FIXING THE 12% CASE STUDY: ATLANTA, GEORGIA FUEL CONSUMPTION AND EMISSIONS IMPACTS

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Spaghetti Junction in Atlanta, GA - Photo courtesy of Doug Turnbull, WSB Radio

ATRI RESEARCH ADVISORY COMMITTEE

Introduction

In 2015, the American Transportation Research Institute's (ATRI) Research Advisory Committee (RAC)[1] identified as a top research priority a study to address the most inefficient and costly U.S. congestion locations for the trucking industry. Citing past ATRI research,[2] the RAC proposed that since 89 percent of the trucking industry's congestion costs generate from just 12 percent of interstate highway miles, improving that 12 percent could positively impact the flow of people and goods. Furthermore, it was posited that small-scale, lower cost solutions could provide travel time benefits for both trucks and passenger vehicles.

Congestion is estimated to have caused the trucking industry to consume an additional 6.87 billion gallons of fuel in 2016.[3] This represented approximately 13 percent of the industry's fuel consumption and added $15.74 billion to its fuel bill.[4] This consumption also resulted in 67.3 million metric tons of excess carbon dioxide ($CO2$) emissions.[5] While these figures provide perspective on a national basis, this study analyzes potential fuel and emissions impacts from relieving congestion at specific interchanges.

The following report is the second case study ATRI is publishing as part of the "Fixing the 12%" research initiative. As individual infrastructure issues tend to be unique, ATRI, with the assistance of Trinity Consultants,[6] utilized three baseline data components for this analysis.

- ATRI's Freight Performance Measurement (FPM) database of truck Global Positioning System (GPS) data was used.[7] Through this resource, congestion impacts on nearly 1 million large trucks can be quantified.

- To identify traffic volumes, Average Annual Daily Traffic (AADT) figures were obtained from the Georgia Department of Transportation's (GDOT's) Traffic

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[1] ATRI's Research Advisory Committee (RAC) is comprised of industry stakeholders representing motor carriers, trucking industry suppliers, federal government agencies, labor and driver groups, law enforcement, and academia. The RAC is charged with annually recommending a research agenda for the Institute.

[2] Pierce, Dave & Murray, D. "Cost of Congestion in the Trucking Industry." American Transportation Research Institute. Arlington, Virginia. April 2014.

[3] Estimate derived from: Hooper, Alan. "Cost of Congestion in the Trucking Industry – 2018 Update"; Hooper, Alan & Murray, D. "An Analysis of the Operational Costs of Trucking: 2018 Update." American Transportation Research Institute. Arlington, Virginia. October 2018 and U.S. Energy Information Administration "Annual Retail Gasoline and Diesel Prices.

[4] Energy Information Administration, "Annual Retail Gasoline and Diesel Prices" (2016).

[5] Energy Information Administration, "Carbon Dioxide Emissions Coefficients".

[6] Trinity Consultants is an international environmental, heath, and safety consulting firm that specializes in air quality issues.

[7] ATRI's anonymized truck GPS dataset is comprised of a continuous stream of truck position data that is reported from more than eight hundred thousand trucks. For each individual truck, a latitude/longitude, date and time stamp, speed and other information is recorded continuously. Rates of position are extremely frequent; anywhere from every 30 seconds to every several minutes.

Analysis and Data Application (TADA) website.[8] The website uses a dynamic mapping interface to present data collected from the Georgia Traffic Monitoring Program for public roads in Georgia.

- The analyses used EPA's Motor Vehicle Emission Simulator (MOVES), a state-of-the-science emission modeling system that estimates emissions for mobile sources at the national, county, and project level for criteria air pollutants and greenhouse gases.[9]

This "Fixing the 12%" case study examines the potential fuel consumption and emissions benefits which could be derived from improvements to an interstate interchange in Atlanta, Georgia that costs commuters and the trucking industry millions of dollars each year due to congestion.

[8] Georgia Department of Transportation, Traffic Analysis and Data Application (TADA!) website, https://gdottrafficdata.drakewell.com/publicmultinodemap.asp.
[9] U.S. Environmental Protection Agency, MOVES and Other Mobile Source Emissions Models, https://www.epa.gov/moves.

Background

The intersection of Interstate 285 and Interstate 85, along with several access roads, in northern DeKalb County, Georgia, just northeast of Atlanta is known locally as Spaghetti Junction (see Figure 1). I-285 is the beltway around Atlanta. I-85 is a major traffic corridor from the northeastern suburbs of Atlanta into downtown Atlanta. The interchange is a five-level stack with additional ramps to accommodate traffic on four nearby side roads. It has 14 bridges, the highest rising 90 feet, and handles approximately 300,000 vehicles each day.

Figure 1. Intersection of I-285 and I-85

This location is consistently ranked as one of the worst traffic bottlenecks in the country. In 2019, this intersection was again identified by ATRI as one of the most congested freight bottleneck in the country.[10] ATRI's Top Truck Bottleneck List assesses the level of truck-oriented congestion at 300 locations on the national highway system. The analysis, based on truck GPS data from nearly 1 million heavy duty trucks, uses several customized software applications and analysis methods, along with terabytes of data from trucking operations to produce a congestion impact ranking for each location.

[10] American Transportation Research Institute, 2019 Top 100 Bottleneck List, https://truckingresearch.org/2019/02/06/atri-2019-truck-bottlenecks/#.XHBugIhKjD4.

Methodology

In order to examine the potential fuel consumption and emissions benefits which could be derived from improvements to the intersection of I-285 and I-85, the three data sources described above were utilized.

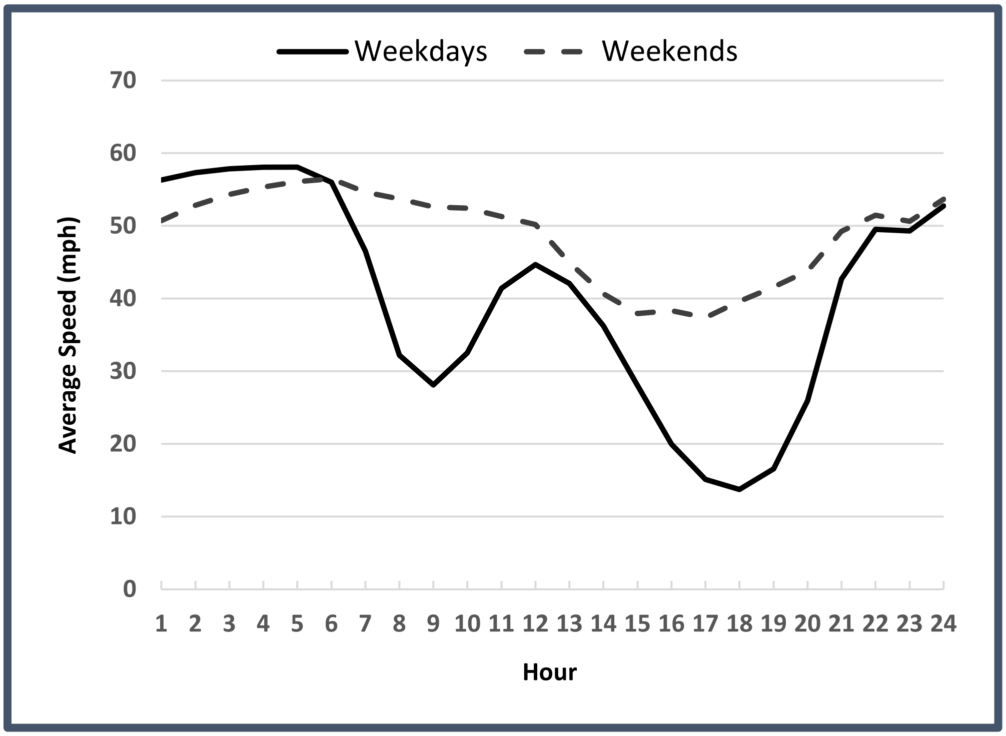
GPS Data Analysis

The first step in this analysis was to utilize ATRI's truck GPS database to identify average truck speeds by time of day through this intersection. As shown in Figure 2, position and speed data derived from the wireless onboard communications systems used by the trucking industry were used to identify truck speeds on three specific 2-mile segments of the interchange (project area). These data were assigned to one of 24 one-hour time slots and averaged to estimate truck speeds for the interchange during each hour of the day. It was assumed truck speeds are a surrogate for car speeds at this interchange.

Figure 2. Truck Activity Traces, Intersection of I-285 and I-85

As shown in Figure 3, average speeds during the weekday morning commute (7 - 10 a.m.) slow to as little as 28 mph while the evening commute (3 - 7 p.m.) drops to a low of 14 mph. The average speed during these weekday peak periods is 23 mph while the average during weekday non-peak periods is 47 mph, still below free-flow conditions. The overall average speed throughout the weekday at this interchange is 40 mph while weekend speeds average 49 mph overall with average hourly speeds as low as 37 mph.

Figure 3. Average Speed by Time of Day, Intersection of I-285 and I-85



Trip Counts

The GDOT Traffic Analysis and Data Application (TADA) website presents data for activity at various sites near the interchange.[11] Rather than modeling each specific segment, an estimate of the aggregate volume in each direction was made based on the volumes upstream and downstream of the interchange. Traffic was often only reported in one direction on TADA, so it was assumed traffic in the opposite direction would be equivalent. Based on this methodology, daily traffic volumes for the three segments of the interchange were estimated and are shown in Table 1.

[11] Georgia Department of Transportation, Traffic Analysis and Data Application (TADA) website, https://gdottrafficdata.drakewell.com/publicmultinodemap.asp.

Table 1. Average Annual Daily Traffic Volumes, Intersection of I-285 and I-85

Direction	SE	NW		Direction	SW	NE
I-285 N of I-85	225,000	225,000		I-85 NE of I-285	302,000	302,000
I-285 S of I-85	203,000	203,000				

The TADA website also reported the percent of traffic in each direction that was represented by single-unit trucks (approximately 3% of total volume) and combination trucks (approximately 6% of total volume) in each direction. These percentages were then incorporated into the emissions modeling.

Emissions Estimates

EPA's MOVES2014a model was used to estimate emission rates for the following scenarios:

- DeKalb County vehicle data and ATRI reported speeds; and
- DeKalb County vehicle data at free flow speeds.

MOVES estimates emissions rates for: i) passenger cars; ii) light-duty trucks; iii) single-unit long haul trucks; and iv) combination long-haul trucks as a function of vehicle speed, and then aggregates the results. To estimate the emission rates, the weekday/weekend and hourly distributions of activity from the MOVES defaults for DeKalb County were utilized. However, the real-world vehicle speed data collected by ATRI is likely more accurate than the default speeds contained within MOVES for DeKalb County, so each hourly period was modified based on the ATRI-developed speed distribution. As a comparison, this analysis was repeated using free-flow conditions which were assumed to be a constant average speed of 55 miles per hour. The model was run for each of these scenarios on an hourly basis with the results generated on an annual basis.

Results

In order to estimate the total fuel consumption and emissions impact for the project area, total vehicle miles traveled were multiplied by the emission rates (grams/mile) derived from the MOVES model for each category of vehicle. Aggregate annual estimates are shown in Table 2.

Table 2. Estimated Change in Fuel Consumption and Emissions Associated with Free-Flow Conditions at the Intersection of I-285 and I-85

	DeKalb County			
	Scenario A: Current Speeds	Scenario B: 55 MPH	Difference	% Change
I-285/ I-85 daily VMT	2,920,000	2,920,000	--	
Gasoline (gallons/year)	39,645,899	36,818,991	-2,826,908	-7.1%
Diesel (gallons/year)	15,214,587	13,593,993	-1,620,594	-10.7%
NOx (tons/year)	757	716	-41	-5.5%
ROG (tons/year)	138.8	118.4	-20.4	-14.7%
PM2.5 (tons/year)	31.9	26.4	-5.5	-17.1%
CO2 (tons/year)	558,933	513,079	-45,854	-8.2%

Conclusion

This analysis estimated the fuel consumption and emissions benefits of improving the interchange of I-285 and I-85 just northeast of Atlanta. The data sources used to develop the estimates included average vehicle speeds by time of day, traffic counts and emissions factors.

Based on these sources, fuel consumption and emissions from existing traffic conditions were estimated and compared to an assumed free-flow condition. This analysis reveals that if improvements to the interchange were made to allow the free-flow of traffic, fuel consumption and emissions could be reduced.

Increasing average vehicle speeds to 55 mph is projected to save 4.5 million gallons of fuel annually among the vehicles passing through the project area. This is equivalent to a fuel economy increase of 7 percent for gasoline vehicles and nearly 11 percent for diesel vehicles. Associated annual emissions reductions range from 41 tons of oxides of nitrogen (NOx), representing a 5.5 percent reduction in this smog-forming pollutant; to 5.5 tons of fine particulate matter or a 17 percent reduction in PM2.5 emissions when traveling through the project area. Emissions of carbon dioxide, which is the primary pollutant associated with climate change, are estimated to be reduced by nearly 46,000 tons or 8 percent of the CO2 produced within the project area. These reductions in fuel consumption and emissions illustrate the potential ancillary benefits which could be achieved by making road improvements which eliminate or reduce congestion at this interchange as well as others throughout the nation.