintenance and repair costs of the EV powertrain is another cost advantage favoring adoption of EVs in freight transportation.

Key to widespread adoption, the EV battery supply chain must expand relatively rapidly. New raw material sources can take up to ten years to develop. While long, this development cycle is within the predicted 2035 timeframe. Transitionary fuels and drivetrains are expected to coexist during the next ten years before BEVs and FCEVs reach TCO parity at scale. These transition or bridge fuel and drivetrain technologies will likely include liquefied/compressed renewable natural gas (renewable LNG/CNG) and biodiesel trucks.[117]

A meta-analysis[118] of EV TCO studies completed by UC-Davis's National Center for Sustainable Transportation in June 2022 states that "while there is a wide range in estimates across studies for specific types of trucks in specific years, all the studies expect the total cost of ownership for battery-electric trucks to reach cost parity with diesel trucks between 2025 and 2035."

Growing EV fleets will require additional electric power distribution infrastructure development and standardization. Charging stations will become the new truck stops, and these new truck stops will become significant electric power consumers. Close coordination with electric utilities is required to determine "behind the meter" updates needed based on estimates of how much electric capacity is required to meet fleet power demand. Electric utilities will need to supply reliable electric power to this new charging infrastructure, and electric grid modifications will be required in many areas. Connected, intelligent charging management services can enable vehicle electrification without negatively impacting the grid while also possibly providing additional benefits like using vehicle

[116] For example, see "Comprehensive Total Cost of Ownership Quantification for Vehicles with Different Size Classes and Powertrains" published by Argonne National Laboratory in April 2021. Available at https://publications.anl.gov/anlpubs/2021/05/167399.pdf

[117] MPP, "Making Zero-Emissions Trucking Possible," published July 2022 by Mission Possible Partnership. Accessed December 5, 2022 at https://missionpossiblepartnership.org/wp-content/uploads/2022/11/Making-Zero-Emissions-Trucking-Possible.pdf

[118] Guihua Wang, Lewis Fulton and Marshall Miller, "The Current and Future Performance and Costs of Battery Electric Trucks: Review of Key Studies and A Detailed Comparison of Their Cost Modeling Scope and Coverage," published 2022 by UC Davis NCST. Accessed December 5, 2022 at https://escholarship.org/uc/item/8zj9462h

batteries as off-peak power storage sinks. Utilities like Georgia Power are actively seeking to understand and serve the electric vehicle fleets of the future.

A white paper released in November 2022 – Electric Highways: Accelerating and Optimizing Fast-Charging Deployment for Carbon-Free Transportation- analyzed the impact of highway fast-charging site installations. The study revealed six primary insights to help policy makers, transportation planners, utilities, and charging site operators meet the coming power needs of BEVs[119]:

1. A typical highway charging site will eventually have 20+ fast chargers to meet drivers' needs. Peak power demand at some sites requires charging capacity comparable to that of major power users like large commercial or industrial sites. Delivering this amount of power to a site requires long lead time investments in utility infrastructure.
2. Electric light-duty vehicles (LDVs) will drive load increases in the near term, but medium/heavy duty vehicle (MHDV) electrification will magnify charging needs over the long term. By 2045, over 75 percent of average daily energy need across all sites is expected to come from MHDVs.
3. The need for power at fast-charging highway sites exceeds the distribution system's typical limits. Fortunately, there is overlap between highway rights-of-way and those of the high-voltage transmission system. This coincidence provides an opportunity to facilitate the interconnections required.
4. Proximity to transmission lines should be considered in tandem with expected charger utilization during site selection. Charging developers site charging stations based on factors like traffic, expected utilization, and land availability. Access to electric infrastructure should play an equally critical role. By keeping both in mind, charging sites can be placed in areas that make sense for both EV operations and for the power grid.
5. Build scalable grid infrastructure. For many sites, a transmission interconnection will likely be needed in the next decade to serve LDVs alone. Once a new electric infrastructure upgrade is required, it should be scalable and suitable for long-term needs.
6. Begin preparing now. While charger installation can be completed in a matter of months, larger transmission interconnections and upgrades can take as long as 8 years to complete.

Transportation electrification will require successful collaboration. Addressing the challenges for the local grid infrastructure and vehicle-connected charging accessibility will involve building new work relationships between parties unused to coordinating with each other.

For FCEVs, the deployment of hydrogen production and distribution is a barrier. Hydrogen must be produced and then distributed to the fueling station. In this sense, hydrogen fueling is very similar to diesel fueling. The major difference is there is no developed infrastructure for hydrogen fuel comparable to today's gasoline and diesel fueling networks. Companies like Nikola are working to

[119] Middlebrooks, George. "Electric Highways: Accelerating and Optimizing Fast-Charging Deployment for Carbon-Free Transportation." Published November 11 2022 by CALSTART. Accessed December 5, 2022 at https://calstart.org/electric-highways-study/.

develop a hydrogen fuel network for FCEVs. Dense freight corridors will see the initial build-out of hydrogen fueling stations served by mobile "tank to truck" fueling sites.

The expansion of EVs will hasten the need for an alternative system to fund roadway maintenance and improvements. As gasoline and diesel fuel use declines per vehicle mile travelled (VMT), gasoline and diesel fuel tax revenue will decline. Collectively, governments will need to identify new methods to assess and collect taxes for transportation infrastructure support. Long a subject of concern[120], reforming the transportation finance system will become more critical as electricity replaces diesel and gasoline as a fuel source for on-road vehicles.

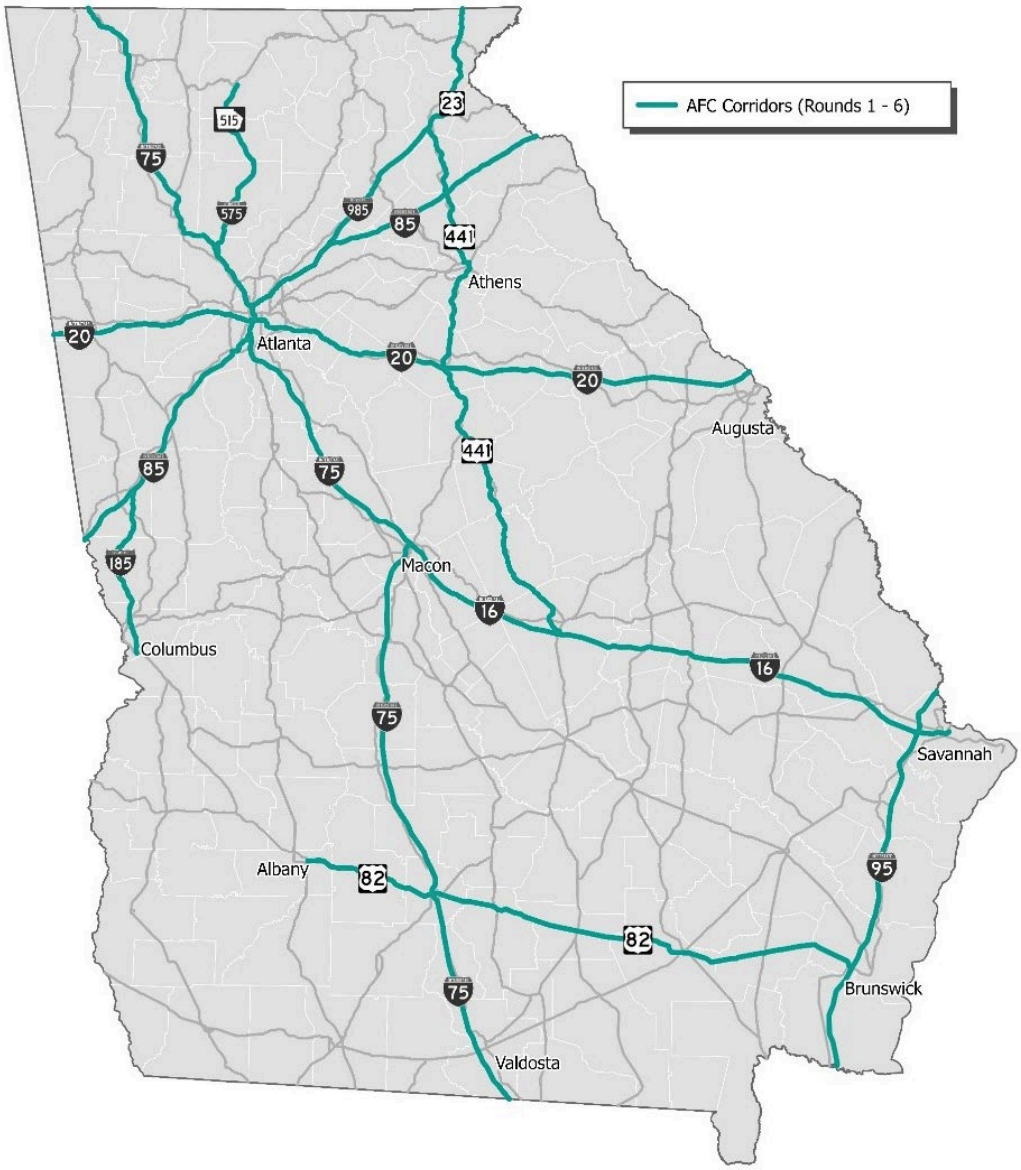
Electric Vehicle Infrastructure

The National Electric Vehicle Infrastructure (NEVI) Formula Program is a $5 billion program established by the Bipartisan Infrastructure Law (BIL) to build a national network of 500,000 electric vehicle (EV) charging stations by 2030 along federally designated Alternative Fuel Corridors (AFC). NEVI will provide funding to states over the next five years to strategically deploy Electric Vehicle Supply Equipment (EVSE) charging station infrastructure and increase access to charging stations for Americans to travel nationwide in EVs. Each state DOT is required to submit a deployment plan to the Federal Highway Administration (FHWA).

Georgia's plan was approved by the FHWA in September 2022. Initial NEVI fund deployment will occur along Georgia's Alternative Fuel Corridors (AFCs) along I-75, I-20, I-85, I-16, US 82, US-441, I-95, I-985/US 23, I-575/GA 515, and I-185. Over the coming years, the NEVI funds must be invested in DC fast charging stations that are compliant with federal guidelines. Among the primary requirements, each station must have at least four ports that can simultaneously charge at 150 kilowatts, be located along every 50 miles of the AFC, less than one mile off the exit, and be accessible to the public 24 hours a day.

[120] Transportation Research Board, "The Fuel Tax and Alternatives for Transportation Funding," published 2006 by TRB. Accessed December 5, 2022 at https://trb.org/publications/sr/sr285.pdf

Figure 135. Alternative Fuel Corridors for EV Charging Stations



The map shows Alternative Fuel Corridors (AFC) where NEVI-funded EV charging stations are required to be installed.

Source: Georgia EV Infrastructure Deployment Plan

4.2.10. Remote Working and Urban/Rural Location

Remote working and household relocations from urban to rural locations arose through the national experiment in working from home during the pandemic. Freed from needing to live in proximity to their workplace, many workers took the opportunity to relocate to a new area completely, often moving from urban areas to higher-amenity areas in more rural areas. This is a societal change with a scope and permanence yet to be understood. Speed, reliability, cost, and safety are KPIs subject to this trend, and there are consequences for the location of demand on GDOT's network and the traffic mix it supports.

According to a brief by the Center on Rural Innovation, if the rate of full-time remote workers settles at 12 percent, twice the pre-pandemic rate, it would mean an additional 9 million remote workers in the U.S. economy. When considering how to incorporate remote work into economic development strategies, the authors recommend an approach that addresses broadband, housing, workforce development, and quality of life.[121] What is not cited as a development factor is transportation. Remote work from more rural or suburban locations is not dependent upon transportation infrastructure. Rather, its impacts on transportation infrastructure may be indirect impacts like urban commuting demand and e-commerce freight activity in outlying areas.

The Minnesota DOT worked with researchers in 2022 to study remote work.[122] The research found that geographic area, life circumstances, and demographic characteristics all made differences in remote work activity. Rural workers were more likely to be back in the office compared to urban workers. Surprisingly, workers without children work remotely more than those with children and older workers work remotely more than younger ones. The study also found that higher education level and higher income workers had more remote work opportunity than less educated and lower wage earners. Racial differences also exist, with white workers having more remote work opportunity than others.

Regarding relocation, only 12 percent of those surveyed said they were highly likely to relocate. Another 15 percent said they were somewhat likely to do so. As intent is not action, an even smaller portion of those able to work remotely are likely to relocate. When asked about relocation destinations, only 14 percent of those likely to relocate would choose a rural Minnesota location. Another 22 percent of them would leave the state entirely. Most would move within the Twin Cities and their suburbs. While it is difficult to say these results would be similar in Georgia, both states have one large metro area and several smaller cities surrounded by large rural regions. It should be noted that some jobs are not open to remote working, especially those in the freight industry such as truck driving and warehouse operations. This leaves the workers in these jobs with few options to experience the benefits of working from home, although some workers may opt to move closer to their place of employment to reduce their commute times. If the trend towards remote

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[121] Mark Rembert, Adenola Osinubi, and Dani Douglas, "The Rise of Remote Work in Rural America," published October 2021 by EDA. Accessed December 6, 2022 at https://ruralinnovation.us/wp-content/uploads/2022/01/Remote-Work_122721.pdf

[122] Minnesota Local Road Research Board, "TELECOMMUTING DURING COVID-19: HOW DOES IT SHAPE THE FUTURE WORKPLACE AND WORKFORCE?", published May 6, 2022. Accessed December 6, 2022 at https://researchprojects.dot.state.mn.us/projectpages/pages/lrrbProjectDetails.jsf?id=24821&type=CONTRACT&jftfdi=&jffi=lrrbProjectDetails%3Fid%3D24821%26type%3DCONTRACT

work continues, it could result in fewer applicants for in-person jobs and a decline workforce available to supply chains.

4.3. Freight Mobility Strategies

This section describes strategies to address the performance of the freight network in the state. These strategies were developed based on the current conditions and anticipated changes as a result of anticipated growth and logistics trends. This section looks at strategies generally by mode and also in relation to workforce and freight generators.

4.3.1. Highway Strategies

Georgia's highway network is a strength for the state and as such attracts heavy freight traffic which results in area bottlenecks, desire for truck parking options and information, potential for commercial vehicle lanes, and overall network improvements for freight mobility.

Bottleneck Relief

As described in Section 4.1.1, the top 20 bottleneck clusters were identified for Urban Atlanta, Urban Other, and Rural portions of Georgia.

Roadway congestion is a major source of unreliability and costs in modern supply chains. For example, the food and agriculture supply chain sees $4.0 million per day in statewide congestion costs, $700,000 of which are directly caused by bottlenecks. Daily statewide congestion costs reach over $15 million per day, over $3 million of which are due to bottleneck locations.[123] In May 2022, FHWA published *Addressing Truck Emissions and Noise at Truck Freight Bottlenecks Final Report*, that documents the issues with idling trucks in congested conditions and potential mitigation strategies to address these issues. Congested conditions, particularly at bottlenecks, cause lower speeds and stop and go conditions that have higher emissions per mile than at cruise speeds.[124]

There are often several potential causes of a bottleneck, such as the proximity of a truck terminal to an interchange of two Interstates. Although these factors often interact, the following provides examples of bottleneck causes independently of one another and provides mitigation strategies that can be combined depending on the combination of bottleneck causes at a particular location.

Bottlenecks in Urban Atlanta-Region

The top 20 bottlenecks in the Atlanta region represent 105 centerline miles of roadway and generate $3.5 million in daily user costs to trucks and shippers. Supply chains most impacted by these top 20 urban Atlanta bottlenecks include food and agriculture, construction, and distribution. All 20 bottleneck locations are projected to see at least 85 percent growth in truck traffic from 2019 to 2050.

[123] Congestion data and costs derived from NPMRDS and Transearch data as well as NCHRP Report 925
[124] FHWA-HEP-22-026, Addressing Truck Emissions and Noise at Truck Freight Bottlenecks Final Report, May 2022

The most common cause of bottlenecks in the Urban Atlanta region is congestion at interchanges due to merging and diverging. Locations where merge/diverge congestion causes bottlenecks are shown in **Table 107.** Other reasons for bottlenecks at interchanges include geometric conditions such as the loop ramp at I-20 and I-285 west.

Table 107. Atlanta Region Merge/Diverge Bottleneck Locations

Bottleneck Location	County	MPO
I-75 at I-675	Henry County	Atlanta Regional Commission
I-285 at SR 400	Fulton County	Atlanta Regional Commission
I-285 at I-20 East interchange	DeKalb County	Atlanta Regional Commission
I-75 at I-285 North interchange	Cobb County	Atlanta Regional Commission
I-85 at SR 316	Gwinnett County	Atlanta Regional Commission
I-285 at SR 78/Stone Mountain Freeway	DeKalb County	Atlanta Regional Commission
I-285 at SR 29/Lawrenceville Highway	DeKalb County	Atlanta Regional Commission
I-75 at I-85	Fulton County	Atlanta Regional Commission
I-75/85 at I-20	Fulton County	Atlanta Regional Commission
I-85 at I-285 North interchange	DeKalb County	Atlanta Regional Commission
I-285 at Buford Highway	DeKalb County	Atlanta Regional Commission

Through trucks are prohibited on I-75/I-85 inside I-285, therefore truck traffic traveling through Atlanta must bypass downtown. This restriction contributes to bottlenecks at system-to-system interchanges with other Interstates including, I-75, I-85 and I-20. As shown in the listed top 20 bottlenecks, the interchanges with I-285 do create regional bottlenecks.

Bottlenecks can also be caused by temporary conditions. Work zones create recurring congestion for periods of months or years. For example, the Transform 285/400[125] construction has been taking place since 2017 and contributes to congestion along the northern section of I-285. Frequent vehicle crashes can also contribute to recurring congestion, such as the high frequency of crash incidents at I-75/I-85 northbound from I-75/I-85 south split to John Lewis Freedom Parkway and at I-75 southbound from I-75/I-85 north split to Howell Mill Road. Event traffic can also contribute to bottlenecks, such as the recurring congestion at the I-75/I-285 north interchange, which abuts Atlanta's Major League Baseball stadium.

Clusters of truck terminals, freight distribution centers, and warehousing facilities create locations of concentrated demand for truck traffic, contributing to bottleneck formation and affecting non-freight traffic. Within the Atlanta region, this type of bottleneck occurs at I-20 eastbound from Fulton Industrial Boulevard to Thornton Road. Fulton Industrial Boulevard is the largest industrial corridor

[125] https://transform285400-gdot.hub.arcgis.com/

in the eastern United States, containing more than 50 million square feet of industrial space, and accounting for 33 percent of Fulton County's total industrial space.[126]

Some bottlenecks in the Urban Atlanta region are likely caused by the characteristics of the roadway. In some instances, lane drops force trucks and other vehicles to merge, such as on I-85 southbound from Beaver Ruin Road to SR 316 and on I-85 southbound at the I-75/I-85 south split. In other locations, horizontal curves create slower traffic patterns, like at I-75/I-85 northbound from I-75/I-85 south split to John Lewis Freedom Parkway and at I-75 southbound from I-75/I-85 north split to Howell Mill Road. In addition, short on- and off-ramps create vehicle queuing and congestion, like at I-75/I-85 northbound from I-75/I-85 south split to John Lewis Freedom Parkway.

Other Urban Bottlenecks

The top 20 bottlenecks in the other urban regions of the state represent 50 centerline miles of roadway and generate $600,000 in daily user costs to trucks and shippers. Supply chains most impacted by these top 20 urban bottlenecks include food and agriculture, construction, and lumber and paper manufacturing.

Merge/diverge congestion is a contributing factor to many of the other urban bottlenecks in Georgia. Locations where merge/diverge congestion contributes to bottlenecks are shown in **Table 108**.

Table 108. Other Urban Bottleneck Locations

Bottleneck Location	County	MPO
I-75 at SR 146	Catoosa County	Chattanooga-Hamilton County/North Georgia TPO
I-16 at I-95	Chatham County	Coastal Region MPO
I-85 at SR 53	Jackson County	Between ARC and MACORTS
SR 21 at I-95	Chatham County	Coastal Region MPO
SR 133 at US 82	Dougherty County	Dougherty Area Regional Transportation Study
I-24 at I-59	Dade County	Chattanooga-Hamilton County/North Georgia TPO
SR 369 at I-985	Hall County	Gainesville-Hall County MPO
SR 11 at I-985	Hall County	Gainesville-Hall County MPO

Other urban bottlenecks also stem from short-term events such as work zones, like the I-16@ I-95 project[127] contributing to the I-16 bottleneck from Chatham Parkway to Pooler Parkway. Event traffic can also contribute to bottlenecks, like congestion at US 192 at I-16, likely caused by proximity to the Macon Coliseum.

[126] https://boulevardcid.org/portfolio/economic-development/
[127] https://majormobilityga.com/projects/i1695improvements/

Many of the other urban bottlenecks are caused by proximity to truck terminals, port facilities, and freight distribution centers. For example, many of the bottlenecks in and around Savannah, like I-95 northbound from SR 21 to the South Carolina state line, SR 21 from SR 307 to SR 30, and SR 21 from Jimmy Deloach Parkway to I-95, are major entry and exit points to the Port of Savannah, and the Georgia Port Authority. The bottleneck at US 80 from Bradley Park Drive to SR 219 is likely caused by a density of freight and distribution origins/destinations at Bradley Park Drive. Likewise, a density of truck terminals at I-85 at SR 53, I-95 at US 129, and I-85 at SR 82 likely contribute to the bottleneck on I-85 from SR 53 to SR 82.

Many bottlenecks in urban areas throughout Georgia are located on major access roads through a city center (such as SR 369 in Gainesville) or are the major entryway to a large trip generator (such as SR 383 at I-20 where SR 383 is the major access point to Fort Gordon).

Some Urban Other bottlenecks are likely caused by the characteristics of the roadway. The bottleneck at the SR 22 at US 129 intersection may be caused in part by the intersection's irregular alignment. Likewise, the bottleneck at I-95 northbound from SR 21 to the South Carolina state line may be due in part to a drop from three to two lanes at the I-95 bridge over the Savannah River. I-24 eastbound at I-59 may be due to horizontal curves as well as grade changes that make it difficult for trucks to accelerate quickly. Finally, narrow lanes and short on-ramps on I-75 from Battlefield Parkway to the Tennessee state line likely contribute to the bottleneck in that location.

Rural Bottlenecks

The top 20 rural bottlenecks represent 48 centerline miles of roadway and generate $300,000 in daily user costs to trucks and shippers. Supply chains most impacted by these top 20 rural bottlenecks include food and agriculture, construction, and lumber and paper manufacturing.

As is the case with urban bottlenecks, many rural bottlenecks are likely caused by merge/diverge congestion at interchanges. Examples of rural bottlenecks are shown in **Table 109**.

Table 109. Rural Bottleneck Locations

Bottleneck Location	County
SR 144 at I-95	Bryan County
US 17 at I-95	Camden County
US 129 at I-20	Morgan County
SR 53 at US 41	Gordon County
US 82 at I-75	Tift County
US 27 at US-84	Decatur County
US-129 at I-16	Bibbs County
US 441 at I-16	Laurens County

Also similar to urban bottlenecks are rural bottlenecks near work zones. These occur at SR 316 from SR 53 to SR 11 as part of the Transforming SR 316 project[128]. Truck terminals also contribute to rural bottlenecks, as with urban bottlenecks. Examples include freight origins/destinations adjacent to I-95 off SR144 that likely contribute to the bottleneck on SR 144 from I-95 to the Liberty County line, US 76 in Ellijay, and US 1 in Wrens.

Unique to rural bottlenecks are routes that serve as the primary route through a city's commercial district or the primary route running in a particular direction through the city. This is the case for US 441 in Milledgeville, US 280 in Cordele, SR 37 in Moultrie, US 1 in Baxley, US 76 in Ellijay, US 27 in Bainbridge, US 129 in Eatonton, US 441 in Dublin, and US 1 in Wrens.

Bottleneck Mitigation Strategies

Truck bottleneck mitigation strategies are dependent on the cause of the bottleneck. In many cases, GDOT has plans to or is already implementing strategies to lessen bottlenecks and their economic implications. The Major Mobility Investment Program is a key investment to provide additional capacity and operational improvements that target some of these key areas. These projects benefit freight mobility overall and the projects included in the program are shown in **Figure 136**.

As part of the MMIP, GDOT is implementing a managed travel lane solution in the Atlanta Urban area by way of the Express Lane project.[129] The tolled lanes, already in operation on I-75 North, I-575, I-85 North, and I-75 South, are optional priced lanes that run alongside Atlanta's major Interstates. Congestion-based pricing maintains free-flowing travel and aims to reduce bottlenecks on the mainline by allowing automobiles to opt for a less congested route. Although trucks are not permitted in Express Lanes, redistribution of vehicles to the paid lanes is more likely to reduce congestion in the general-purpose lanes, creating better travel conditions for freight vehicles.

[128] https://transformingsr316-gdot.hub.arcgis.com/
[129] http://www.dot.ga.gov/DS/GEL

Figure 136. Major Mobility Investment Program (MMIP) Projects

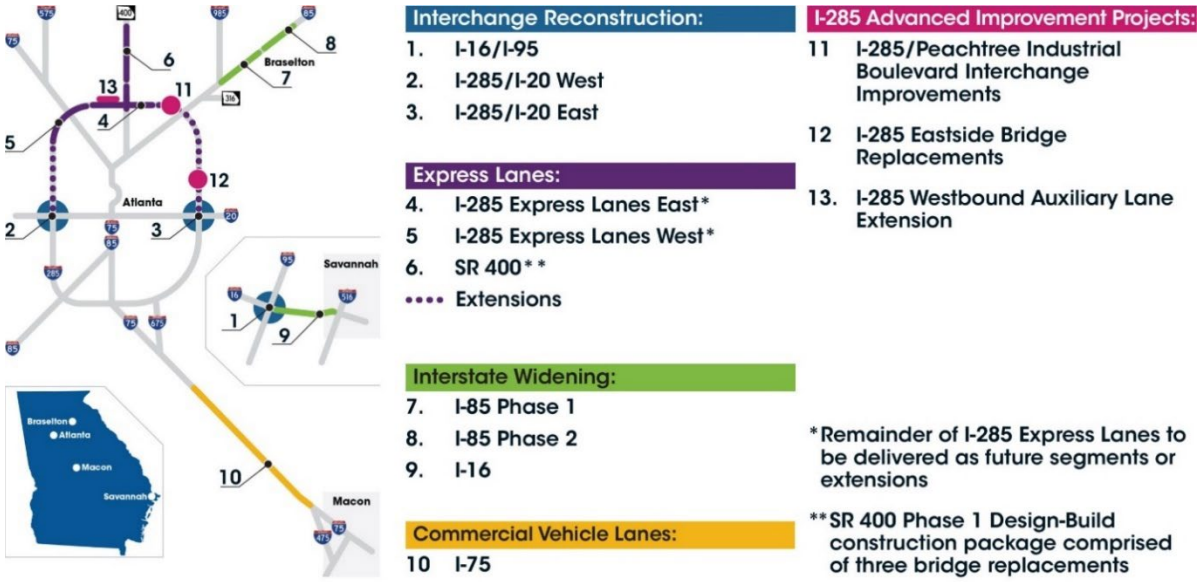


Image source: GDOT

Interchange Improvements

Solutions to bottlenecks that arise at major interchanges, such as where two Interstates meet, can encompass strategies such as roadway expansion, ramp metering, syncing arterial signals to moderate the flow of merging traffic, and managed travel lanes. Two major interchanges in the Atlanta region, I-285 at I-20 west and I-285 at I-20 east are included as system-to-system interchange improvements in the MMIP.

In other urban areas and some rural areas, it may be appropriate to create grade separations at highly congested intersections. The Transforming 316 project proposes several locations along SR 316 where signalized intersections would become unsignalized, grade separated facilities. One proposed location for this type of improvement is SR 316 at SR 11, identified as part of the fourth most severe rural bottleneck in Georgia.

Work Zones

There are several emerging technologies that can reduce congestion and bottlenecks that arise due to work zones.

These may include:

- Advanced closure notification
- Real-time, in-cab alerts to truck drivers prior to reaching the work zone so the truck driver can re-route
- Coordinated traffic control

Frequent Crashes

In highly travelled corridors where crashes are common, there are two types of strategies—those that prevent crashes, and those that clear out crashes so that normal traffic flow can resume.

Strategies to reduce crashes will vary based on the reason for the high crash rate:

- High crash rates due to weather may necessitate real time weather warnings for drivers
- If crashes are due to closely spaced exits and numerous travel lanes, increased signage may help drivers anticipate their movements earlier

GDOT has implemented Highway Emergency Response Operators (HERO) and the Coordinated Highway Assistance & Maintenance Program (CHAMP). HERO and CHAMP vehicles are dispatched after traffic-related incidents occur and clear roads to allow normal traffic flow to resume. HERO serves metro Atlanta and CHAMP serves Interstates outside of metro Atlanta except I-59 and I-24.

Figure 137. Statistics on HERO and CHAMP Services

	HERO	CHAMP
Monitored Routes	30	26
Active Operators	100	80
Miles of Patrol Routes	382	981
Total Assists Performed	88,747	164,529

Source: GDOT https://www.dot.ga.gov/GDOT/Pages/HERO.aspx; https://www.dot.ga.gov/GDOT/Pages/Champ.aspx

Single Access Route

Primarily in rural regions of Georgia, bottlenecks often form when there is only one arterial that runs through a major commercial district or through a city center. In these cases, the city may benefit from an access management study to assess driveway spacings and left-turn locations, median treatments, and intersection alignments. Signal timing assessments may also help the flow of traffic.

Narrow Lanes

In cases where bottlenecks arise because lanes are too narrow to handle existing levels of truck traffic, it may be beneficial to widen lanes or shoulders, create a truck bypass lane or passing lane for non-freight vehicles, or consider implementing redundant, parallel routes.

Commercial Vehicle Lanes

Commercial Vehicle Lanes (CVLs), also known as truck-only lanes, are designations and restrictions which require trucks to travel within specified lanes. The following subsections present an overview of the proposed CVL lanes within Georgia and their impact.

Georgia's I-75 CVL Project

The I-75 CVL project proposes to add two northbound-only commercial-vehicle (CV) only freeway lanes for all truck traffic along approximately 40 miles of I-75 between the I-475 interchange (near Macon) and the SR 155 interchange (near McDonough in Henry County). The project design will physically separate the proposed CVLs from the general-purpose (GP) lanes with a stated purpose to improve safety and travel time along the corridor.

GDOT is leading the development of the I-75 CVL with support of numerous key stakeholders and partners including, but not limited to, the Georgia Ports Authority, freight and logistics representatives, regional commissions, and support of the local governments along the corridor. The support is based upon the understanding of the growing truck volumes and increasing safety incidents between automobiles and commercial vehicles. Much of the support likely stems from the understanding of the rapidly growing freight traffic along the corridor, showing increases in traffic volumes upwards of 44 percent with truck percentages of 33 percent between the 2018 base year and the 2048 future horizon year. [130] The projected benefits of the I-75 CVL project to all Georgians is described below.

The I-75 CVL project will provide an array of benefits from operational, safety to economic to support the successful and growing freight and logistics industry throughout Georgia.

Expected Performance Benefits

The projected operational benefits for the I-75 CVL project show increased traffic capacity with reduced travel times over the no build alternative. The estimated time savings is 3.6[131] days per vehicle over the 20-year design life. The projected safety benefits are even greater showing over the 20-year design life, a reduction of 6 crashes per week, reduction of fatal and injury crashes of 750[132], and reduction of property damage crashes by 5,580[133].

The increase in reliability is directly related to the projected reduction in travel times and crash incidents along the 40-mile corridor, especially due to the separation of trucks in the CVL from the GP lanes. Two crash scenarios were evaluated (high and low) for both the CVL and GP lanes using Planning Time Index (PTI) as a metric:

The results indicate that for the high crash scenario under the no build scenario, travel times would be unreliable with a PTI between 1.30 and 1.43. However, under the build scenario, travel times

[130] I-75 Commercial Vehicle Lane Traffic Report. November 12, 2020.
[131] I-75 Commercial Vehicle Lane Traffic Report. November 12, 2020.
[132] I-75 Commercial Vehicle Lane Traffic Report. November 12, 2020.
[133] I-75 Commercial Vehicle Lane Traffic Report. November 12, 2020.

would be reliable with a PTI for the CVL between 1.03 and 1.05 and for the GP lanes between 1.16 and 1.24.

For the low crash scenario under the no build scenario, travel times would be reliable except in the PM peak period. Both GP and CVL travel times would be reliable in the build with PTI varying between 1.02 and 1.05[134].

Truck Network Improvements

This section considers improvements to the Georgia truck route network from two perspectives:

- The adequacy of the network for serving rural Georgia, especially in respect to truck shipments of food and agriculture.
- The potential for establishing long distance routes that do not pass through the congestion of metropolitan Atlanta.

These considerations are in addition to the bottleneck relief and CVLs presented above. The data employed findings presented here are enlarged upon at the system level in Chapter 5, incorporating projections and analysis from the Georgia Statewide Travel Demand Model (GSTDM) using the Transearch 2050 forecast.

Rural Freight Roadway Network

Annual 2019 truck traffic on the Georgia roadway system is depicted in Figure 138, using data from Transearch and distinguishing four-lane from two- and three-lane facilities. Interstates are shown, but without traffic levels. Several observations of the data:

- The network is extensive and reaches throughout the state. The range of volumes on four-lane facilities seems largely comparable to the two/three-lane facilities, although the highest annual volume on four-lane facilities is around 1 million units greater than the highest annual volume on two/three-lane facilities, which equates to around three thousand more units per day.
- There is a triangular connection with significant truck volume between Columbus, Albany and Warner Robins, described generally as SR 520 from Columbus to Albany, SR 300 from Albany to I-75 near Cordele, I-75 to Warner Robins, and SR 96 between Warner Robins and Columbus. The non-Interstate sections are predominantly four-lane routes except SR 96 from Fort Valley to I-75 in Warner Robins, however from Fort Valley SR 49 is a four-lane route to I-75 in Byron.
- Comparably heavy volumes are on two-lane sections of SR 96 from Warner Robins to I-16, and two-lane US 129 northeast from Macon, connecting to four-lane US 441 near Eatonton and continuing to I-20.

[134] I-75 Commercial Vehicle Lane Traffic Report. November 12, 2020.

- Four-lane US 23 continues with significant volume on the same northeast vector as I-985 and joins to US 441.

The Governor's Road Improvement Program (GRIP) was designed to create a four-lane highway system across the state. Its explicit objective is to connect 95 percent of Georgia cities with populations of 2,500 or more to the Interstate system, and for 98 percent of Georgia's population to live within 20 miles of a four-lane road. The 3,300-mile GRIP is two-thirds built or under development, leaving about 1,000 miles to go. The GRIP network is portrayed in **Figure 139**, distinguishing the four-lane portions built or underway from the two-lane remainder, and indicating the truck volumes. The major unbuilt portions are parts of the east/west SR 32 between Brunswick and Albany, most of the east/west US 280 from Savannah to conjoint SR 520/US 280 below Columbus, the north/south SR 15 from Vidalia to Athens, and a series of routes including SR 52 from west of Dalton to US 441, dubbed the East-West Highway.

Stakeholders near unbuilt facilities underscore the importance of four-lane facilities for faster, safer connection to Interstates, which has an effect on economic development as well. Allowing for these points, the current and projected congestion is around urban centers (Albany, Columbus, Augusta, Athens, Chattanooga, as well as Atlanta and Savannah) and intersections, such as near Waycross and Eatonton. Deteriorating forecast conditions are most notable around Albany, SR 19 south from Atlanta, SR 21 north from Savannah, and SR 441 from Eatonton to Athens.

Figure 138. Freight Flows on Two- and Four-Lane Roadways

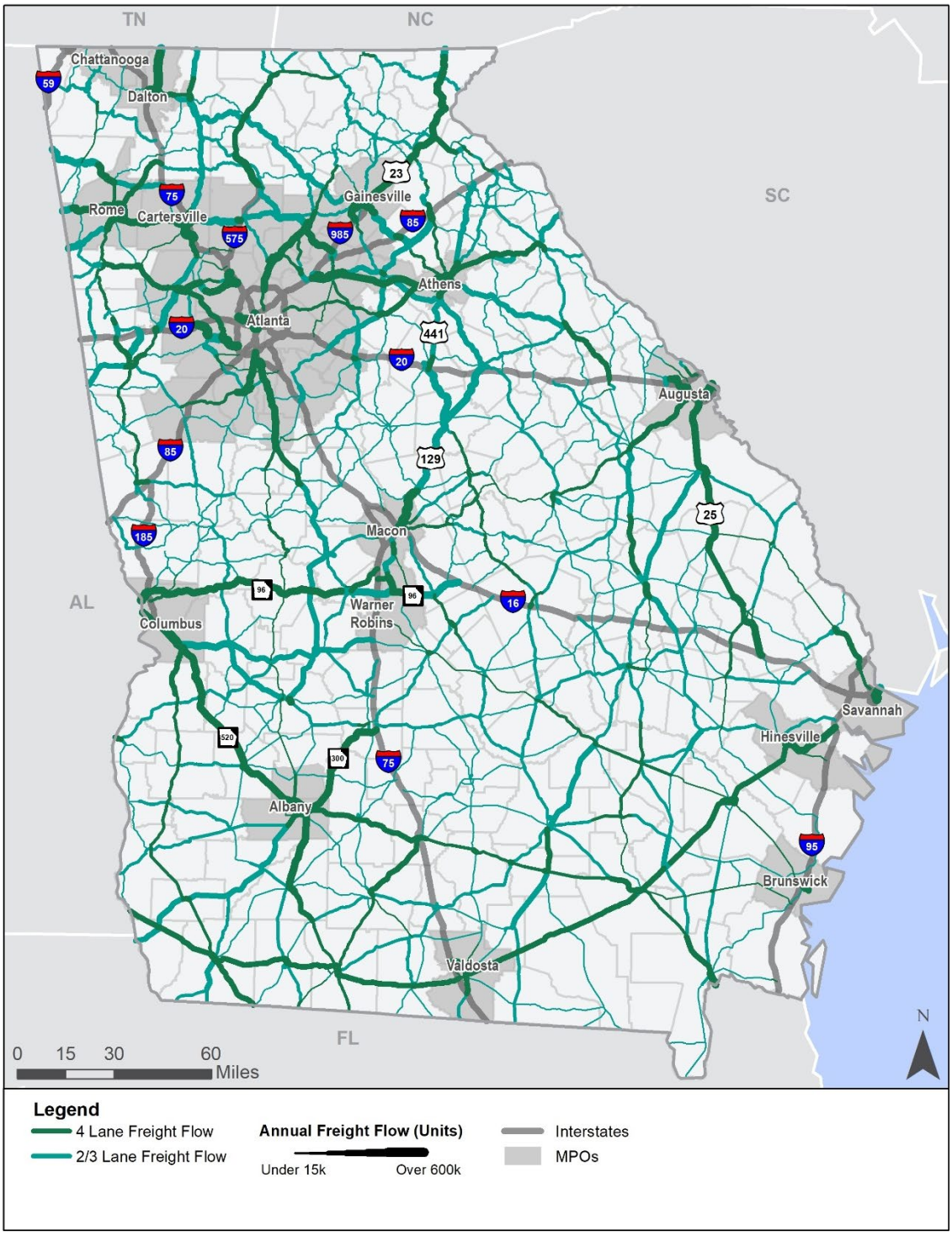
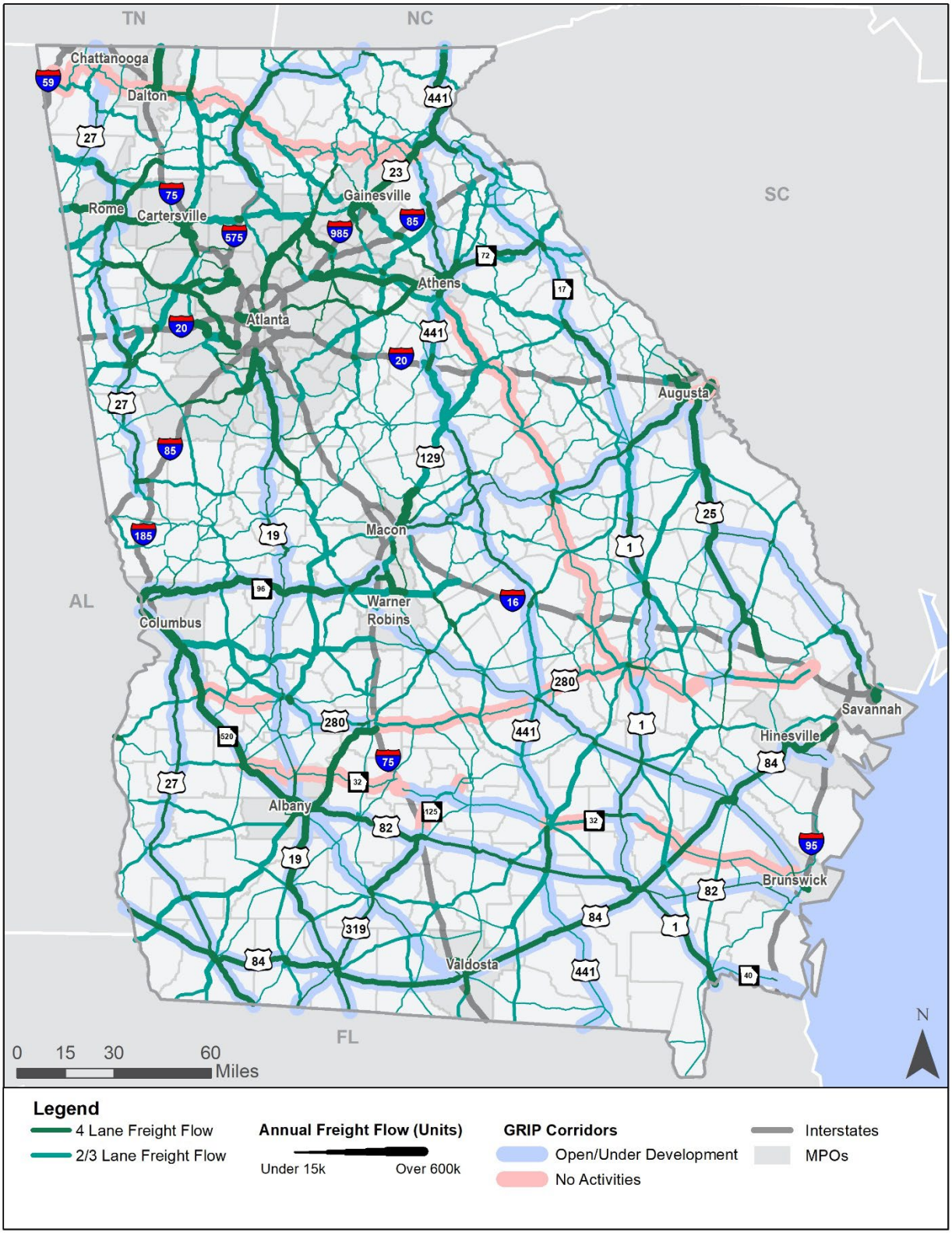


Figure 139. Freight Flows on GRIP Corridors and Other Two- and Four-Lane Roadways

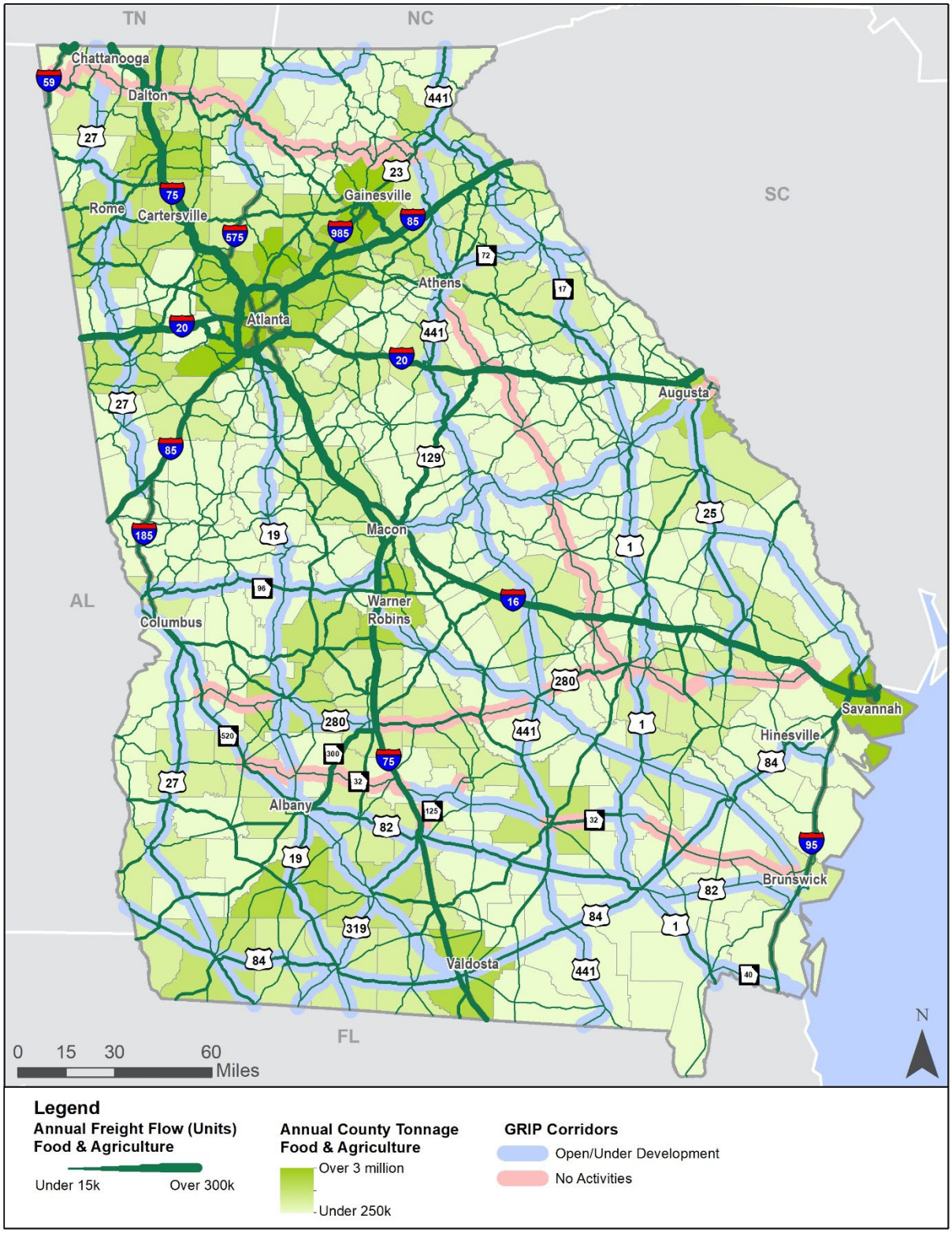


How well does the GRIP system serve rural Georgia, and particularly its prevalent food and agriculture industry? The overall and good linkage between towns in southern Georgia is evident from the analysis. Redundancy (the availability of alternative routes) is one of the strengths of the network, lending it resiliency and mitigating congestion. The system usage by food and agriculture appears in **Figure 140**, displaying the total truck tonnage from the industry by county, and the routes that the traffic travels. The highest volume that is not part of the GRIP network is the previously discussed four-lane SR 300 from Albany to I-75. While light volumes appear on a scattering of two-lane routes in rural territory, the primary conclusion is that the industry is well served: most county locations with substantial freight are connected and the entire network is in use. The most significant facility not yet completed is US 280, which affords a direct east/west connection to Savannah. One aspect of the performance on this system that is not well captured by congestion projections is how well it accommodates volume surges, which occur seasonally in the agriculture sector. Section 4.1.1 identified a number of rural bottlenecks affecting the GRIP, notably north and west of Valdosta toward Albany, which would come under seasonal stress. Once again, the redundancy of the network is an advantage in this respect, and operational solutions can help, such as signal priority and seasonal adjustments to signal timing.

Rural Network Strategy

The preliminary conclusion from this discussion is that the GRIP network – particularly US 280 – should be completed because it meets the intent of the program and builds in redundancy to the freight network, which becomes important at harvest time. The KPIs affected will be speed and cost for access to markets, as well as reliability and safety from higher grade facilities.

Figure 140. Food & Agriculture Industry Freight Flow (2019)



Alternative Route Strategy

Alternative routes to avoid Atlanta and other congested areas were considered as options to provide redundancy in the system and support freight movements that do not serve the Atlanta region but just pass through. One option is four-lane US 27, passing through Rome and the western edge of the Atlanta region to reach Florida through southern Georgia. Another option is to four-lane US 441 to the east. This route would require connection in north Georgia to reach Chattanooga. The main north-south alternatives are four-lane facilities. To be competitive with I-75, the routes would need to have controlled access or be upgraded to Interstate standards. The KPIs involved will be speed and reliability; cost may be lower but must overcome the penalty of circuity.

4.3.2. Truck Parking Strategies

When assessing truck parking needs, numerous factors were considered including truck parking locations, unauthorized truck parking locations, the location of existing and anticipated freight generating industries, existing and anticipated freight volumes, utilization at existing truck parking facilities, and the presence of ports and major intermodal facilities.

These factors were combined to identify the most prominent areas of opportunity for additional truck parking.

Table **110** depicts the location of the areas with the greatest truck parking opportunities as well as the criteria used to identify them. Orange Grid IDs indicate locations where one criterion was met. In total, there are 17 grids meeting one criterion. These grids are clustered along I-75, I-285 and I-85 northeast of Atlanta, I-20 near the Georgia/Alabama line, and near the state ports. Red indices indicate areas where more than one criterion was met. There are five grids meeting more than one criterion. These grids are concentrated in northwest Georgia, primarily within the Atlanta Metropolitan area and north along I-75.

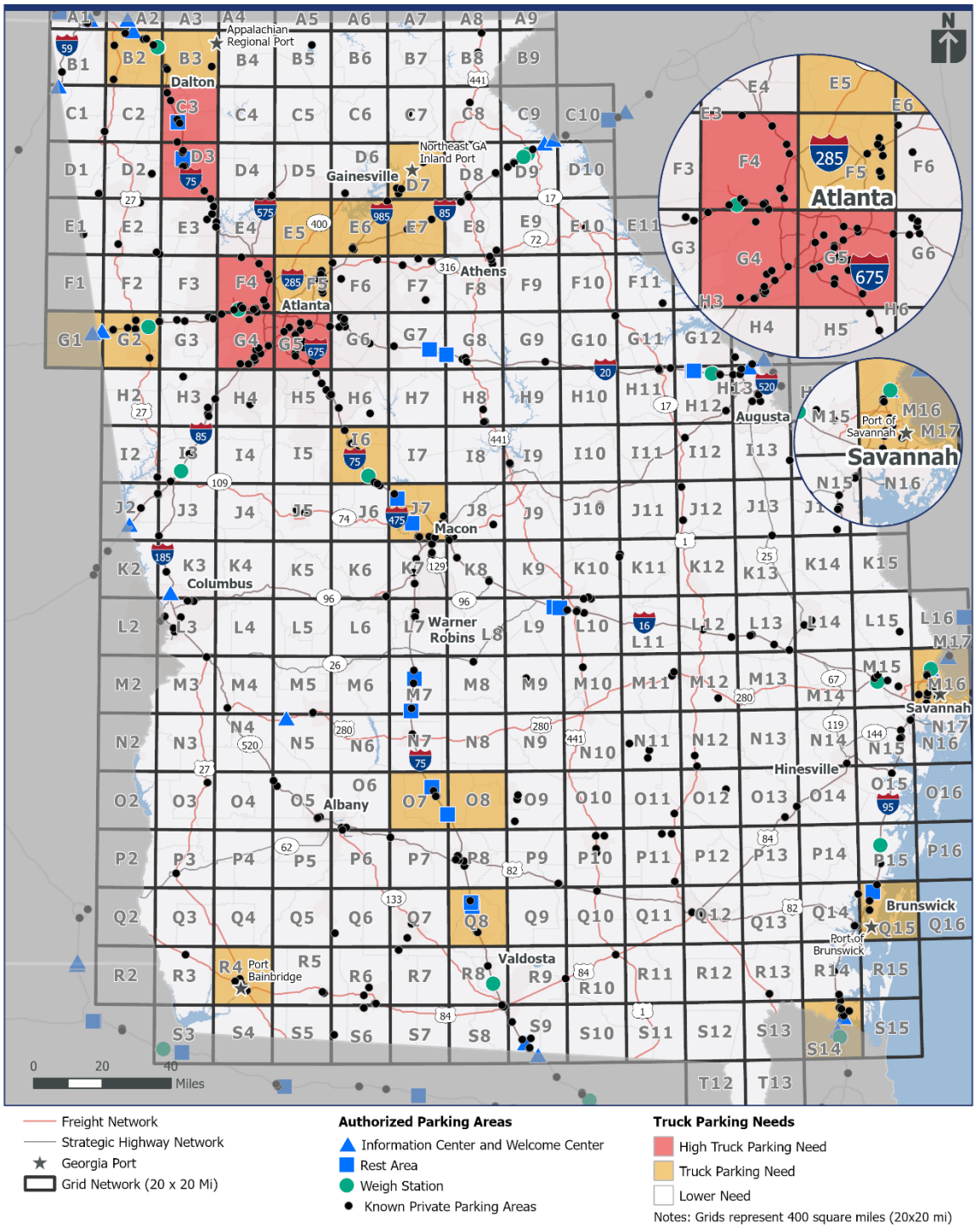
GDOT should update the truck parking needs assessment once data and findings from planned studies and programs are available. The following GDOT studies and programs were planned at the time of this update:

- GDOT Truck Parking Pilot Study (PI 0019350)
- Truck Parking scoping studies (PI 0019106 / 0019107 / 0019108) for Regions 1, 2 and 3

Table 110. Location of Truck Parking Need and Identifying Criteria

Grid ID	Overall Parking Area	Potential Unauthorized Parking	Potential Freight Development and Volume	Exceeding Public Space	Marine or Inland Port
B2	-	-	-	X	-
B3	-	-	-	-	X
C3	X	-	-	X	-
D3	-	X	-	X	-
D7	-	-	-	-	X
E5	-	-	X	-	-
E6	-	-	X	-	-
E7	-	X	-	-	-
F4	X	-	X	-	-
F5	-	-	X	-	-
G1	-	-	-	X	-
G2	-	-	-	X	-
G4	X	-	X	-	-
G5	X	-	X	-	-
I6	-	X	-	-	-
J7	-	-	-	X	-
M16	-	-	-	-	X
O7	-	-	-	X	-
Q8	-	-	-	X	-
Q15	-	-	-	-	X
R4	-	-	-	-	X
S14	-	X	-	-	-

Figure 141. Statewide Truck Parking Need Areas

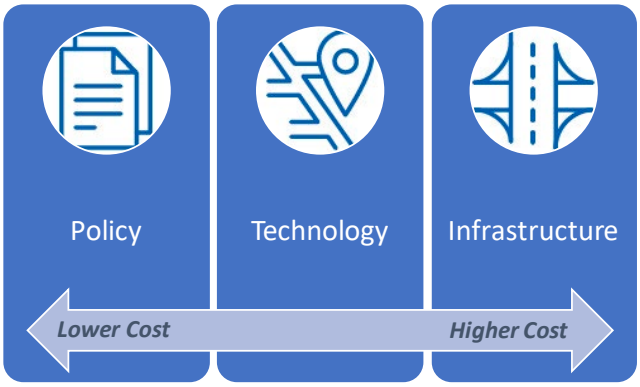


Source: ATRI (8/21 through 11/21), GEARS, MCIMS, Georgia Power, local economic development councils, GA DCA DRI website

Based on the identified needs, the following strategies, split into three (3) categories by policy, technology, and infrastructure, as presented in **Figure 142,** may be considered for implementation.

Policy Strategies

Figure 142. Potential Truck Parking Strategies



Most policy strategies, in comparison to technology and infrastructure strategies, can be implemented relatively quickly for little to no cost. Policy strategies are broader than other types of strategies and include a range of approaches in many categories. These general categories are shown in **Figure 143**. Specific policy recommendations are in Chapter 5.

Figure 143. Policy Strategy Categories

Technology Strategies

There are two main types of truck parking technologies:

A. Onsite parking detection - technologies that collect data on how many truck parking spaces are available.
    - In-ground magnetometer sensors
    - Radar and laser technology
    - Infrared sensor technology
    - Camera vision systems
    - Closed-circuit television cameras
    - License plate recognition systems
    - Inductive loops
    - Blue-band Bluetooth sensors

B. Communication technologies - technologies that communicate parking availability to drivers and other users to make informed decisions regarding their route planning.
    - Truck Parking Information Systems, Advanced Traffic Management Systems and Servers
    - Dynamic Messaging Signs
    - Applications, In-Cab Systems, and Websites

Between these two types of technologies, there are several different strategies available. GDOT's Office of Traffic Operations is currently exploring some of these strategies. GDOT's Office of Traffic Operations has received initial reports that there has been an increase in trucks parking at weigh stations due to the installation of Truck Parking Permitted Signage. The Office plans to confirm these initial reports by conducting intermittent count collections in spaces or at gates across all Georgia's public parking facilities.

Infrastructure Strategies

The majority of truck parking in Georgia is privately owned and operated. Given the limited supply and location of suitable publicly-owned undeveloped land and funding limitations, the private sector is anticipated to continue being the major provider and increase the truck parking supply while GDOT's primarily role will be to encourage construction of truck parking by the private sector. Increases in private truck parking infrastructure will largely be accomplished through implementation of the policy and technology recommendations discussed above.

The private sector also has the ability to take advantage of BIL funding through public-private partnerships (P3s) with the public sector. This provision in the law is new, so there are limited examples or pilot programs available to date. Georgia has an opportunity to become a leader in this area and should consider P3 opportunities further, including conducting interviews with the states that have initiated various levels of truck parking solutions using P3s. Examples include PennDOT and UDOT. Ongoing conversations with FHWA should also be pursued as federal guidance covering P3s and truck parking are released by FHWA.

While public infrastructure improvements will only make a small dent in improving truck parking supply in the state, GDOT recognizes the opportunities that do exist to increase public truck parking. These strategies include:

- Repurposing existing facilities
- Expanding existing facilities
- Building new facilities
- Designating emergency facilities

GDOT has expanded existing facilities by removing restrictions preventing trucks from parking at weigh stations. It has also programmed three scoping projects in three regions identified as having the greatest need.

GDOT has also assessed its inventory of existing and abandoned facilities including visitor/ information centers, rest areas, weigh stations as well as other state-owned land and right-of-way that could be used to expand the supply of public truck parking supply.

Trucking Parking Signage at GDOT Weigh Stations

4.3.3. Port Strategies

The Georgia Port Authority operates sea terminals in Garden City, Savannah and Brunswick, and currently one inland port in Chatsworth, GA. It has also operated pop up container storage yards in other locations such as Statesboro, GA and Charlotte, NC, in order to accommodate the needs of shippers who didn't have enough of their space to be able to do so.

GPA has mentioned a range of expansion plans impacting the sea and inland ports, over a 3-to-10-year timeframe. These plans include:

- Expansion of the Garden City terminal by
    - Straightening out Berths 1-3 (in progress) so that newer and post Panamax (15 thousand TEUs) vessels can be handled simultaneously
    - Development of new property on the west side of the Garden City terminal, with relocation of the transload facility operated on dock by NFI over there, so that more containers can be stored and handled closer to the waterfront
    - Development of 150 acres to the West of the Savannah River and contiguous to the Garden City Terminal, which was acquired in 2019. The additional acreage would allow port users who need a longer dwell time, to do so without creating container yard operation issues for GPA
- GPA also plans to eventually build a new terminal on its property on Hutchison Island, that will be capable of handling the largest container ships in the world
- Ocean terminal capacity and infrastructure is being upgraded to handle growing volumes of containers there

- Brunswick plans are based on expanding automobile roll on-roll off operations in anticipation of the Hyundai plant to be built on I-16
- Future inland ports potentially serving northeast and western Georgia

It is important to note that the port just completed the Mason Mega rail project which will allow CSX and Norfolk Southern to build several unit trains per day that could terminate in Chicago.

The overall capex plan was recently mentioned to be $3.5 billion. To partly fund these plans the port has already issued about $500 billion of bonds.

The current height of the Talmadge Bridge over the Savannah River provides air draft challenges for most of the ships of 18,000 TEU and above carrying capacity. With the Savannah Harbor Expansion Project (SHEP), super-sized freighters will be able to be accommodated in the Savannah River but potentially not by the Talmadge Bridge. GDOT is studying various options to resolve this constraint to allow for larger vessels to reach the Port of Savannah as anticipated to manage the growth in freight traffic and maintain a competitive advantage.

Within 10 years, GPA may be able to handle over 11 million TEUs. Its growth rate has been higher than Los Angeles, Long Beach and New York-New Jersey ports'. It is quite possible that within the next 10 years Savannah could become the second largest container port gateway. If it does, it will be because of the ports' continued investments since 1958 on making sure it offers the best cost, capacity and consistency of service. Mason Mega rail and inland ports are important investments to keep road traffic fluid and allow the port to serve more US geography to take up overflow from other ports that have been able to expand their infrastructure as much. The KPIs affected are cost, reliability speed and risk.

4.3.4. Rail Strategies

Chapter 2 of this plan details freight flow projections by mode and by commodity group. Nationally, the decline of coal is impacting rail traffic. However, in Georgia this trend is offset by a greater increase in intermodal, fueled by growth at Georgia's ports. Inbound rail flows by value are projected to grow at a greater rate than by tonnage, due again to a shift from coal to other commodities, such as mixed freight, vehicles, plastics, and chemicals.

By 2050, the amount of Georgia-based freight is forecasted to nearly double; trucking is anticipated to absorb 86 percent of that change and rail 13 percent if the status quo is maintained, further compounding congestion on key freight corridors. Certain commodities and trip types observed in Georgia present opportunities to shift future growth to rail. Top growth industries that are compatible with rail transportation include: manufacturing, automotive, food and agriculture, and construction.

Rail transportation saves industries an average 23 percent in shipping costs compared to truck. The following presents potential strategies to strengthen the state's rail network and offer competitive options for shippers.

Grant Programs

The BIL presents opportunities for private railroads to participate in federal grant programs on projects that benefit the movement of freight. Select states also offer grant programs to target corridor preservation, economic development, safety, or track upgrade needs. In some situations, state programs take on improvements that serve a public benefit but are not necessarily profitable enough for the private sector. State programs can also be used to incentivize private investment or to leverage additional federal investment. In Georgia, the state has historically only made direct investments in state-owned shortlines, as the state constitution prohibits spending public funds on private projects.

Rail Network Improvements

Strategies to bolster the capacity and resiliency of the state rail network would improve the efficiency of rail from both a time and cost perspective.

Network Connectivity

Completing gaps in the network where rail lines have been disused and are out of repair can provide new access for industries and better resiliency for the overall network. For example, the Heart of Georgia (HOG) railroad between Vidalia and Midville would connect agricultural and manufacturing businesses in Central Georgia to the Class 1 network and the Port of Savannah. Reopening the CSX route from Athens to Union Point would offer an alternate route on the east side of Atlanta. Likewise, the Norfolk Southern (NS) route from Senoia to Griffin and McDonough would complete a western route between Tennessee and Savannah bypassing Atlanta. Additionally, the CSX section between Albany and Oglethorpe would provide better access for industry in Albany and would offer potential Class 1 connections to multiple intersecting shortlines.

Improving network connectivity can also mean opening transfer opportunities between individual railroad owners. For example, the Georgia Central Railroad traverses east-west between Macon and Savannah, roughly parallel to I-16, stopping just short of the Port of Savannah. Accessing CSX tracks for the last mile to the port would open new opportunities for rail customers and may require incentives to make the arrangement viable for both railroads.

Network Capacity

The majority of the rail network in Georgia is single track, with a few exceptions of track within metro Atlanta. Single tracking limits the industry's growth potential, particularly with longer trains, which is the trend. Double track and siding improvements will benefit high volume corridors that are currently constrained and expected to continue growing. While double tracking may not be cost effective over long-distance routes, longer sidings at regular intervals allow trains to pass one another more efficiently – and with trains now reaching two miles in length, extended sidings are becoming essential. These solutions improve reliability for not only the mainline railroad but other connecting shortlines.

Inland Port and Short-Haul Strategies

Inland ports are truck-rail intermodal facilities that supplement seaport functions at remote locations and collect freight onto rail traveling to the seaport and vice versa. The Georgia Ports Authority (GPA) uses inland ports to improve intermodal rail service between Savannah and inland markets. Inland ports are advantageous to shippers, as they shorten the truck trip between the shipper location and the port. They can also be advantageous to local jurisdictions as they attract new industries, jobs, and warehouse and distribution development and potentially relieve highway congestion.

The Appalachian Regional Port in Murray County opened in 2018 and offers a 388-mile rail route between northwest Georgia near I-75 to the Garden City Terminal. Customers are able to clear customs at the inland port instead of in Savannah and they are able to avoid the risk of congestion on metro Atlanta Interstates. The location is strategically positioned near the epicenter of Georgia's carpet and flooring industry as well as automobile and tire manufacturers. GPA has announced plans to develop the Northeast Georgia inland port in Hall County with direct access to I-985. Rail service times are anticipated to be faster than those between Savannah and the Appalachian Regional port because of shorter mileage between the two. The Northeast Georgia inland port will benefit poultry producers and manufacturers with a new competitive option for shipping and, like its counterpart in Murray County, avoid the risk of truck delays in metro Atlanta.

In order to be successful, new inland port locations should be strategically located to capture an adequate freight volume, balance outbound and inbound containers, and provide adequate highway and rail access. The distance to the seaport should be far enough to warrant a two-day truck roundtrip. Successful inland ports are generally made possible by partnerships among local leaders, port authorities, and private industry. Public investments, like the on-dock rail service at the Port of Savannah, make short-haul intermodal services financially feasible for ports and shippers. As congestion and associated truck costs are anticipated to grow in the future, the minimum viable distance for rail trips may decline, making short-haul rail service and inland ports more attractive.

Shortline Strategy

While shortline railroads generally carry less volume and produce less revenue than the Class 1 railroads, they play a critical first-last mile role and provide an opportunity for Georgia's rural industries and farms to participate in the global marketplace with access to the national network. The following shortline strategies are aimed at improving access and growing small businesses.

Capacity and Speed Upgrades

Improving the condition of track, rails, and bridges to accommodate the industry standard 286,000-lb railcars and 25 mph operating speeds will improve the efficiency of shortline rail travel from both a cost and time perspective. Eliminating weight restrictions makes rail a viable option for more customers that generally move heavier loads and utilize shortlines to connect to Class 1 lines for longer trips.

Business Development

Efforts to attract new rail customers to locate on shortlines could include marketing strategies,

industrial park development at the local level, and coordination with the Georgia Department of Economic Development's (GDEcD) GRAD site program to promote the availability of rail access. Sidings and spurs developed in partnership between railroads and local economic development authorities can attract new rail-oriented businesses and offer new options for existing businesses. For example, the Walker County Development Authority, in partnership with the GDEcD and GDOT, was able to attract the $50M Audia Plastics development to the Walker County Industrial Park by subsidizing the construction of a rail spur on the CCKY shortline. Today, Audia is one of CCKY's prime rail customers in Georgia and produces plastics products for building construction, automotive, and consumer products.

4.3.5. Air strategies

The principal air cargo operations in Georgia are at Hartsfield Jackson Atlanta International Airport (HJAIA). The integrated air cargo carriers UPS, FedEx and Amazon Air have their main facilities there, although UPS has a presence in Albany and FedEx in Savannah. However, it is the passenger hub operations of Delta that give HJAIA global significance. International air cargo travels substantially in the bellies of widebody aircraft on overseas routes, whereas domestic air freight largely relies on integrated carriers. With direct flights to Europe, Asia, the Middle East and Latin America, Delta is the main source of overseas capacity. Cargo is trucked in Road Feeder Service (RFS) from as far away as Virginia to take advantage of overseas schedules, and the majority of the international freight reportedly comes from outside Atlanta. RFS connections are common for the top air hubs, with the result that HJAIA competes with Miami, Chicago O'Hare, and JFK in New York. In addition, HJAIA is the hub for Delta's company material - the supplies ranging from food and utensils for onboard services to maintenance parts for technical operations – without which planes cannot fly. These are purchased in bulk and depend on RFS to reach Atlanta.

HJAIA has three main cargo areas, and there are plans for a fourth on a 40-acre site. Autonomous truck operations are being explored for use within the confines of the cargo districts. The HJAIA has a Cargo Community System, which is a way for multiple parties in a logistics operation to improve efficiency and throughput via better visibility into cargo location, arrival times, sequencing and queues. However, the system is voluntary and reportedly undersubscribed, to the extent that urgent shipments may be kept waiting because the less urgent are tying up dock space. Marine ports with multiple terminal operators (unlike Savannah) experience similar problems of coordination. Efficient throughput has clear implications for capacity.

The status of HJAIA for international service is important to Georgia's vision to be the global gateway of choice. However, there is a stakeholder perspective that HJAIA cannot be a global cargo hub without significant international freighter operations. Freighters are dedicated cargo aircraft (familiar from the branded airplanes of the integrated carriers) that fly overseas and bring a substantial boost to carrying capacity: by one estimate, ten freighters carry the cargo equivalent of 150 transpacific passenger flights. Freighters for example are vital to Miami's market position: according to 2020 FAA data, Miami imported by freighter nine times the air cargo volume as HJAIA, largely from Latin America, and is the leading gateway for perishables from that source. Overseas freight can only travel by ship or air and development of freighter service would contribute to Georgia's vision; however, this is not within the direct purview of GDOT.

Unmanned aerial vehicles (UAVs, or drones) are a relatively new entrant in air operations and are not airport-based. Their carrying capacity and range (roughly five pounds and fifteen miles round trip) thus far has limited their utilization, although both are increasing. UPS is working with truck-launched drones as a way to improve delivery efficiency in rural areas: the truck makes delivery at multiple stops along the road in the usual way, then sends the drone to deliver to remote locations such as distant farms. However, heavier cargo craft are coming into play, and are part of the larger development of Urban Air Mobility. This term refers mainly to passenger air taxis with increasing degrees of automation that provide a route around congestion without requiring an airfield. One cargo version being tested is an electric-powered Vertical Takeoff and Landing (VTOL) aircraft with a carrying capacity of 1,400 pounds and a 250-mile range; the VTOL capability enables operation in dense urban areas. UPS has placed a small trial order of these vehicles, pending FAA approval for operation in 2024.

Four strategies emerge from the foregoing discussion:

- **Improve road conditions on RFS routes.** These are chiefly bottlenecks on Interstates leading to HJAIA, and responsibility would fall to GDOT. The KPIs affected are reliability, speed and cost for a mode where time is of the essence.
- **Raise participation in the cargo community system**. Responsibility falls to the City of Atlanta Department of Aviation, with KPI payoffs in terms of cost and reliability. This is not a new investment, although the Department of Aviation may seek methods to further incentivize participation.
- **Develop international freighter service**. Responsibility lies with the marketing arm of the Atlanta Department of Aviation, but it has trade mission overtones with which the State may choose to assist. While there is no immediate investment, the successful attraction of new services may require construction or modification of cargo handling facilities for the carrier, which would catalyze introduction of service. KPIs affected are speed and reliability in the new service lanes.
- **Monitor development of unmanned aerial vehicles**. This is an evolving area with FAA oversight, and operations as well as vehicles are still being created. Monitoring may be undertaken by other parties, but GDOT should do so as well. The forms of investment that may be required are still to be determined but are likely to be categorized as innovation. KPIs also are uncertain but cost and speed would be important motivations.

4.3.6. Technology Strategies

Understanding the emerging freight technologies and their impact to safety, operations, and ultimately the economy of Georgia is key to advancing innovative ideas to support freight. GDOT

will need to stay abreast of the latest technological innovations if they are to keep pace with modern supply chain and freight movement needs. It must identify and capture information about emerging technologies and trends and to deliver it in a usable form to decision makers, which is a best practice approach for building institutional knowledge on emerging and potentially disruptive technologies.

Innovation and collaboration go hand in hand and must include both private and public entities, encompassing their perspectives, interests, and input. Public agencies' missions include providing transportation infrastructure, promoting safety, and maximizing the throughput and productivity of the transportation networks. In turn, private sector firms rely on these publicly provided goods and services to increase supply chain efficiency and productivity to deliver their products safely, securely, and on time to demanding customers. This interplay of private and public sector decision making is growing in importance as the world becomes more connected and dependent on standardized, complex technologies.

Programs supporting these technologies fit in the category of innovation. KPIs affected are speed, cost and reliability.

4.3.7. Freight Generators Strategies

Georgia-based freight flows account for the vast majority of total freight flows in volume and in value, both in the present and the future. Additionally, outbound freight flows will grow by 86 percent by tonnage and by 114 percent by value in the next three decades. Thus, it is critical to optimize the transportation performance around freight generators, such as Developments of Regional Impacts (DRIs), Georgia Ready for Accelerated Development (GRAD) Sites, intermodal facilities, seaports, and inland ports across the state. The following list of strategies utilizes readily available tools that were developed in previous studies by the GDOT Office of Planning as well as recommendations for an optimization framework:

a. Prioritize transportation investment around high-scoring GRAD sites using the Screening Tool

The GRAD Site Screening Tools offers a multitude of qualitative and quantitative criteria such as geographic location, traffic and infrastructural conditions on adjacent roadways, proximity to primary freight generators (e.g., airports, 4-lane arterials, seaports, and inland ports, etc.), as well as existing and planned projects by GDOT in the area *(see more details in the GRAD Site Analysis Report, GDOT, June 2021*). The Screening Tool was developed in June 2021 and will need continuing maintenance, including regularly updating the GRAD Sites Transportation Database and revising scoring criteria based on current transportation needs and policies. It is recommended that the update and revision be done annually to ensure decision making is based on the most up-to-date data. Focusing investments around high-scoring GRAD sites ensures that the same amount of dollars will be spent on the maximum amount of freight volumes, effectively bringing down the average cost of investment over the next decades.

b. Regularly update and utilize truck parking technologies and data around freight originators

Truck parking shortage is a universal challenge in the US. The fast growth of freight flows in Georgia has made it even more urgent to strategize existing and anticipated truck parking. The end goals are (1) to ensure safety and mobility associated with the freight movements, (2) to reduce the average cost from maintenance, wait time and fuel spent in searching for parking, and (3) to boost Georgia's ability to attract and retain businesses. While the existing freight-intensive land uses and density are largely found in the metropolitan areas, most notably in Atlanta and Savannah, there is much potential to expand truck parking availability around freight generators, such as DRIs, GRAD sites, and other industrial sites where the local land uses allow. This expansion must be done with strategies for technology (i.e., onsite parking detection and communication), infrastructure strategies (i.e., parking capacity), and policies for funding, design, and stakeholder partnerships.

c. Periodically Update the designation of the Georgia State Freight Network

The designation of the State Freight Network (SFN) is made by the Director of Planning with the approval of the State Transportation Board. It includes all the Interstates in Georgia and partially overlaps with other defined networks, such as the National Highway Freight Network, the Strategic Highway Network, and the Governor's Road Improvement Program (GRIP) Network. The most recent revision to the SFN was in 2016. Since then, Georgia has experienced significant growth. From 2016 to 2021, the state had a compound annual growth rate in Gross Domestic Product (GDP) of 4.5 percent for all industry totals. In the last quarter of 2021, Georgia's real GDP grew at an annual rate of 7.5 percent, outpacing the national rate at 6.9 percent[135]. Such growth has translated to and has been supported by the growth in freight movements, much of them on the SFN that connects the freight generators across the state.

4.3.8. Strategies by KPI

The following table provides a summary of strategies identified to meet the challenges for freight mobility and areas of opportunities to continue to improve the freight network and conditions for freight services throughout Georgia. The identified strategies provide the framework for the development of programs and investment presented in Chapter 5. The summary below connects the strategies with Key Performance Indicator categories that are used in Chapter 5 with more detail on specific metrics for each KPI.

[135] Bureau of Economic Analysis

Table 111. Summary of Strategies and Effect on KPIs

Strategy	Key Performance Indicator				
	Reliability	Speed	Cost	Safety	Risk
Interchange improvements	X	X	X	X	
Work zone technology	X		X	X	
Crash prevention			X	X	
Crash clearance	X		X	X	
Access management		X	X		
Roadway capacity		X	X	X	
Truck parking availability information system	X	X	X	X	X
Commercial vehicle lanes	X	X	X	X	
Rural freight roadway network	X	X	X	X	
Atlanta alternative routing	X	X	X		
Improve road conditions on RFS routes	X	X	X		
Raise participation in the cargo community system	X		X		
Develop international freighter service	X		X		
Monitor development of unmanned aerial vehicles		X	X		
Grant programs for rail preservation, development, and upgrades	X	X	X	X	
Rail network connectivity improvements		X	X		
Rail network capacity improvements	X	X	X		
Strategically located inland ports	X	X	X		X
Shortline capacity and speed upgrades	X	X	X		
Freight technological innovation	X		X	X	
Prioritize transportation investment around high-scoring GRAD sites			X		

Strategy	Key Performance Indicator				
	Reliability	Speed	Cost	Safety	Risk
Update and utilize truck parking technologies and data around freight originators			X	X	
Periodically review the Georgia State Freight Network	X	X	X	X	X