TRUCK EMPTY BACKHAUL

January 2018

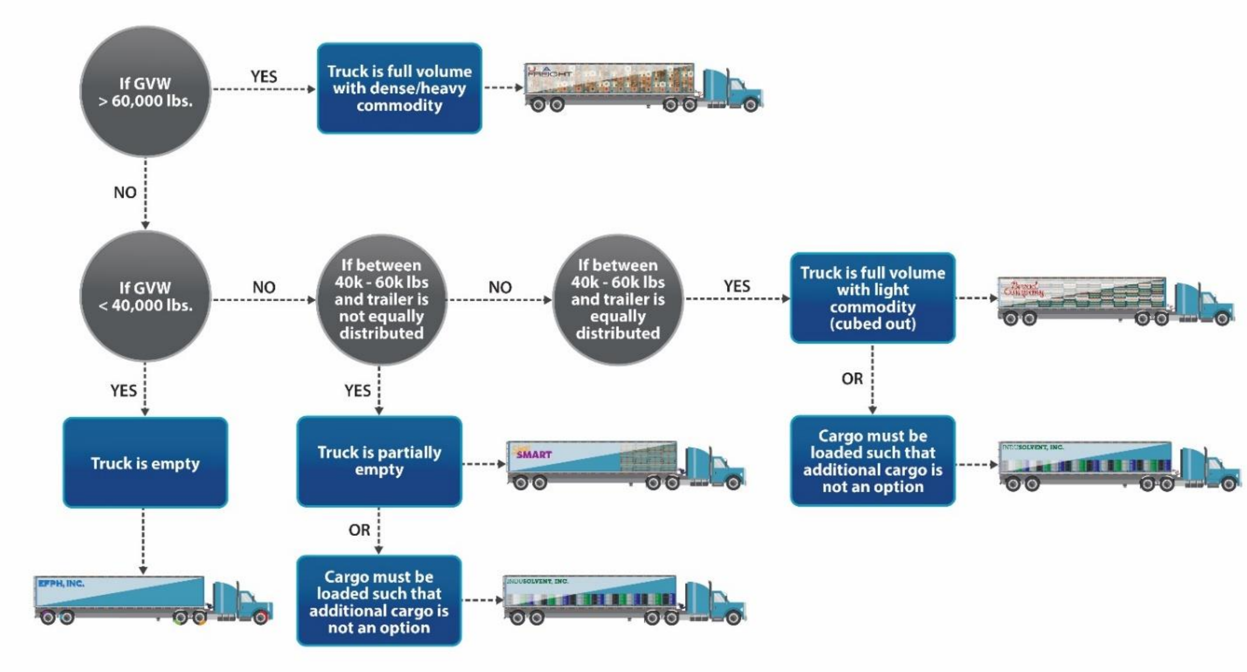
Transportation Data and Analytics Office

A FLORIDA FREIGHT STORY

EXECUTIVE SUMMARY

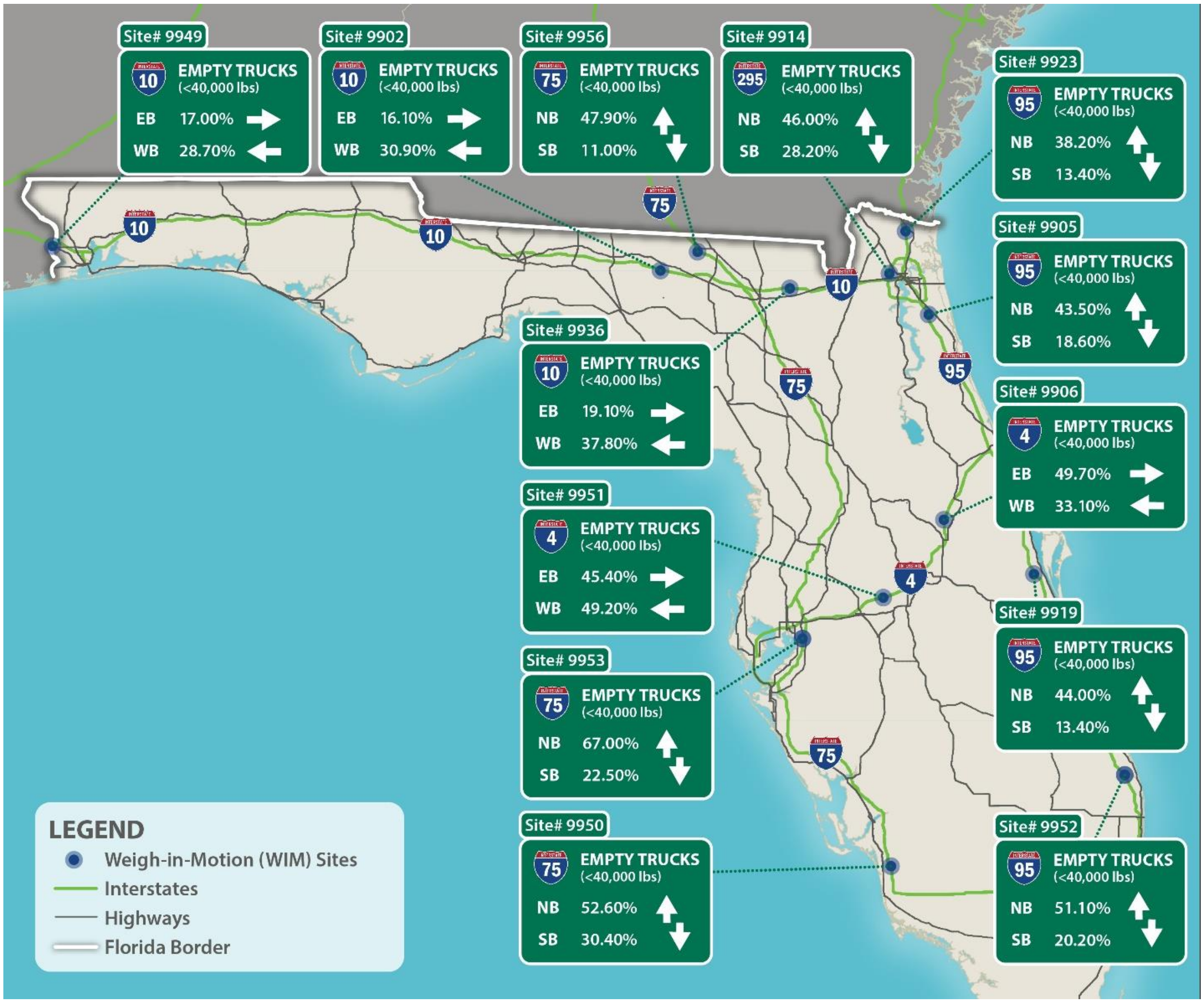
Empty backhaul is one of the freight industry challenges facing Florida. In the trucking industry, backhaul is the return movement of a truck from its original destination to its point of origin. When the truck is not hauling cargo during this movement, it is considered an empty backhaul. Historically, Florida has been a consumer state where truckers brought consumer goods to capitalize on market opportunities. However, due to a relatively small manufacturing sector coupled with the state's distance from other major U.S. consumer markets and production centers, those same truckers who bring goods to this state often return either partially loaded or completely empty. In 2011, 146 million tons of freight came into Florida while only 85 million tons left the state as per the Florida Freight Mobility and Trade Plan, 2013. This imbalance of trade flows is the fundamental reason behind empty backhaul. Empty backhaul tends to increase supply chain costs, as carriers need to pass along the cost of empty backhaul to shippers and customers. It also reduces both productivity and profitability of the motor carrier industry. Addressing empty backhaul reduces costs and environmental impacts for the commercial motor vehicle industry. During the passage of House Bill 599 in 2012, the Florida Legislature acknowledged that empty backhaul was a significant issue for Florida. Section 334.044(33)(a), Florida Statutes (F.S.), required that the Florida Freight Mobility and Trade Plan include "investments that capitalize on the empty backhaul trucking and rail market in the state." While this has been a discussion topic since the 1980s, the industry made few attempts to systematically quantify empty backhaul to gain insights into the magnitude of the problem.

The purpose of this project is to quantify truck empty backhaul in Florida using weigh in motion (WIM) data. The WIM dataset contains information on date, time, travel direction, travel lane, truck gross weight, vehicle class, vehicle length, axle spacing and axle weights for each truck passing through 30+ WIM stations across the state of Florida. We used WIM data from 2015 through 2017 for this analysis. The figure on the next page illustrates the analysis methodology.



The fundamental hypothesis behind the methodology is that the gross vehicle weight (GVW) of a truck is an indicator of emptiness or fullness. Based on empirical research, we established that if the gross vehicle weight is greater than 60,000 lbs., the truck is full. Similarly, if the gross vehicle weight is less than 40,000 lbs., it is empty. Trucks with gross vehicle weight between 40,000 lbs. and 60,000 lbs. are either partially empty or cubed out (reached the volume limit of a container).

It is a common practice for the trucking industry to push cargo forward within a box trailer, thereby showing greater weight on axle 3 compared to axle 4. This loading practice improves vehicle stability and safety and allows room for shippers to add additional loads per trip. Acknowledging this industry practice, axle weight load distribution analysis was conducted in order to determine whether a truck with gross vehicle weight between 40,000 lbs. and 60,000 lbs. is partially empty or cubed out.



Given the purpose of the analysis, only WIM sites on the interstate system were considered, as trucks using the interstate are likely to be long haul trucks. In addition, we only considered Class 9 trucks in the analysis since most of long haul commodity is typically transported on Class 9 trucks (60-80% of all trucks that pass through these WIM sites are Class 9 trucks).

The figure above shows the percentage of empty trucks by direction of travel. The percentage of empty trucks leaving the state ranges between approximately 30% and 50% depending on the corridor. In addition, approx. 10% trucks on these corridors are partially empty. It is also important to note that approximately 15% to 20% trucks entering Florida are also empty. The percentage of empty trucks in the inbound direction is highest during the month of May, while the percentage of empty trucks in the outbound direction is the lowest during the same month. Less seasonal variation is observed for the inbound direction compared to the outbound direction. The data showed that the percentage of empty trucks increases during the middle of the day as compared to overnight.

Several Florida specific factors and general industry factors influence empty backhaul. Being a consumer state, Florida consumes more than it produces and more freight comes into Florida than Florida exports to other states. High number of retirees and visitors, an economy focused on the service industry, and the lack of manufacturing in the state all contribute to the cause. Some types of cargos can only be transported with specialized modes and equipment. Thus, even if there is cargo available for a backhaul movement the conveyance for the inbound haul may not be suitable. For example, tanker trucks that carry orange juice, milk, or cooking oil cannot be used to haul caustic chemicals immediately without thorough cleaning. Many transport flows are over short distances covering a specific sequence, such as feeders or local deliveries. They may thus be unavailable for backhaul cargo opportunities that could be further away.

The Florida Freight Mobility and Trade Plan and Motor Carrier System Plan addressed empty backhaul and identified 3 strategies:

1) Seek to increase the development of manufacturing industries in the state;

2) Investigate the need for trailer transfer stations to allow drivers to stay within smaller regions with switchovers for longer hauls; and

3) Support projects that improve the efficiency of goods movement at the statewide level.

The Florida Department of Transportation is investing in infrastructure that will support industries that will create more outbound freight and thus reduce empty backhaul movements. In addition, the Department is developing strategies and policies to capitalize on the empty backhaul trucking and rail markets in the state. Florida Legislature has also pushed for the development of Intermodal Logistics Centers (ILCs) and growth of the manufacturing industries in the state. Currently, companies and various entities are exploring opportunities to minimize the losses due to empty or light backhaul through early detection and planning. Emerging technological and partnering solutions like Empty Miles and Uber Freight also hold much promise. Collapsible cargo containers hold potential to reduce the number of trucks needed to return multiple cargo containers from their destination back to their origin. Potential exists for a host of other logistic opportunities such as improved loading and unloading times and container storage benefits. As the industry evolves, the Department is exploring new ideas and defining the rules of engagement for successful outcomes.

Based on the findings of the study, we recommend the following actions for Department's consideration:

- Expand the analysis scope for future efforts to include all freight modes. While truck empty backhaul paints a good picture of the trade imbalance in Florida, a comprehensive multimodal evaluation will provide better insights into the forces influencing empty backhaul and potential solutions.
- Obtain industry data to better understand private sector perspective of empty backhaul. The industry is constantly exploring options to maximize efficiency of their supply chain to reduce cost and maximize profitability. Private parties may be able to offer unique business perspectives that influence empty backhaul.
- Investigate opportunities to improve the quality of the WIM data, perhaps through regular calibration of the WIM sites and coordination with the FDOT Motor Carrier Size and Weight Office.
- Investigate opportunities to improve the robustness of the WIM data. For example, it was identified that Class 9 tractors with no trailer (3-axle bobtails) are currently classified as Class 6 single-unit 3-axle trucks. Creating a new bin (14) within the WIM data could more accurately reflect empty truck movements since, by default, any bobtail Class 9 tractor is not hauling cargo.
- Consider a partnership with Florida Department of Agriculture and Consumer Services and Florida Department of Revenue to identify cargo inside trailers and/or other commodity related data. This additional data for analysis may reveal which industries result in the greatest percent of empty truck movements.
- Investigate Bill of Lading data acquired by FDOT Traffic Operations.
- Leverage synergies between Freight Facilities dataset, Truck Taxonomy research, Empty Backhaul analysis, and Vehicle Inventory and User Survey.
- Consider a Florida Freight Commodity Survey to understand commodity flows at a micro-level.

TABLE OF CONTENTS

APPENDICES

APPENDIX A – References

APPENDIX B – Attributes of Weigh in Motion Data

APPENDIX C – FHWA Vehicle Classification Scheme

APPENDIX D – Truck Percentages by Vehicle Class

APPENDIX E – Average Gross Vehicle Weight Per Unit Length

APPENDIX F – Average Gross Vehicle Weight Per Unit Length By Month

APPENDIX G – Empty and Full Trucks by Direction of Travel

APPENDIX H – Trucks with Gross Vehicle Weight 40K to 60K lbs

APPENDIX I – Empty Trucks by Month

APPENDIX J – Empty Trucks by Time of Day

Page intentionally left blank.

CHAPTER 1: INTRODUCTION

Context

In the trucking industry, backhaul is the return movement of a truck from its original destination to its point of origin, whether full or empty. When the truck is not hauling cargo during this movement, it is considered an empty backhaul. According to the National Private Truck Council, more than one quarter (28%) of the miles travelled by private fleets in the U.S. are with empty trucks. Empty trucks negatively affect the utility and efficiency of the trucking industry with increased supply chain costs, reduced productivity, increased emissions, unnecessary fuel consumption, added roadway congestion and inefficient use of driver resources.

Florida has a large, complex multimodal freight transportation system. High truck empty backhaul has been widely acknowledged as a major issue in Florida. It has also been widely believed that there is a negative trade imbalance with heavier truck head haul into Florida when compared to truck backhaul out of Florida. The following are studies, reports and plans specific to Florida on this issue:

- During the passage of House Bill 599 in 2012, high truck empty backhaul was considered a major issue.
- Section 334.044(33) (a), Florida Statutes (F.S.), made it a requirement for the Florida's Freight Mobility and Trade Plan to include "investments that capitalize on the empty backhaul trucking and rail market in the state."
- Florida Freight Mobility and Trade Plan (FMTP) and the newly released Florida's Motor Carrier System Plan (FMCSP), both rank truck empty backhaul as a major issue in Florida. They rated empty backhaul to have 3.8 / 5.0 average importance rating.
- The Florida Chamber Foundation's Trade and Logistics Study identified an imbalance of trade flows as one of five challenges facing Florida.

The issue of high truck empty backhaul has been identified as a regular phenomenon in Florida in the past few decades. The Florida Department of Agriculture and Consumer Services sponsored research projects in the 1980s to address truck empty backhaul associated with the Fresh Fruits and Vegetables industry. Currently, companies and various entities are exploring opportunities to minimize the losses due to empty or light backhaul through early detection and planning. As trade opportunities continue to increase, the challenge is to create ways to reduce the number of empty trucks moving across Florida's transportation network.

Figure 1 illustrates a typical representation of an empty backhaul trip in a freight supply chain.

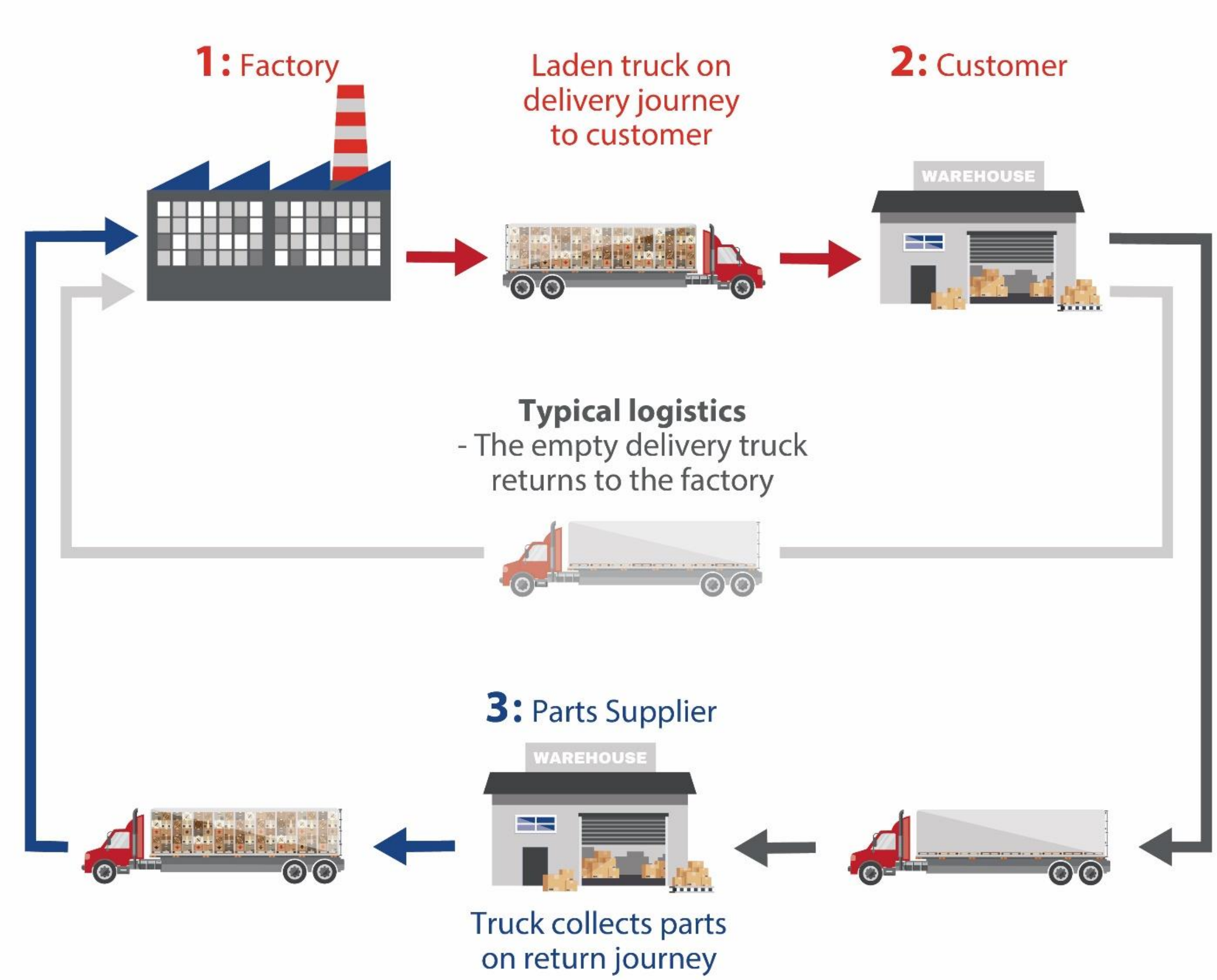


Figure 1 - Empty Backhaul Trip in a Freight Supply Chain
(Source: http://eurekapub.eu/case-study/2013/03/14/backhauling-boosts-logistics-cost-effectiveness)

Literature Review

A literature review was conducted to explore similar past efforts and seek ideas for analyzing truck empty backhaul using weigh in motion (WIM) data. A full list of reviewed documents is included in Appendix A. The following are excerpts and summaries from the relevant literature.

1) *Using Weigh-in-Motion Data to Calibrate Trade Derived Estimates of Mexican Trade Truck Volumes in Texas, Transportation Research Board.*

This paper examines how WIM data collected on truck corridors can be used in the determination of standardized truck volumes (termed equivalent trade trucks or ETT) on international highway corridors. Data from the Texas-Mexico border are used to determine ETT NAFTA volumes.

"Some limits can be drawn from observing the values of the peak modes and their standard deviations. For example, a value of 32,000-34,000 pounds can be set as an upper weight limit for an empty tractor-semi-trailer, and 72,000-76,000 pounds can be set as a lower limit for trucks carrying heavy cargo that weighs out. Trucks partially full or carrying cube out commodities will lie between those limits. For the purposes of this paper, empty trucks are those that weigh less than 32,000 pounds, while cube out trucks are those that weigh between 32,000-72,000 pounds. The lower limit for trucks that weigh out was established as 90 percent of the maximum load (80,000 pounds). Overloaded trucks were those with gross vehicle weights higher than 80,000 pounds, the U.S. federal truckload limit on most U.S. interstate highways." (page 7)

2) *Traffic Monitoring Guide (2001), FHWA, US Department of Transportation*

This guide provides methodologies and guidelines for collecting, analyzing and applying traffic data for transportation planning.

"Truck volumes and characteristics can also change by direction. One example of directional differences in trucks is the movement of loaded trucks in one direction along a road, with a return movement of empty trucks. This is often the situation in regions where mineral resources are extracted. Volumes by vehicle classification can also change from one direction to another, for example when loaded logging trucks (classified as 5-axle tractor semi-trailers) move in one direction, and unloaded logging trucks (which carry the trailer dollies on the tractor and are classified as 3-axle single units) move in the other." (page 47)

"The resulting road groups for truck weight data should be easily identified by users of truck weight data within the State. They must provide a logical means for discriminating between roads that are likely to have very high load factors and roads that have lower load factors (i.e., between roads where most trucks are fully loaded and roads where a large percentage of trucks are either partially loaded or empty). In addition, States should incorporate knowledge about specific types of very heavy vehicles into their weight grouping process so that roads that carry those heavy trucks are grouped together, and roads that are not likely to carry those trucks are treated separately. For example, roads leading to and from major port facilities might be treated separately from other roads in that same geographic area, simply because of the high load factor that is common to roads leading to/from most port facilities.

In the 1990s, Australia proposed a similar grouping technique in the chapter on traffic data collection in its pavement design guide (Update of the AUSTROADS Pavement Design Guide – Traffic Design Chapter, Final Draft Working Document, September 1998). In the Australian guide, 25 different truck-loading patterns are identified nationwide. These patterns are structured by type of trucking movement, and the infrastructure linkages being served." (page 116)

Table 1 shows axle spacing and weights for class 9, five axle semi-trucks.

Table 1 - Axle Spacing and Weights for FHWA Class 9, Five Axle Semi-Truck

	Weight (lb), by Type of Axle or Vehicle								Spacing (ft), by Type of Axle			
Statistic	Steer	Drive No. 1	Drive No. 2	Trailer No. 1	Trailer No. 2	GVW (lb)	NVW (lb)	Log Weight (lb)	Steer to Drive No. 1	Drive No. 1 to Drive No. 2	Drive No. 2 to Trailer No. 1	Trailer No. 1 to Trailer No. 2
Loaded												
Average	12,225	15,610	17,369	19,020	18,478	82,701	32,331	50,370	17	4	27	7
SD	2,856	4,668	2,785	3,287	2,570	4,064	1,879	4,528	1.5	0.2	2.6	2.5
Maximum	18,540	25,900	22,680	22,660	25,300	91,900	36,120	60,380	19	4.5	32.5	10.5
Minimum	9,030	5,660	10,300	8,160	13,230	78,060	30,860	44,070	14	4	24	4
Sample	20	20	20	20	20	20	20	20	20	20	20	20
Empty												
Average	9,930	6,953.3	6,736	4,011	4,493	32,257	32,158	0	16	4	28	6
SD	609	657	714	573	515	1,904	1,954	0	1.7	0.2	3.1	1.7
Maximum	10,640	8,180	7,940	5,010	5,080	35,560	35,560	0	19	4.5	32.5	8.5
Minimum	8,650	6,220	6,000	3,220	3,490	30,860	30,860	0	14	4	24	4
Sample	12	12	12	12	12	12	12	12	12	12	12	12

NOTE: No. = number; SD = standard deviation.

(Source: Traffic Monitoring Guide (2016), FHWA)

3) *Analysis of Data on Heavier Truck Weights: Case Study of Logging Trucks (2015), Transportation Research Board.*

This document provides a reference point for observed WIM data for heavy vs. empty trucks and additional research for determining thresholds for our analysis.

4) *Quick Reference Freight Manual II (2007), FHWA.*

This manual brings up the point about using VIUS (2002) as a validation/reference point. In Virginia, it was assumed that the most efficient freight carriers operate at 20% empty or less (page 5-10). In addition, the manual indicated that the Florida Freight Model does not account for empty miles by direction (page 4-47). Table 2 shows Florida freight model tonnage to truck conversion factors (note that Florida recently developed a new model called Florida Freight Supply-Chain Intermodal Model, FreightSIM).

Table 2 - Florida Freight Model Tonnage to Truck Conversion Factors

	Average Payload in Pounds					
Commodity Group	On Road Average	Less Than 50 Miles	50-100 Miles	100-200 Miles	200-500 Miles	500+ Miles
Agricultural	16.36	9.20	18.14	21.95	19.48	17.79
Minerals	20.82	20.62	17.50	21.07	N/A	23.00
Food Products	18.23	8.64	18.60	22.29	21.10	21.23
Nondurable Manufacturing	8.68	3.58	5.05	18.10	6.22	14.79
Lumber	14.03	4.70	25.19	22.39	28.32	24.16
Paper	15.11	11.32	9.96	19.86	17.00	18.48
Chemicals	16.59	11.61	20.75	19.62	23.46	18.66
Petroleum Products	21.04	19.55	25.52	27.32	21.85	17.33
Durable Manufacturing	11.38	5.12	6.97	18.72	19.21	17.23
Concrete, Clay, Glass, Stone	18.47	15.82	20.31	19.97	22.71	22.40
Non-Municipal Waste	12.90	10.28	17.03	16.15	23.07	21.03
Miscellaneous Freight	12.44	6.90	7.21	20.89	19.29	18.43
Warehousing	9.07	9.02	6.53	23.91	3.34	11.56
Average	14.21	9.97	12.02	20.57	19.61	18.80

(Source: Quick Reference Freight Manual II (2007), FHWA.)

5) *An Assessment of Empty Backhauls and their Impact on Perishable Produce Truck Shipments: Florida Fresh Fruits & Vegetables (1982), University of Florida*

"Total direct variable costs per unit of FF&V transported increases as the amount of empty backhauls increases. Although no exact figures exist, it is estimated that 30-50 percent of those truck hauling Florida FF&V experience empty backhauls. Empty backhauling creates resource use inefficiencies which result in higher costs to shippers and receivers." (page 75)

"Empty backhaul miles per trip represent 35 percent of the average front haul mileage of Florida FF&V truckers. There appears to be adequate exempt and nonexempt commodities coming into Florida to reduce this percentage; however, government regulation, lack of information concerning the locations of backhauls, the cost of finding a backhaul, and the opportunity cost of using specialized equipment to haul general freight have kept this from happening." (page 76)

6) *The Determinates of Full-Empty Truck Movements (1986), Agricultural and Applied Economics Association*

"A model is developed to explain full-empty movement decisions for motor carriers. The model is estimated for movements to Florida of carriers serving the Florida produce/ ornamentals industry. The results indicate that carriers act rationally, basing their decisions on a wide range of factors. The findings also suggest that regulatory restrictions continue to result in unnecessary empty movements." (page 67)

"The Interstate Commerce Commission (ICC) found that over 20% of refrigerated trailers on inter- state highways were empty (ICC, p. 12), and the estimates for specialized equipment (e.g., tank truck and bulk goods carriers) ranged as high as 40%. Finally, ownership of an ICC authority appears to be an important determinant of south-bound full/empty movements for fleet carriers. This suggests that the interstate regulatory structure continues to contribute to unnecessary empty movements despite the reforms of the Motor Carrier Act of 1980. The magnitude of the added costs of regulation-forced empty movements to the agricultural transportation sector is a matter of speculation; however, its existence is almost a certainty." (page 67)

Methodology

Based on literature review and research, we developed this methodology to quantify empty backhaul using WIM data. The WIM dataset contains information on date, time, travel direction, travel lane, truck gross weight, vehicle class, vehicle length, axle spacing and axle weights for each truck passing through 30+ WIM stations across the state of Florida. Appendix B contains information on WIM data attributes and Appendix C contains information on FHWA vehicle classification. Given the purpose of the analysis, we considered only WIM sites on the interstate system since trucks using the interstate are likely to be long haul trucks. In addition, we considered only Class 9 trucks in the analysis because that truck type carries most long haul commodity shipping (60% of all trucks that pass through these WIM sites are Class 9 trucks).

Figure 2 shows the methodology flow chart. The fundamental assumption behind the methodology is that the gross weight of a truck is an indicator of emptiness or fullness. Based on empirical research, we assumed that if the gross vehicle weight is greater than 60,000 lbs., the truck is full.

A) Full Truck = Gross vehicle weight > 60,000 lbs.

Similarly, if the gross vehicle weight is less than 40,000 lbs., it is empty. Trucks with gross vehicle weight between 40,000 lbs. and 60,000 lbs. are either partially empty or cubed out (reached the volume limit of a container).

B) Empty Truck = Gross vehicle weight < 40,000 lbs.

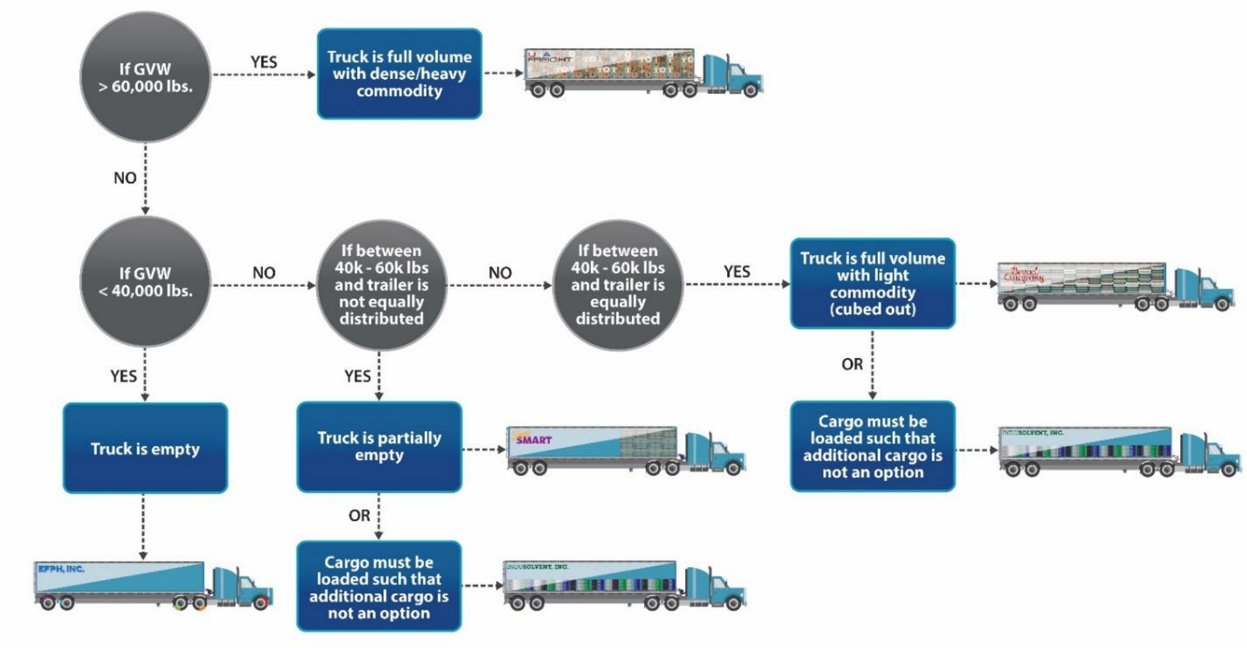


Figure 2 - Methodology Flow Chart

It is important to note that even though a trailer may be partially empty, this does not necessarily mean that it has additional cargo carrying capacity. For example, some cargo cannot be mixed, high value items may not occupy the entire trailer (cost/per mile is such that additional revenue is not necessary, or allowable given time constraints), and some cargo must be loaded in specific ways.

It is a common practice for the trucking industry to push cargo forward within a box trailer, thereby showing greater weight on axle 3 compared to axle 4. This loading practice improves vehicle stability and safety and allows room for shippers to add additional loads per trip. Acknowledging this industry practice, we conducted an axle weight load distribution analysis in order to determine whether a truck with gross vehicle weight between 40,000 lbs. and 60,000 lbs. was partially empty or cubed out.

C) Partially Empty = Unequal Trailer Weight Distribution = If > 5% difference (between axles 3 & 4, of 5 axle vehicle) = Available capacity for additional cargo

These trucks are full on the leading axles but have zero or partial cargo weight on the trailing axles. The focus is on the weight distribution between axles 3 and 4. If the weight distribution reaches a specific threshold, indicating that axle 3 has a significantly higher proportion of the total trailer weight compared to axle 4, then it can be assumed that significant space is still available for additional cargo. The original idea was to compare axles 2/3 to 4/5, but the analysis showed that simply comparing 3 and 4 is faster and simpler to automate within the traffic polling software and the intent was to make it a standard data item within the WIM data.

D) Cubed Out (Full) = Equal Trailer Weight Distribution = If < 5% difference (between axles 3 & 4, of 5 axle vehicle) = No available capacity

These trucks might be full by volume but are light by weight. These trucks can be identified using the assumption that the weight distribution of the "Light weight but full" truck follow a similar distribution to "Full weight" trucks. For example, if a truck weighs 50,000 lbs. but the weight distribution is equal over axles 3 & 4, then it can be assumed that the trip is "light weight but full" (i.e., 'cubed out').

Axle weight load distributions for full, empty, partially empty and cubed out trucks are shown in Figures 3 through 6. These percentages were calculated based on observations and analysis of multiple individual WIM records. Information was provided to corroborate the overall weight and axle weight distribution of an empty Class 9 tractor with a refrigerated trailer (GVW of 34,160 lbs.). The figures were further verified by expert freight stakeholders.

Figure 3 - Full Class 9 Truck Axle Weight Load Distribution

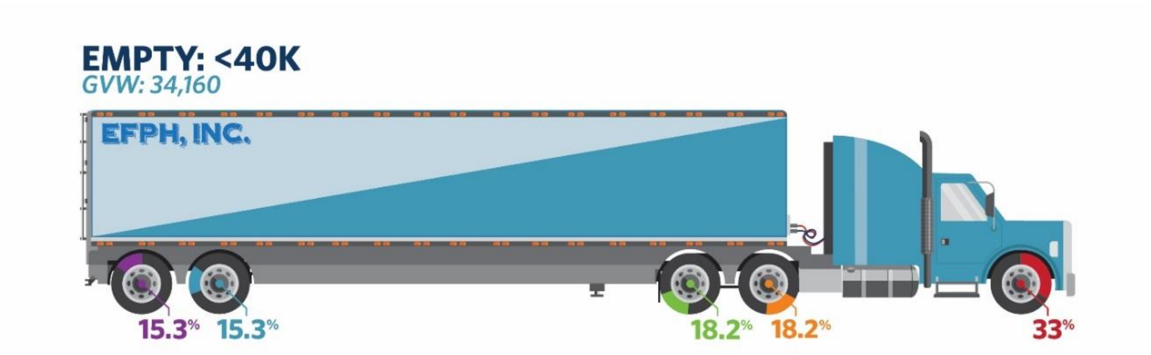


Figure 4 - Empty Class 9 Truck Axle Weight Load Distribution

Figure 5 - Full Volume but Light Weight Class 9 Truck Axle Weight Load Distribution

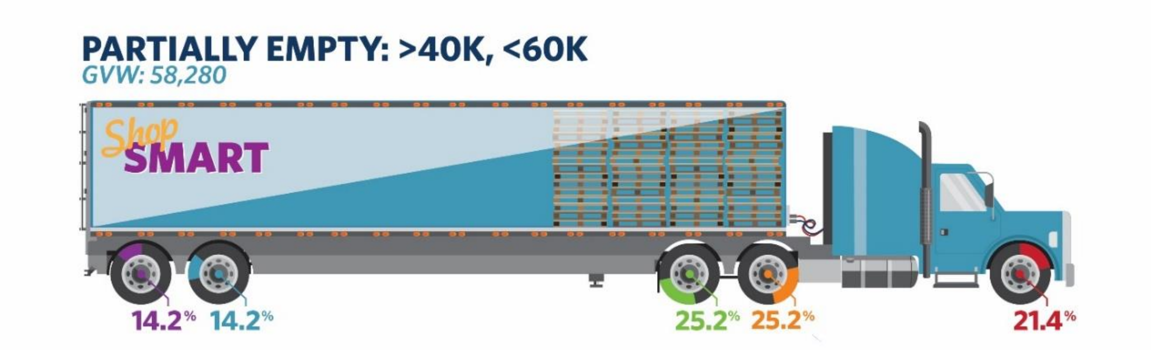


Figure 6 - Partially Empty Class 9 Truck Axle Weight Load Distribution

CHAPTER 2: WIM DATA ANALYSIS AND FINDINGS

Data Introduction and Validation

Weigh-in-motion is the process of estimating the motionless (static) weight of a vehicle from measurements of the vertical component of dynamic tire forces applied to a sensor on a smooth, level road surface. The WIM dataset contains individual records of trucks (FHWA Classes 5 to 12) passing through each WIM site in the state. The dataset includes date, time, travel direction, travel lane, gross vehicle weight, vehicle class, vehicle length, axle spacing and axle weights for each truck (refer to Appendix B for a complete list of the data attributes). We used WIM data from 2015 through 2017 for this analysis.

Strength of dataset: This micro dataset is composed of individual records as opposed to an aggregate dataset. Aggregate datasets are compiled statistics, but micro-datasets are more detailed and inherently flexible. Users do not have to depend on published statistics from a data source that compiled the data in a certain way. Users can generate their own statistics from the data in any manner desired, including individual-level multivariate analyses.

Limitations of dataset: The WIM data may not include all days/times due to sensor damage or cover all lanes due to sensor installation practices. Additionally, if calibration of the sensors is not performed regularly, observed weights will drift over time.

Quality assurance of dataset: This exercise assures that the quality of data is suitable for analysis and processing. Since the WIM dataset is a micro dataset, validation and cross-references are needed to ensure that the data is valid, sensible, reasonable, and secure. These validation techniques are explained below and illustrated in Figure 7.

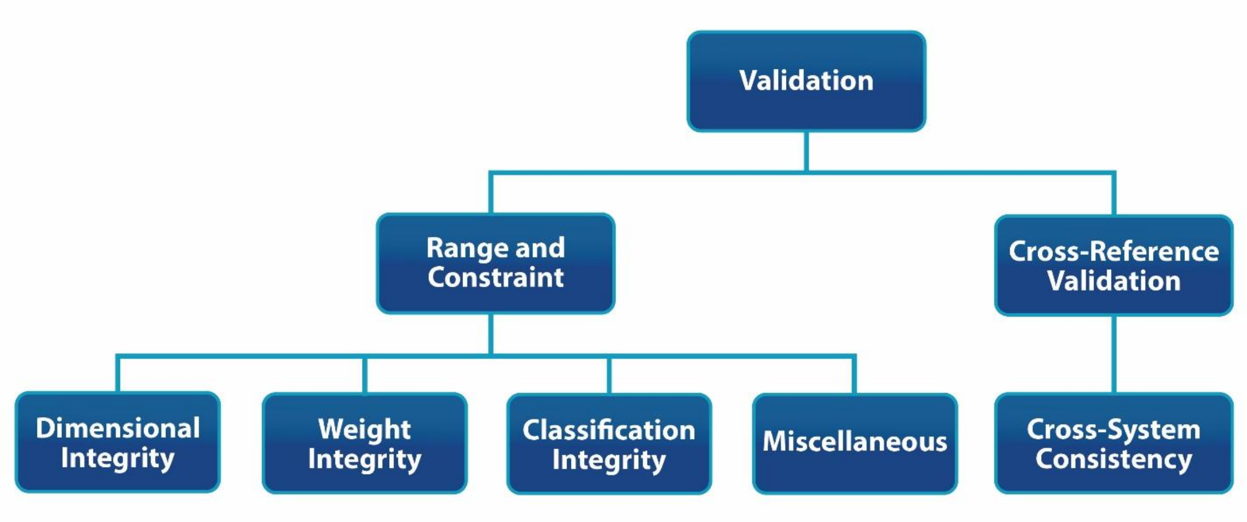


Figure 7 - Validation Technique

Range and Constraint Validation: We performed this validation on multiple data fields. Simple range and constraint validation examined user input for consistency with a minimum/ maximum range, or consistency with a test for evaluating a sequence of characters, such as one or more tests against regular expressions.

- Dimensional integrity: The focus was on the dimensional variables of the individual records (length and spacing of truck and axles). The typical dimensions for different truck types were identified through literature review. The validation rules helped to identify records that fail this sieve test.
- Weight integrity: The focus was on the weight variables of the individual records (gross vehicle weight and weights of axles for different trucks). The typical dimension for different truck types were identified through literature review.
- Classification integrity: The trucks were classified as per FHWA Vehicle Scheme F code. FDOT produced a classification tree based on length, number of axles and axle spacing. The tree already identifies the records with errors as Class 15s. This rule provides a double check of the error records and helps to identify and verify these records.

The FDOT Motor Carrier Size and Weight (MCSAW) office maintains Weigh Station data - these are separate locations from the existing TDA WIM locations. They collect the same attributes as the ones collected by TDA WIM sites. The MCSAW sites that are in close proximity to TDA WIM sites and near the Florida state line along the multiple corridors were considered for this validation exercise.

Data Development and Preparation

We received the raw data files as monthly text files from January 2015 through September 2017 for the entire state of Florida. The dataset is large, complex and contained over 100 million records for trucks (class 4-15). A snapshot of the data is shown in Figure 8.

COUNTY	SITE	DIR	LANE	BEGDATE	TIME_INTERVAL	SCHEMEF_CO...	VEHTYP	SPD	VEH_LENGTH	GROSS_WT
32	9956	S	6	11/30/2017	220712	11	60	62	7415	52490
32	9956	S	6	11/30/2017	135705	9	40	63	6883	75244
32	9956	S	6	11/30/2017	135716	9	40	66	6824	35718
32	9956	S	6	11/30/2017	135736	5	20	68	3163	16998
32	9956	S	6	11/30/2017	135740	9	40	65	7743	77934
32	9956	S	6	11/30/2017	135802	9	40	70	7402	47950
32	9956	S	6	11/30/2017	135821	9	40	74	7323	49758
32	9956	S	6	11/30/2017	135828	9	40	63	7464	80996
32	9956	S	6	11/30/2017	135854	9	40	65	7365	80600
32	9956	S	6	11/30/2017	135909	9	40	69	7162	52294
32	9956	S	6	11/30/2017	135916	9	40	66	7513	41492
32	9956	S	6	11/30/2017	135926	9	40	70	7159	76742
32	9956	S	6	11/30/2017	135929	9	40	65	6982	69446
32	9956	S	6	11/30/2017	135946	9	40	68	7572	35718
32	9956	S	6	11/30/2017	140004	9	40	65	7096	58464
32	9956	S	6	11/30/2017	140012	9	40	65	7477	37634
32	9956	S	6	11/30/2017	140014	9	40	64	7530	61796

Figure 8 - Snapshot of WIM Dataset

The WIM sites across the state appear in Figure 9. We obtained the data for all 30+ WIM sites for this period, except the site on I-75 near Florida / Georgia state border (site "9956"). The data collection at this site began in June 2017 and data was acquired through November 2017.

Figure 9 - WIM Sites in the State of Florida

Some data cleanup was required, post validation, but prior to running detailed analysis. To help eliminate records with errors, the data includes an attribute, "Type", which labels all records that do not conform to the thresholds established by the FDOT's tree classification algorithm with "E." Records that do not conform to the FHWA vehicle scheme classification of trucks were removed. This variable eliminates records that were classified as Class 15s. Other algorithms ensure that every record is within acceptable length, weight and travelling at acceptable speeds. Then, all error records that pass through the sites within the project limits are eliminated (nearly 15% of the records are errors).

Once the data was free of errors, it was imported into SPSS and a set of derived variables were computed including Linear Gross Vehicle Weight Density, Axle Weight Distribution and Axle Spacing Distribution. These variables with their mathematical formulae are shown in the following table.

Table 3 – Estimation of Derived Variables Using WIM Data

Name/ Definition of Derived Variables	Mathematical Formulae
Linear GVW/Unit Length is the ratio of gross weight and wheel base length.	$\frac{\text{Gross Weight}}{\text{Wheelbase Length}}$
Axle Weight Distribution is used to understand the skewness of the weight distribution across the axles. It was computed for every axle of truck as the ratio of every axle weight to its gross weight.	$\frac{Axle\ Weight_i}{\text{Gross Weight}}$ …where, (i is axle number)
Gross weight is a continuous variable, but Gross Weight Range is a conversion of this continuous variable into a discrete categorical variable. The categories were considered in increments of 5,000 lbs. of gross weight.	$0 < \text{Gross}_{\text{Wt}} < 20{,}000$ $20{,}000 \leq \text{Gross}_{\text{Wt}} < 25{,}000$ $25{,}000 \leq \text{Gross}_{\text{Wt}} < 30{,}000$ $30{,}000 \leq \text{Gross}_{\text{Wt}} < 35{,}000$ $35{,}000 \leq \text{Gross}_{\text{Wt}} < 40{,}000$ $40{,}000 \leq \text{Gross}_{\text{Wt}} < 45{,}000$ $45{,}000 \leq \text{Gross}_{\text{Wt}} < 50{,}000$ $50{,}000 \leq \text{Gross}_{\text{Wt}} < 55{,}000$ $55{,}000 \leq \text{Gross}_{\text{Wt}} < 60{,}000$ $60{,}000 \leq \text{Gross}_{\text{Wt}} < 65{,}000$ $65{,}000 \leq \text{Gross}_{\text{Wt}} < 70{,}000$ $70{,}000 \leq \text{Gross}_{\text{Wt}} < 75{,}000$ $75{,}000 \leq \text{Gross}_{\text{Wt}} < 80{,}000$ $80{,}000 \leq \text{Gross}_{\text{Wt}} < 85{,}000$ $85{,}000 \leq \text{Gross}_{\text{Wt}} < 90{,}000$ $90{,}000 \leq \text{Gross}_{\text{Wt}}$

Name/ Definition of Derived Variables	Mathematical Formulae
Axle weight distribution variable is a continuous variable, but Axle Weight Percent Range is a conversion of this continuous variable into a discrete categorical variable. The categories were considered in increments of 10 or 15 of axle weight percent.	$0 \leq \text{Axle Weight Percent} < 15$ $15 \leq \text{Axle WeightPercent} < 25$ $25 \leq \text{Axle WeightPercent} < 35$ $35 \leq \text{Axle Weight Percent} < 50$ $50 \leq \text{Axle WeightPercent} < 65$ $65 \leq \text{Axle WeightPercent} < 80$ $60 \leq \text{Axle WeightPercent} < 70$ $70 \leq \text{Axle WeightPercent} < 80$ $80 \leq \text{Axle Weight Percent}$

As mentioned before, we determined that majority of long haul truck movement that occurs between states would predominantly occur on the interstate system. For this reason, the analysis concentrated on the WIM sites that are on the interstate system. There are 13 sites located on the interstates that provide continuous data. These sites are shown in Figure 10.

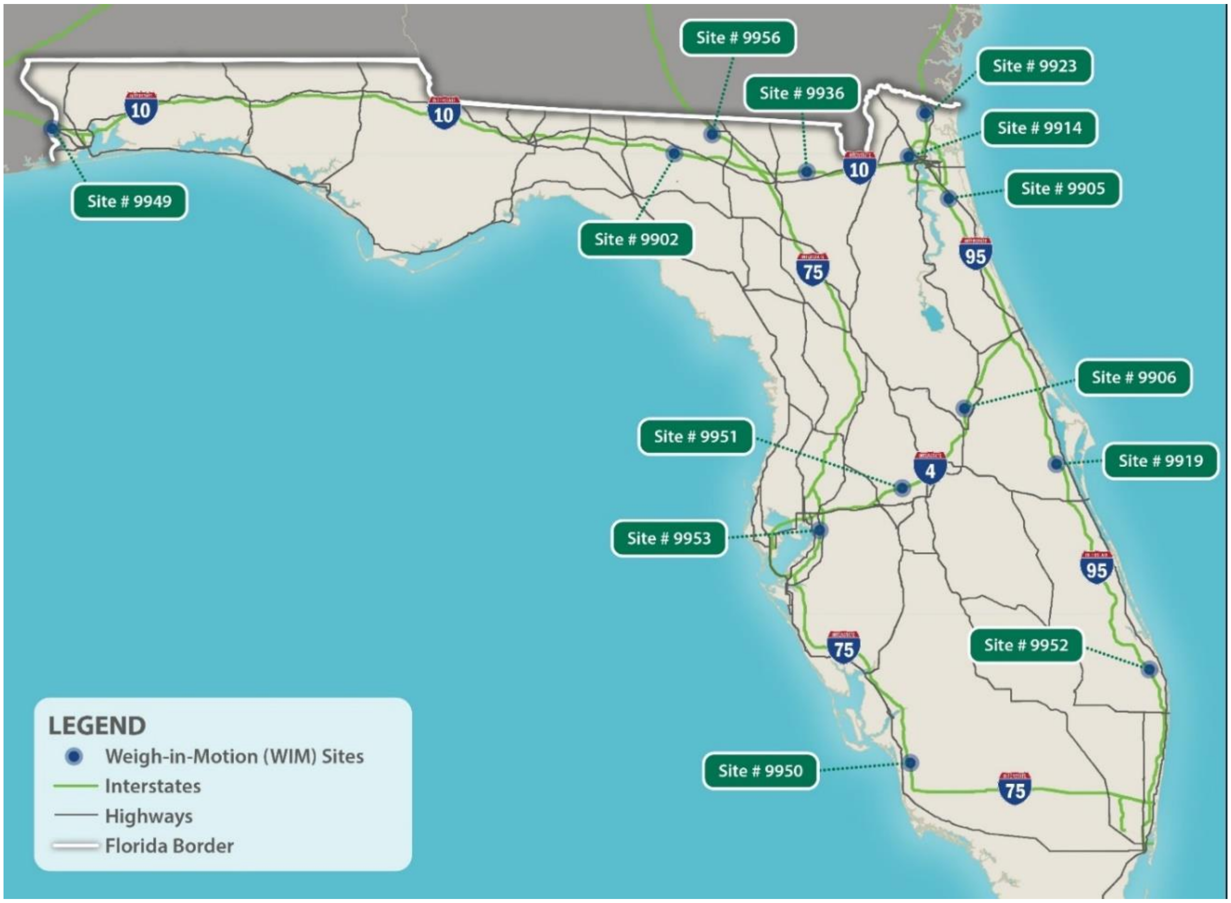


Figure 10 - WIM Sites on Interstate System

A distribution analysis of truck traffic by vehicle class on these sites (Figure 11) indicated that nearly 63% of all trucks that pass through these WIM sites are Class 9 trucks. A detailed distribution of truck traffic over several months confirmed Class 9 trucks to be the highest percentage over all months.

The other important reason to focus on Class 9 trucks is that they typically transport most long haul commodities. The percentage of Class 9 trucks is even higher on sites near the state borders on I-95, I-75 and I-10. The site on I-95 in Nassau County reflects nearly 78% of data to be Class 9 trucks (refer to Appendix D).

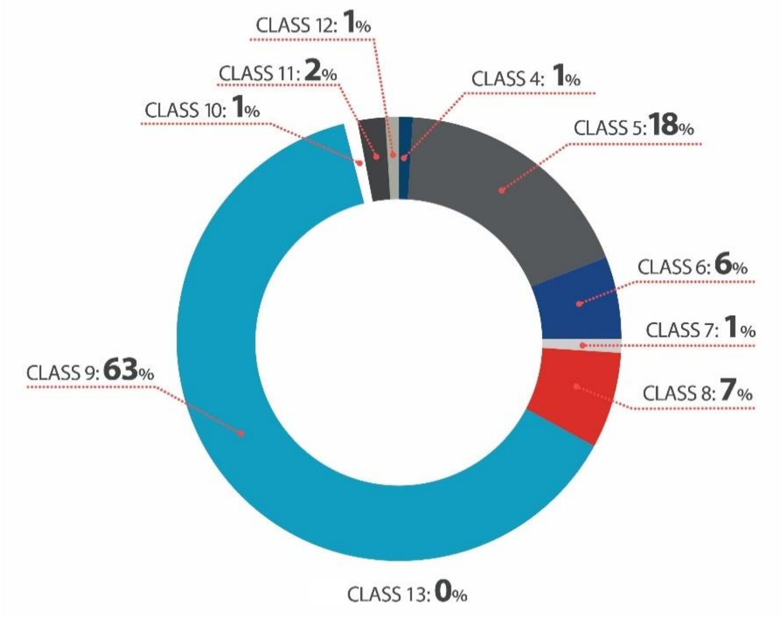


Figure 11 - Percentage of Trucks by different vehicle classes passing through the WIM sites on the Interstate system

Data Analysis

As noted above, we trimmed the raw data received to reflect only sites on the interstates. This was done for every monthly file before merging all the cases into one file to form a dataset with records on all sites on the interstates. The final dataset used for the analysis was the merged dataset for all the months including data for Class 9 trucks on interstate sites only. Prior to finalizing the methodology, we conducted multiple iterations of multivariate analysis to understand the statistical outcome of different variables. Gross weight of each record was analyzed and bins created to understand the distribution of weights of Class 9 trucks across the sites. Analysis of empty weights was also conducted. However, without the knowledge of the cargo information, it was not effective to use the empty weights as a measure. Percentage of weight distribution over each axle was calculated to help identify the uniformly distributed trucks. A statistical distribution analysis was conducted to compare the axle weights between axles 3 and 4. A variable was computed to identify if the truck weighed between 40,000 and 60,000 lbs. One of the derived variables, linear gross vehicle weight per unit length, is of significant importance in understanding freight commodity movement on Florida's interstate system. The measure was computed by taking the ratio of gross vehicle weight to wheel base length. The gross vehicle weight per unit length variable helps in identifying which direction of travel has greatest freight flow by weight. This gives the user a general idea of the pattern of the weight of import vs. export near the state borders. Table 4 shows the average linear gross vehicle weight per unit length of truck passing through the interstate sites at the state line by direction of travel and class of truck.

Table 4 - 3-year Mean Gross Vehicle Weight per unit length of Truckload by Vehicle Class

Site	Location	Class	North Direction		South Direction		East Direction		West Direction	
			Average Gross Vehicle Weight per unit length	Number of Trucks	Average Gross Vehicle Weight per unit length	Number of Trucks	Average Gross Vehicle Weight per unit length	Number of Trucks	Average Gross Vehicle Weight per unit length	Number of Trucks
9923	On I-95 (South of the State Line)	4	1,179	40,138	1,197	37,699	.		.	
		5	813	438,247	846	398,471	.		.	
		6	1,229	99,037	1,282	83,135	.		.	
		7	2,749	2,364	2,379	820	.		.	
		8	696	181,183	686	192,428	.		.	
		9	907	3,343,343	1,032	3,148,820	.		.	
		10	1,122	27,528	1,349	30,360	.		.	
		11	821	98,332	973	97,559	.		.	
		12	820	61,358	916	59,776	.		.	
		13	1,428	2,763	1,492	3,706	.		.	
9949	On I-10 (East of the State Line)	4	.		.		1,166	31,131	1,198	26,054
		5	.		.		798	411,076	822	371,326
		6	.		.		1,406	126,412	1,606	107,785
		7	.		.		2,969	7,400	3,257	19,380
		8	.		.		711	145,708	743	154,043
		9	.		.		1,014	1,521,000	963	1,419,399
		10	.		.		1,047	16,391	1,123	16,832
		11	.		.		845	39,289	847	35,892
		12	.		.		841	29,776	862	21,483
		13	.		.		1,309	3,880	1,334	4,077
9956	On I-75	4	1,307	8,284	1,266	8,549				
		5	823	88,549	826	92,600				
		6	1,160	19,452	1,235	19,369				
		7	2,643	209	2,035	203				
		8	557	89,277	554	102,108				

Site	Location	Class	North Direction		South Direction		East Direction		West Direction	
			Average Gross Vehicle Weight per unit length	Number of Trucks	Average Gross Vehicle Weight per unit length	Numbe r of Trucks	Average Gross Vehicle Weight per unit length	Numbe r of Trucks	Average Gross Vehicle Weight per unit length	Number of Trucks
	(South of the State Line)	9	860	779,914	1,045	822,539				
		10	1,504	4,600	1,026	2,542				
		11	816	37,608	965	38,776				
		12	801	29,617	911	28,756				
		13	1,472	591	1,408	914				

These numbers are pivotal in identifying gross weight surplus flowing across the state borders. For example, the average gross vehicle weights per unit length for sites 9923, 9949, and 9956 indicate a deficit in terms of average freight density coming into the state versus leaving the state indicating an imbalance in freight flow. Similar trends hold true for the other sites as shown in Appendix E. Therefore, the need for further analysis was apparent and we created a variable to identify whether the axle weight distribution between axles 3 and 4 was significantly different. This enabled us to determine the partially empty and cubed out trucks.

We analyzed the three-year average gross vehicle weight per length of truckload over different months to recognize any seasonality in either truck record numbers or in gross vehicle weight per unit length. Figure 12 below depicts the mean gross vehicle weight per unit length in lbs/feet across the data for all Class 9 trucks passing through the sites on the interstates. This line graph does not include the newer site on I-75 close to the border due to incomplete annual data.

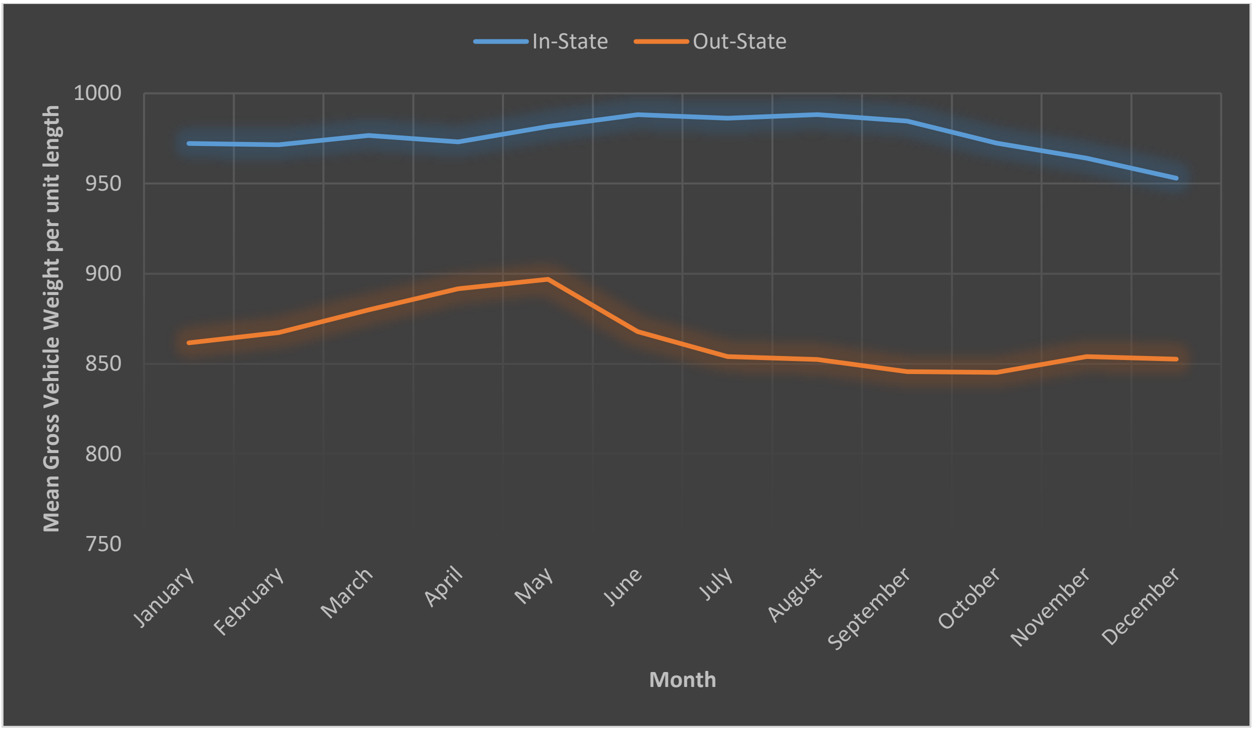


Figure 12 - Monthly Mean Gross Vehicle Weight Per Unit Length of Truckload (lbs/ft)

The analysis exhibited a relatively stable line graph for the mean gross vehicle weight per unit length in the in-state direction for the most part of the year with a noticeable increase around April to September followed by a dip in the later part of the year. In comparison, trucks leaving the state displayed a steady increase leading into May, possibly due to Florida's harvest season followed by a decline in the mean gross vehicle weight per unit length during the months of June through October. Agricultural and related products make up the primary cargo hauled out of state by trucks (14+% of total tonnage hauled by trucks out of Florida). Hence, seasonal factors observed in the figure are intuitively correct. Appendix F includes the graphs for all the individual sites.

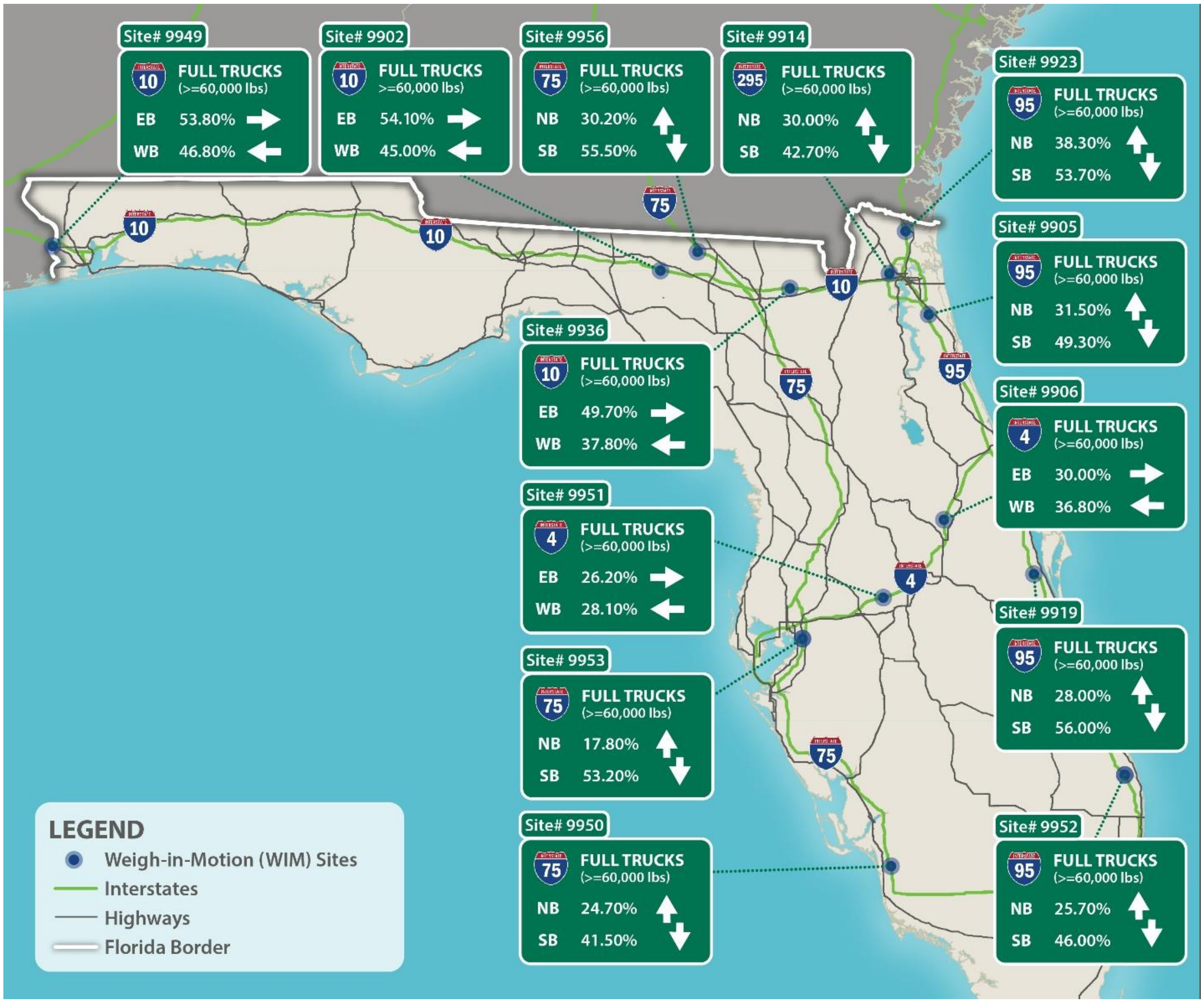


Figure 13 – Percentage of Full Class 9 Trucks by Direction of Travel

Findings and Summary

Figure 13 shows that for the three sites near the state borders there is a larger percentage of full trucks traveling into the state compared to trucks leaving the state. More than half (50+ %) of the trucks coming into the state between the years of 2015 and 2017 are full trucks in comparison to nearly 38% that left the state during the same time period. This shows the trade imbalance between freight coming in and going out of the state in terms of weight of the commodity.

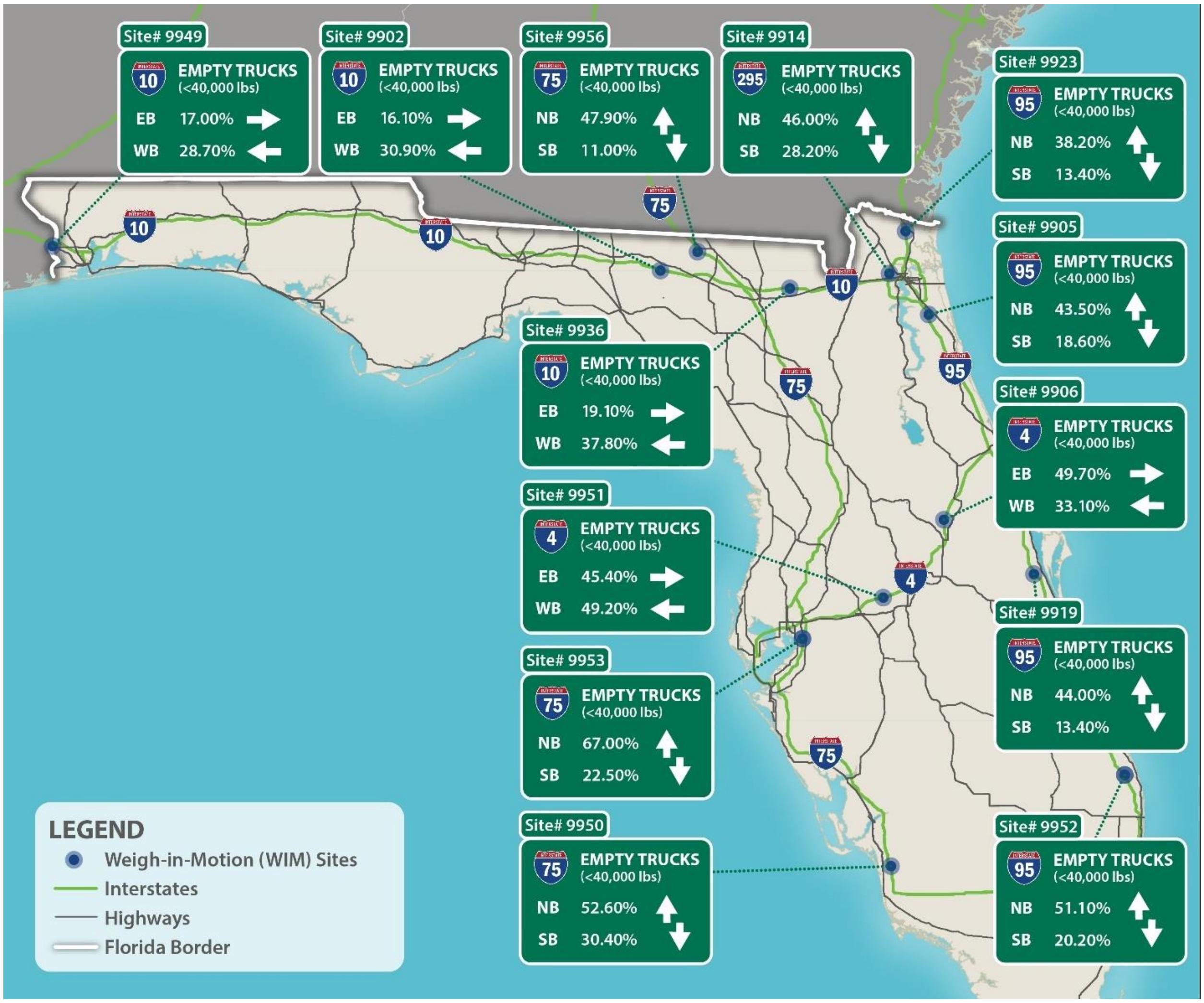


Figure 14 – Percentage of Empty Class 9 Trucks by Direction of Travel

As seen in Figure 14, nearly 38% of all trucks leaving the state and passing through the site on I-95 in Nassau County appear to be empty, while the percentage of empty trucks entering the state at this site is around 13%. There is a similar trend for a majority of the sites on the map. Note that the site on I-75 near the Florida/Georgia border shows approximately 48% empties in the northbound direction. Appendix G includes the detailed tables showing full and empty trucks by direction. Once the full and empty trucks were identified, what remains are partially empty and cubed out trucks. Figures 15 and 16 show the percentages of trucks that are cubed out and partially empty, respectively.

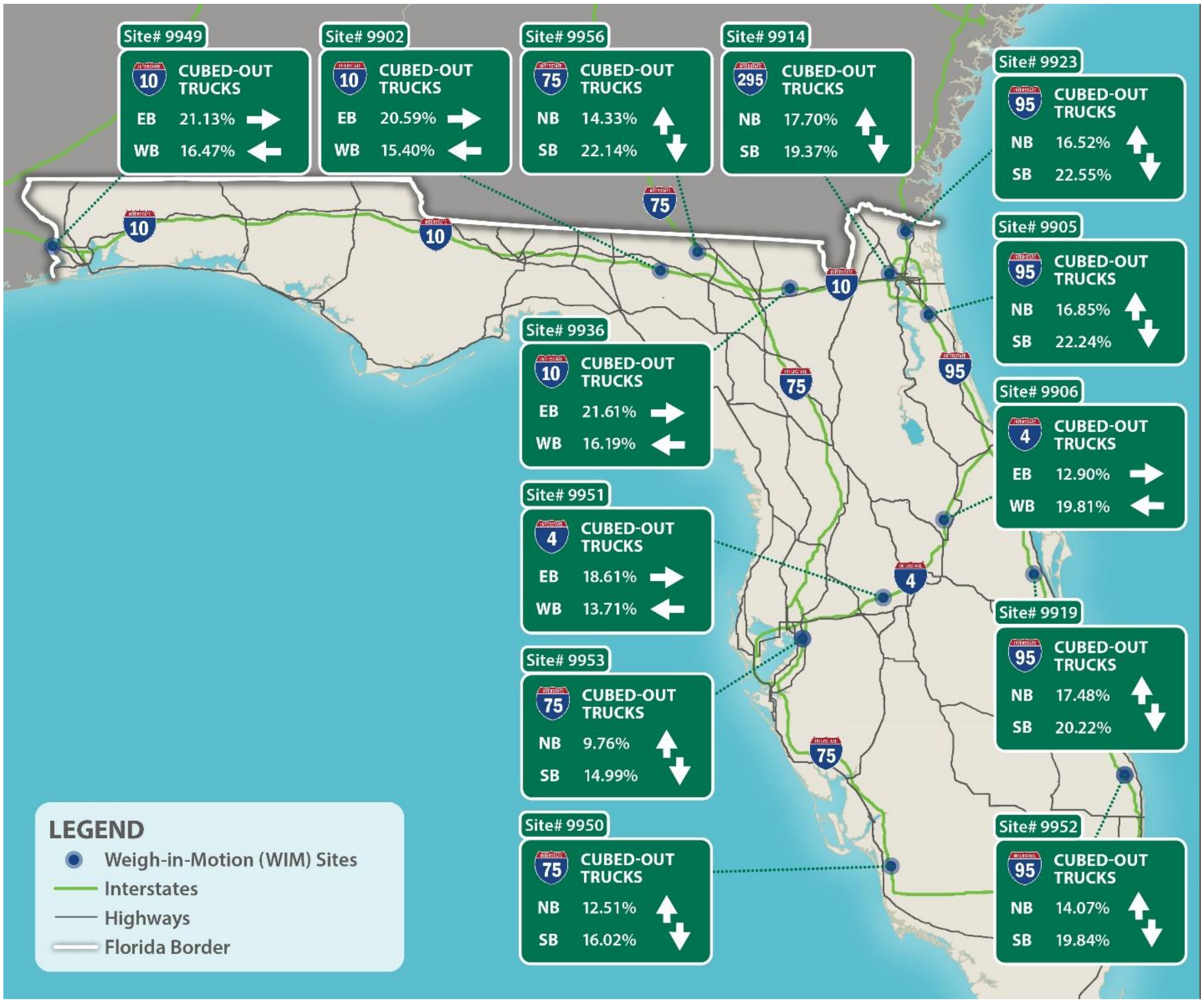


Figure 15 – Percentage of Cubed Out Class 9 Trucks by Direction of Travel

The cubed out trucks make up nearly 20% of all truck traffic at most sites. These can be potentially incorrectly classified as partially empty due to their lighter gross vehicle weights, yet no additional capacity is available for cargo. It is important to recognize this classification of trucks while quantifying empty backhaul. Partially empty trucks make up nearly 10% of all trucks at most sites. Appendix H shows the calculation of cubed out and partially empty trucks for each site.

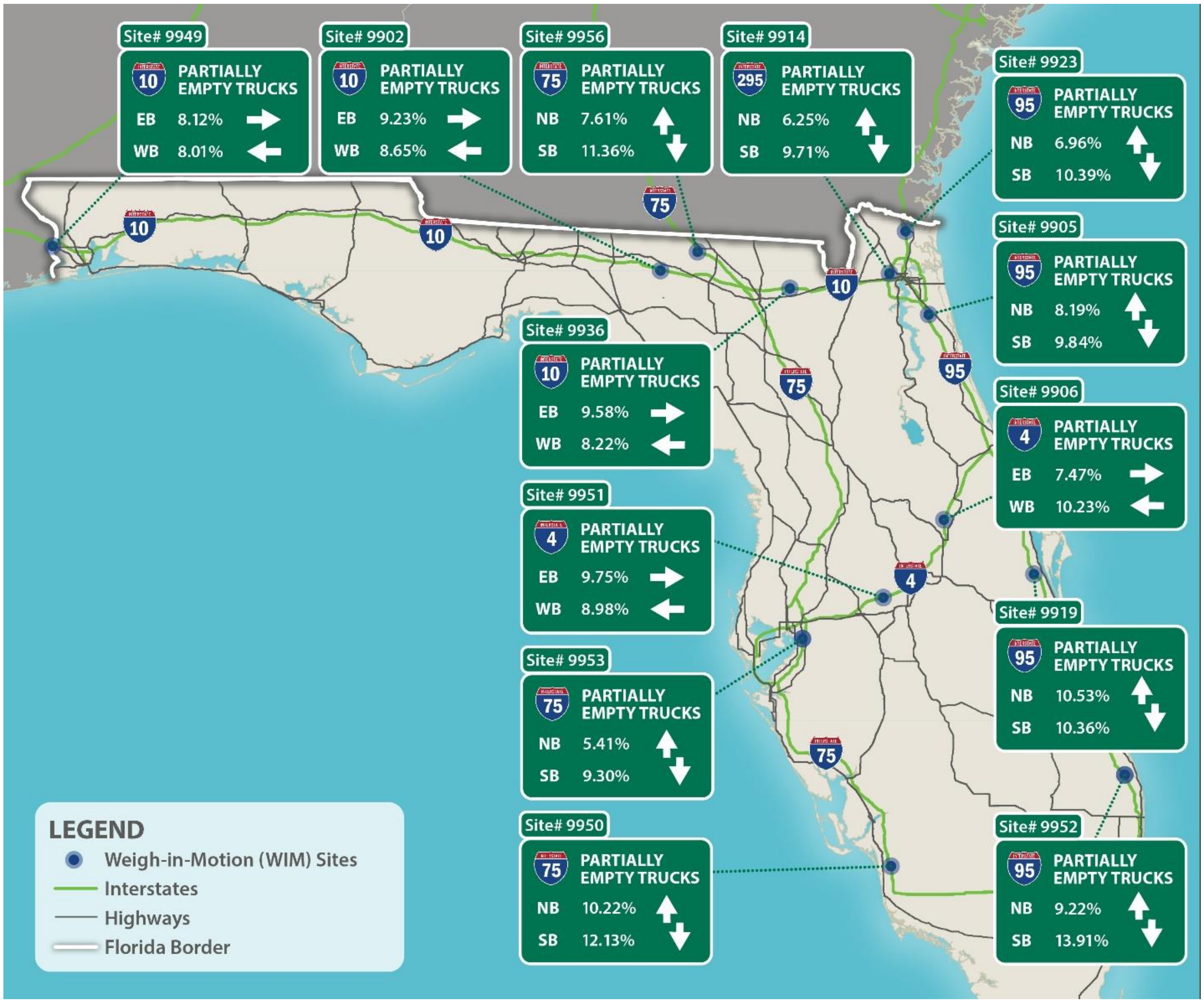


Figure 16 – Percentage of Partially Empty Class 9 Trucks by Direction of Travel

To understand the seasonality of empty backhaul, the data was analyzed by month of the year. Figure 17 illustrates the empty trucks passing through the Site on I-95 in Nassau County south of the state line by time of year. In the inbound direction, less seasonal variation is observed compared to the outbound direction. Also, percent empties are highest during May in the inbound direction, while percent empties are lowest in the outbound direction during the same month. The graphs for the other sites are shown in Appendix I.

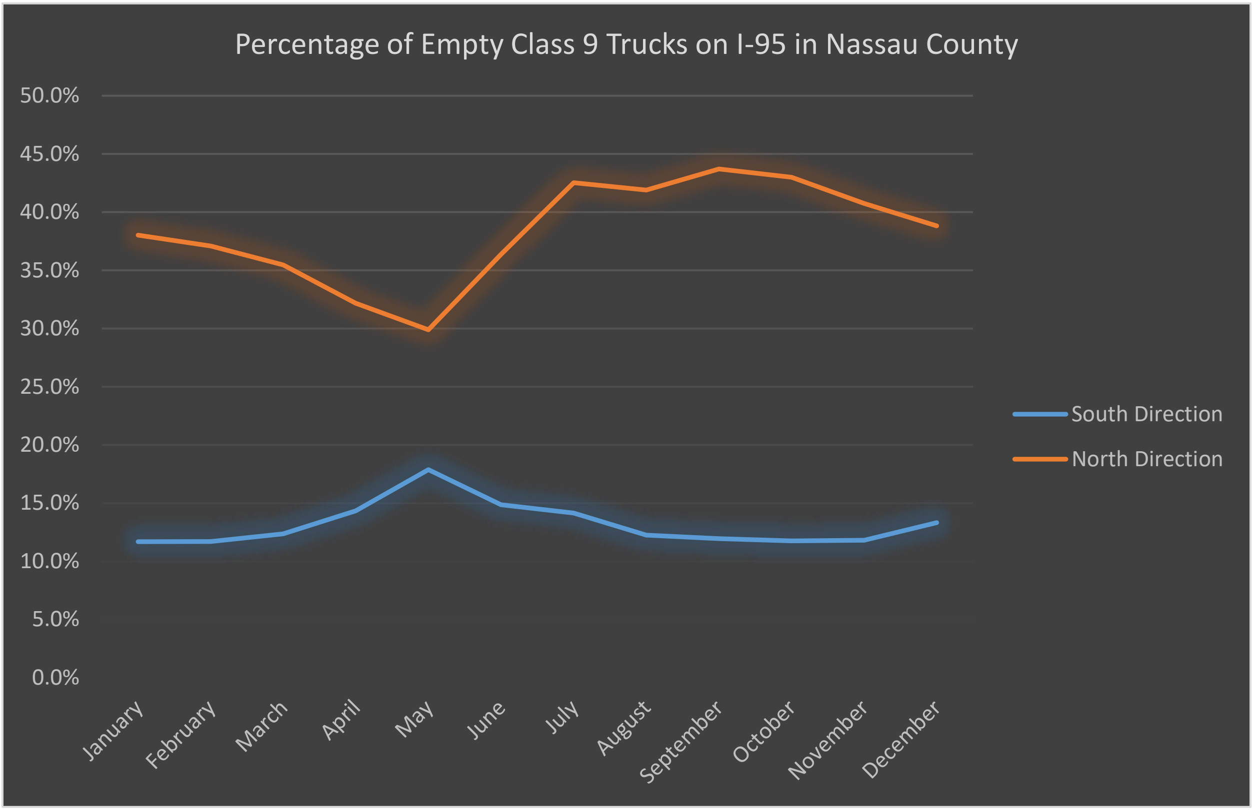


Figure 17 - Empty Class 9 Trucks by Month: I-95 in Nassau County

Percent empty Class 9 trucks were also analyzed by time of day. Figures 18 through 20 show the 3-year average percentage of empty trucks by hour of day as observed on the three sites near the state line, on I-10 in Escambia County, on I-75 in Hamilton County and on I-95 in Nassau County. The percentage of empty trucks increases during the middle of the day as compared to hours in the night. This finding is consistent with the industry knowledge and empty backhaul movements in other parts of the country. Appendix J includes the tables for all other sites.

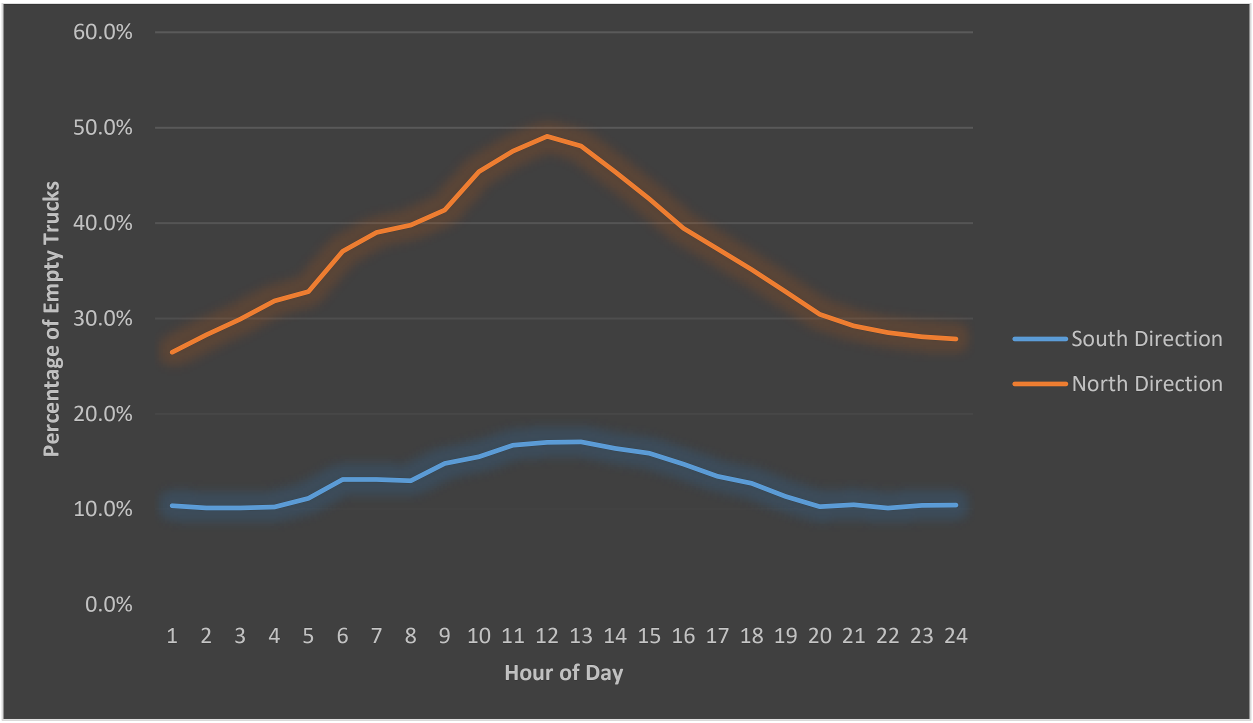


Figure 18 - Empty Class 9 Trucks by Time of Day: I-95 in Nassau County

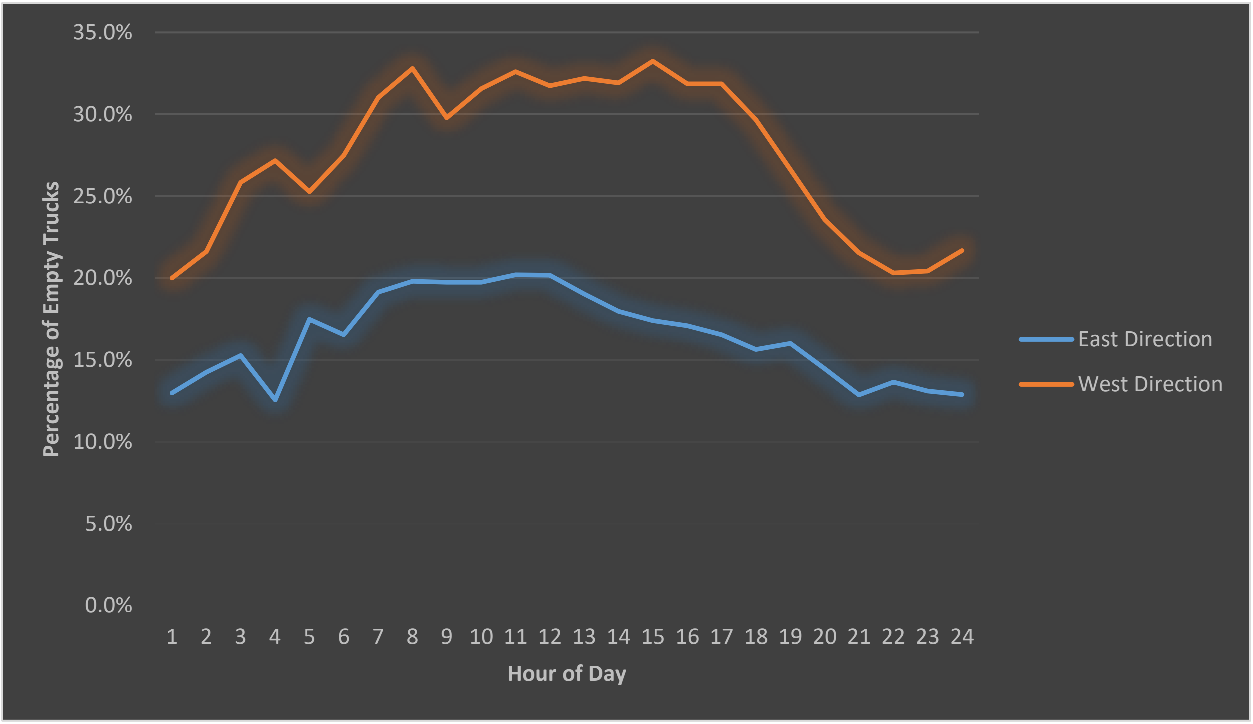


Figure 19 - Empty Class 9 Trucks by Time of Day: I-10 in Escambia County

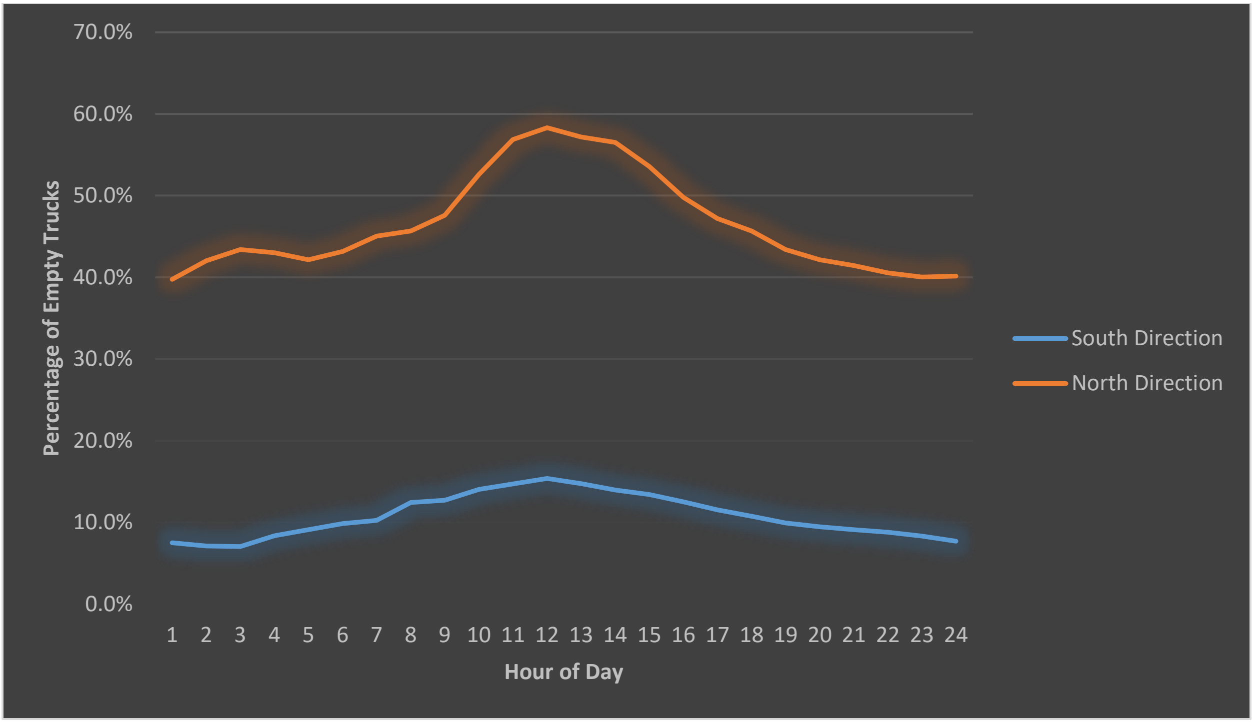


Figure 20 - Empty Class 9 Trucks by Time of Day: I-75 in Hamilton County

Macro Level Reasonableness Check

Although the analysis results using the WIM data are intuitive and consistent with the industry knowledge, we conducted a macro level reasonableness check using commodity flow survey datasets (Transearch and FAF 4).

The most recent purchase of Transearch data (year 2011) provided commodity flow information for different counties in the state of Florida. One of the commodity codes provides empty trips (STCC code = 42 21) information. Table 5 illustrates the percentage of empty truck trips moving through Florida.

Table 5 – Empty Truck trips as per Transearch data

Number of truck trips	In-State	Out-State	Inter State
Empty truck trips	548,816	1,646,031	10,710,513
Total truck trips	4,426,080	3,846,733	20,150,306
Percent of empty truck trips	12.40%	42.79%	53.15%

The outcomes indicate that the truck trips moving out of state include 42.79% empties. On the other hand, 12.40% of truck trips moving in state are empty truck trips. The 42.79 % empty backhaul is reasonably close to the numbers we identified for WIM locations close to Florida borders. Hence, we concluded that the results from WIM satisfy the macro level reasonableness check. Nonetheless, it is important to note few differences in the numbers obtained from commodity flow datasets like Transearch and WIM data.

- Transearch data is inherently a commodity flow dataset and helps us to identify O-D truck trips and O-D truck tonnages. On the other hand, WIM data provides us the spot counts of trucks and their characteristics like tonnage and dimensions.
- Transearch dataset used here is from 2011. As noted earlier, WIM data used in this project is from 2015 to 2017. Hence, some variations in the numbers are expected - 2011 numbers may reflect the lingering effects of the recession, which was not prevalent in the 2015-2017 dataset.
- WIM data used in this analysis includes Class 9 trucks only. Transearch data was for all truck types.

Freight Analysis Framework 4.3 data were also utilized to understand the types of commodities moving in and out of state. The base year of data was 2012. The top 10 commodities coming in and out of Florida via truck mode for 2012 FAF dataset are illustrated in Figures 21 and 22. Commodity tonnage hauled by trucks from Florida to out of state is 36.88 mega tons. Commodity tonnage hauled by trucks into Florida from out of state is 58.22 mega tons. These numbers indicate that there is a net negative flow moving out of state equivalent of 21.34 mega tons.

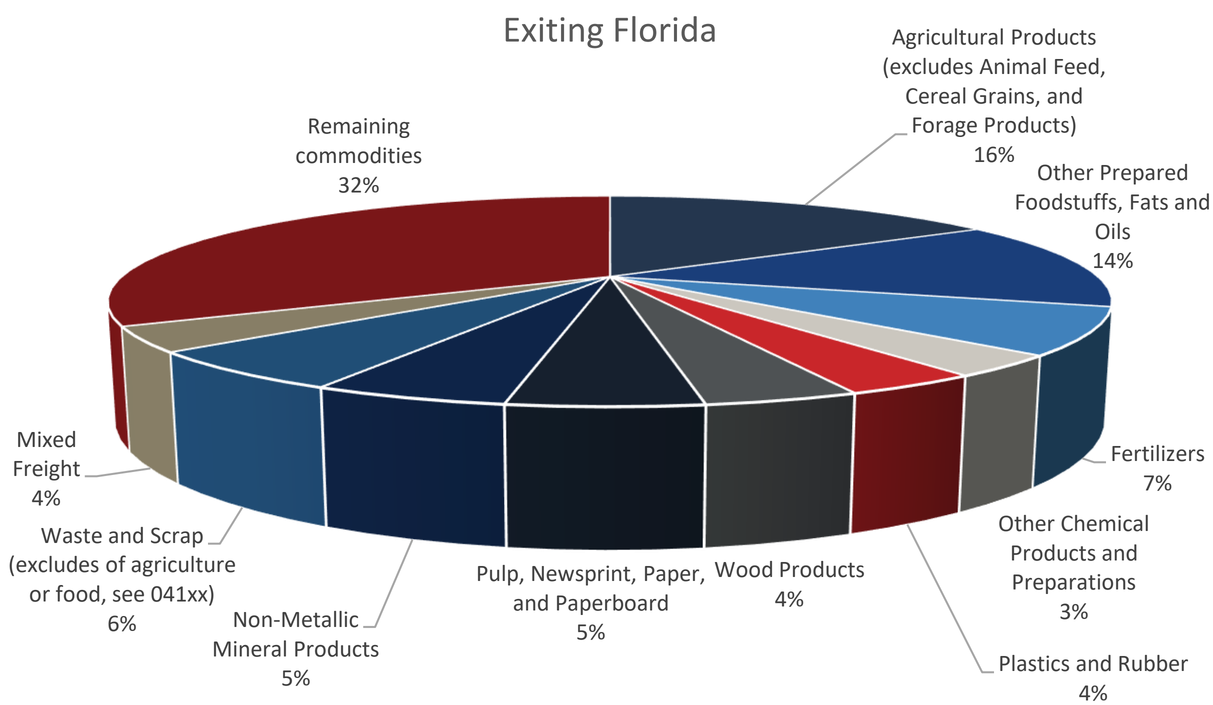


Figure 21 – Commodities Moving Out of Florida on Trucks (FAF 4.3)

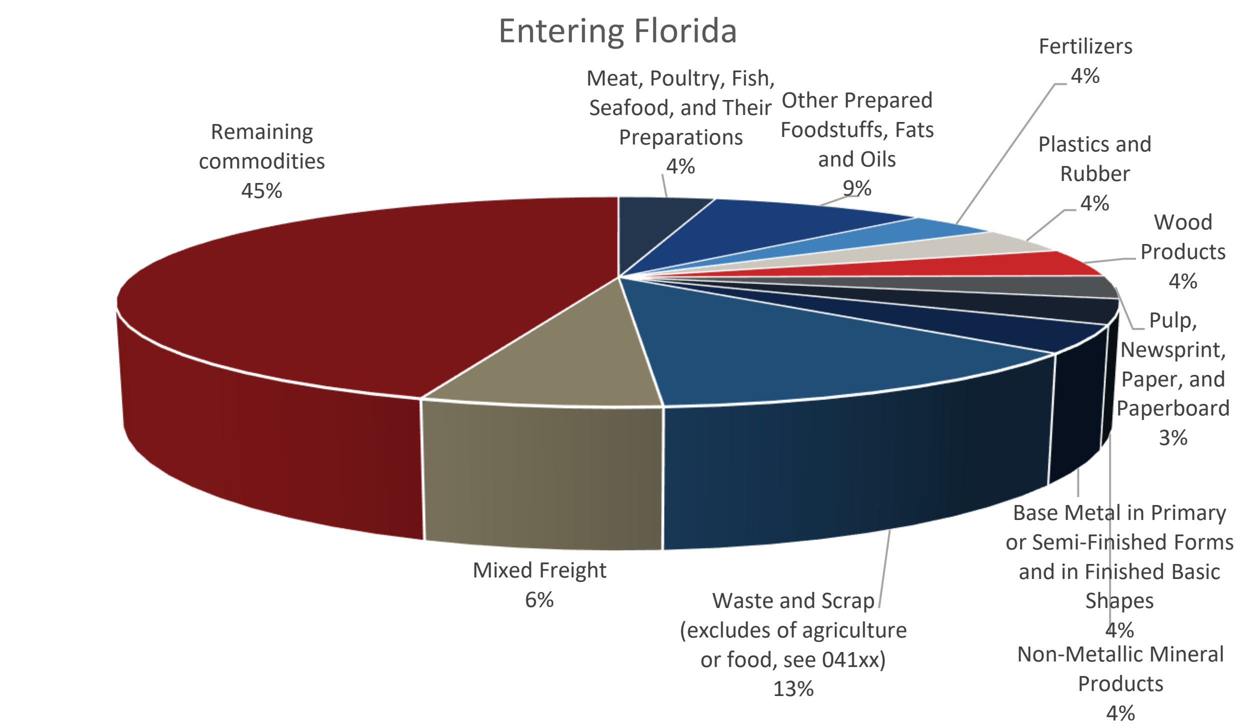


Figure 22 – Commodities Moving Into Florida on Trucks (FAF 4.3)

CHAPTER 3: FACTORS INFLUENCING EMPTY BACKHAUL

Florida Specific Factors

The Florida environment includes several factors (e.g., demographics, geography, economics, and climatic conditions) that may affect the state's balance of trade. The widely held belief that Florida consumes more than it produces and more freight comes into Florida than Florida exports to other states is true. However, the magnitude of the freight flow imbalance is regularly exaggerated.

Demographics

Highly populated (urbanized) areas have high rates of product demand (consumption). Florida is approaching a population of 21 million residents, the 3rd most populous state in the United States. Florida also has some unique demographic characteristics. First, Florida is attractive to retirees. Retirees consume, but generally do not produce. As such, Florida's population is older and relies on an extensive health care system that consumes and do not produce. Second, on any given day, Florida hosts over 3 million visitors. Visitors consume, but do not produce. Demographic composition of the state has a direct influence in contributing to the trade imbalance.

Geography

Product manufacturing and distribution tend to be located in centralized areas of the country. This permits transporting the commodities and goods in multiple directions, which facilitates meeting customer demand of a large demographic area. For example, Atlanta, Georgia has developed into a regional distribution hub for the southeastern U.S. From Atlanta, a one-day reach via truck will facilitate customers in Arkansas, Louisiana, Virginia, Southern Indiana, and most of Florida. Florida is primarily a peninsula, with natural harbors, which favors seaborne maritime freight activity. Conversely, transporting freight from south and central Florida requires a long line haul distance to markets north of Florida. This equates to longer delivery times and higher costs.

Economy

Florida has a robust agriculture industry. Citrus (primarily oranges), livestock, vegetables, sugar cane and many other products thrive in the warm Florida environment. Many of these products are transported north, out of Florida, in their original form (i.e. oranges, tomatoes.) or partially modified form (e.g., orange juice, sugar). A large percentage of edible products require climate controlled transportation equipment (i.e., refrigerated cars or "reefers") to extend its short shelf life. Food production is closely related to the agriculture industry and the transformation of raw agricultural items to those that are more easily consumed increases the value of these products. Florida has a significant aviation and aerospace industry, which includes some production. However, much of this large industry is bi-focal. First, the large military presence is primarily a consumer. Second, the private sector output is primarily new technology, research, engineering, and development and design. Tourism/hospitality is a significant industry in Florida. Florida hosts tourists from throughout the U.S., Canada, Europe, and Asia. Florida also serves as a base for passenger cruise ships, which operate throughout the Caribbean and Gulf of Mexico. Collectively tourism places a large demand for consumables such as. food, drinks, clothes, souvenirs, and other non-durable goods and services. Florida's other major industries include Healthcare/Medical, Life Sciences, Information Technology, Education and Financial services. All of these industries are service related industries, which do not produce goods and commodities in enough quantities to require interstate trucking or rail services. Some industries, like mining of phosphate and harvesting of timber, account for some export activities.

Climate/Weather

Severe storms and hurricanes, which are characteristic of Florida, often result in extended damage to both homes and businesses. These climatic events may render Florida's industries in the affected areas idle until power is restored, physical damage is repaired, and transportation infrastructure is opened, after which the workforce can return to work. The high risk of periodic productivity loss is a dis-incentive to industrial output and may incur high costs associated with the risk, i.e. high insurance rates, maintaining back up power sources, etc.

Industry Factors

Carrier operational issues contribute to deadhead miles. These issues are common throughout the U.S., but in certain geographies and markets, they may be more or less prominent. Figure 23 show four such factors – cargo/equipment specialization, imbalanced flows, short hauls and regulatory constraints.

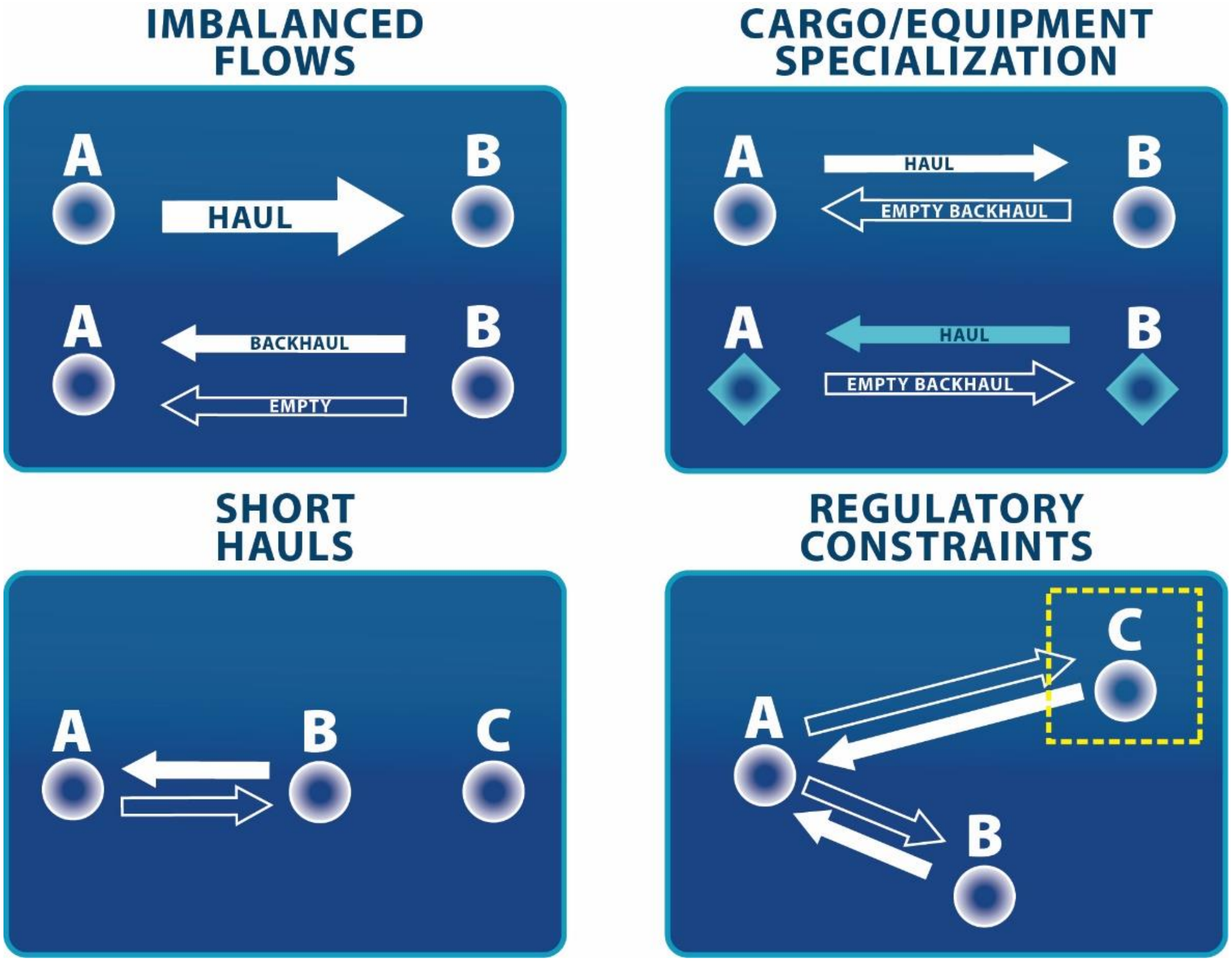


Figure 23 – Industry Factors Influencing Truck Flows
(Source: https://people.hofstra.edu/geotrans/eng/ch1en/conc1en/empty_flows.html)

Cargo/ Equipment Specialization

Some types of cargos require specialized modes and equipment for transport. Thus, even if there is cargo available for a backhaul movement, the conveyance for the inbound haul may not be suitable. First, there are many types of trailers used by the trucking industry. Dry vans are the most common trailer type and can transport wide varieties of goods and commodities. However, trailers used to transport edible food products must be clean and even odor free. Prior to loading a trailer with consumable products, shippers regularly inspect empty trailers to insure that residue, insects and moisture will not contaminate the product. If a trailer is deemed unacceptable, then the carrier must either thoroughly clean the trailer or deadhead the trailer to a shipper that has different equipment needs and standards. Bulk tank trailers are usually dedicated to specific products, such as consumable products (e.g., corn syrup or milk), chemicals, petroleum, etc. Upon delivery, the carrier must deadhead these trailers to specific shippers who can reload with like products or to washout facilities.

Some shippers require trailers that regulate the climate for their products. The most common is refrigerated trailers. Florida's varied agriculture, which includes fruit and vegetables, and the climate, characterized by high temperature and humidity, regularly necessitates the use of so-called "reefers" to keep products fresh while traveling to markets. Consequently, reefer trailers may travel empty for longer distances to meet customer demand. The Interstate Commerce Commission (ICC) found that over 20% of refrigerated trailers on inter-state highways were empty and the estimates for specialized equipment (e.g., tank truck and bulk goods carriers) ranged as high as 40%. (Bielock and Kilmer, 1986)

The rail industry makes extensive use of specialized rail cars designed for specific cargos. Rail open-top hopper cars that transport coal are dedicated specifically for that purpose. Similarly, auto-rack cars are solely used to transport automobiles. Tank cars, which are highly specialized for hauling bulk liquids, are reserved for only specific chemicals or edible products, and well cars are specially designed to transport containers. Because of the highly specialized nature of rail cars, it is common for many rail cars to have a high percentage of empty movement.

Carriers are often committed to servicing selective shippers on a daily basis. Although a driver may be in close proximity to the shipper with the right type of trailer, that driver may have reached the maximum hours-of-service (HOS) as regulated by the Federal Motor Carrier Safety Administration (FMCSA) regulations and will be unable to respond to the need. To meet the service commitment, the carrier may need to haul an empty load (deadhead) via a truck and trailer from a further distance to pick up the freight. Commercial vehicle operators must be certified to transport hazardous materials. Consequently, a carrier may need to deadhead a driver certified for hazardous materials to transport a particular hazmat shipment. Truck trailers and rail cars must provide security and protection for cargo. Freight must be protected from the natural elements (e.g., rain and excessive temperatures), from physical damage due to shifting and improper loading, and from criminal activities (i.e., theft and vandalism). On-time and damage free delivery requires qualified drivers and the right equipment. Often, deadheading is the solution to match transportation equipment with freight.

Modal shift is a topic that often arises as a tactic to reduce the quantity of trucks on the roadways. While there may be some opportunities for modal shifting, supply chain professionals work every day to balance customer service needs versus transportation and logistics costs. The goal is to get the:

Right Product to the ***Right Customer*** at the ***Right Place*** at the ***Right Time*** for the ***Right Price***

This is supply chain optimization. However, depending on customer demand, seasonality, and a variety of factors, the "right" things occasionally change. When they do, then modal switching may be an option. The various freight transportation modes complement each other to a large degree and compete with one another to a lesser degree (Figure 24). Modal switching may not positively affect the empty backhaul situation. Rather, it could exacerbate the problem.

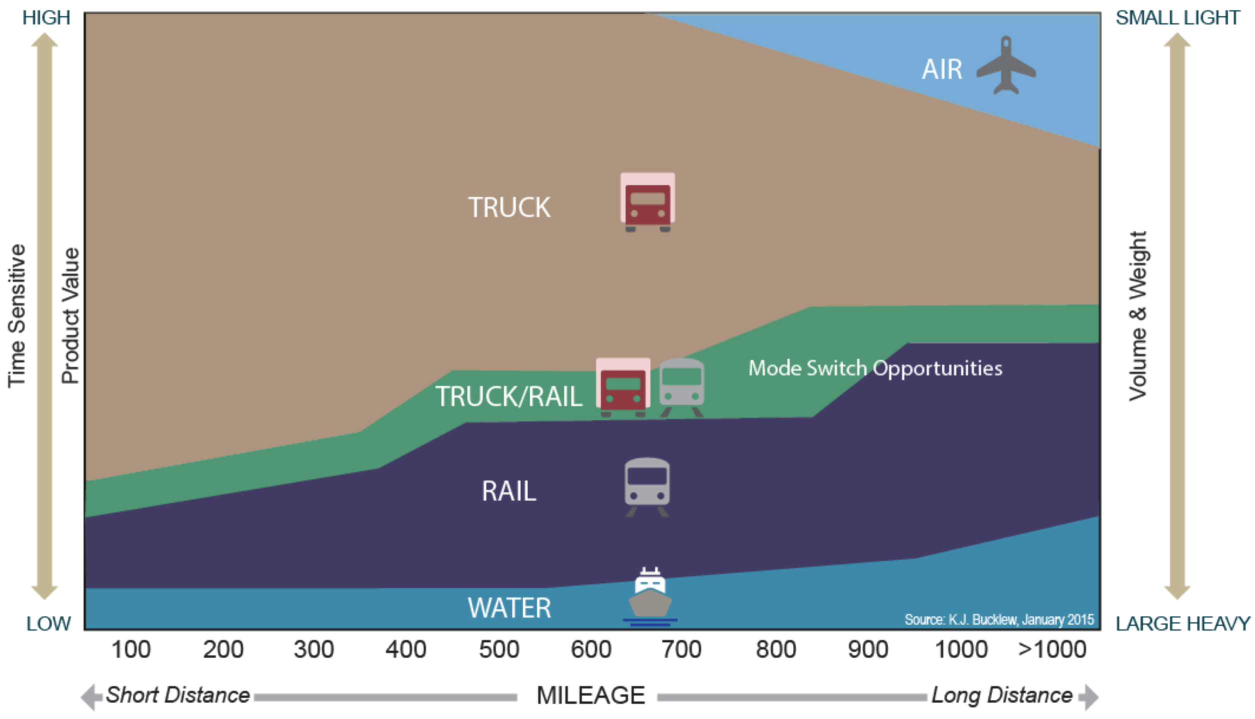


Figure 24 - Domestic Freight Modal Selection

There are some opportunities that carriers may exploit to avoid deadheading. For example, a carrier may transport a full trailer load of bundled scrap cardboard from a large grocery food store in Miami to a paper mill in Georgia for a very low fee. The fee may not cover the true transportation cost, but may offset the fuel costs the carrier would pay to simply deadhead. Also, wood pallets may be worth $12 each, so they are reused. A carrier may transport a full trailer load of pallets from a receiving warehouse to the original shipper for a nominal fee. In these situations, the carrier is avoiding a deadhead (non-revenue) movement, and is opting to recover some of its costs rather than nothing.

Imbalanced Flows

The demand for transportation between two locations is almost never balanced, but there is reciprocity in these imbalances. For instance, international trade relations underline that some nations import more than they export while it is the opposite for others (export-oriented economies). Similar patterns occur at the regional or local (urban) levels. Imbalances can also have a temporal aspect; although flows appear to be balanced at an aggregate level, they could be highly imbalanced for some time periods. For instance, commuting usually involves imbalanced movements between the central area of a city and its periphery, with the dominance of inbound movements in the morning and of outbound movements in the afternoon.

Short Hauls

Many transport flows take place over short distances and cover a specific sequence, such as feeders or local deliveries. They may thus be unavailable for backhaul cargo opportunities for destinations further away. As such, the range of transport services imposes limitations in their market opportunities and the availability of backhaul flows. These can be quantified by analyzing the producer and consumer regions at the borders of Florida, Georgia and Alabama by analyzing commodity data (such as FAF4). Shorter distances may not justify finding cargos for the backhaul trip especially if the search cost to find a backhaul load increases the cost.

Regulatory Constraints

The Florida Motor Carrier System Plan illuminates seventeen (17) issues of concern to the trucking industry. Seven of these issues are regulatory in nature. While most of these regulatory issues are federally controlled, state and local agencies also regulate trucking in various ways. The premise of regulations is to enhance safety, security, air quality, and overall quality of life. Some may view them as constraints, but in reality the restrictions and requirements serve to seek *balance* between the needs of community/livability and the needs of commerce/freight mobility.

The hours-of-service (HOS) regulations, which are under the purview of the FMCSA, are applicable to interstate commercial transportation. These regulations restrict commercial vehicle operators from driving more than 11 hours in a 24-hour period. Further, the driving time must occur within a consecutive 14-hour window, followed by a 10-hour consecutive, uninterrupted rest/sleep period. This mandate could potentially entice drivers to drive when they may be sleepy to avoid "losing" their driving hours. Prior to 2004, commercial drivers could split their mandatory rest/sleep into two segments. This tactic provided drivers the flexibility to sleep in the afternoon, when commuter traffic was heavy, and to drive in the late evening when traffic was lighter. This allowed the driver to be more productive and to be better rested. Even though a commercial truck may be deadheading north from southern Florida, the current hours-of-service regulations may delay this movement. This lack of flexibility may combine with the commercial driver shortage to exacerbate supply chain disruptions.

The mandate for all Commercial vehicles to utilize an Electronic Logging Devise (ELD) went into effect as of December 2017. While ELD is a technology enhancement designed to accurately monitor commercial driving time, many drivers may experience reduced mileage. Due to complexities of maintaining accurate paper logs, it is estimated that a large percentage of log books contain some errors (FDOT MCSP 2017). While ELDs will force stricter compliance with hours-of-service restrictions, it may also deter drivers from driving past available truck parking as the drivers near the maximum allowable driving hours limit. This lack of flexibility may result in a loss of productivity.

Truck Size and Weight issues are controversial. Florida, like many states, aligns intrastate size and weight limits with the federal limits. Safety advocates protest any increase in truck size and weight. Conversely, many shippers would like to increase the limits to reduce shipping costs. At the heart of the issue is that it is difficult to have a single rule to fit all types of trucking. LTL carriers, truckload carriers, drayage, tankers, and flatbeds all have different needs. Trucks supporting agricultural harvest periods, supplying natural disaster relief efforts, transporting non-divisible loads, and moving intermodal shipments have specific needs, many contingent on time. An argument could be made for increasing the maximum gross weight limits for certain truck-trailer combinations. This could reduce the number of trucks that deadhead out of Florida.

Technology implementation and its interface with pending or future regulatory measures will likely demand significant attention by federal and state agencies. Because the technologies are still being developed and perfected, government agencies will be challenged to outline parameters to insure that many concerns, such as safety, security, and air quality, are met. However, many technologies under development will benefit trucking and rail operations in the form of enhanced productivity, efficiency, and safety such as Fleet Management Systems, Self-driving trucks and platooning technology among others. As a result, empty operating miles could be reduced.

Putting Empty Backhaul in Context

All the above factors add to Florida's trade imbalance with the rest of the U.S. This translates into an empty backhaul situation for truckers and the railroads. The cost to deadhead an empty truck is approximately $1.60 per mile or $64 an hour (Owusu-Ababio and Schmitt, 2015). The ATRI report states 19.5% of trucking miles are non-revenue, which translates to deadhead or empty miles. Private fleets, which represent half of the trucking industry experience 28% empty miles, while for-hire or contract carriers, which represents half of the trucking industry, experience a much lower level of empty miles. Data are unavailable to analyze empty rail movement, although it is widely believed the rail industry experiences an imbalance of freight movement into and out of Florida, similar to the trucking industry.

The fact there is a freight flow imbalance in Florida is not necessarily an adverse condition. Throughout Florida, consumer demand is being met. In addition, Florida's unemployment rate of 3.6% in October 2017 is lower than the national average of 4.1%. The Florida environment has a different balance of service versus manufacturing than most states.

Florida is not unique with respect to the empty backhaul issue. Other states and regions experience similar freight backhaul issues. The northeast U.S. is a high consumer region due to highly urbanized population. Similar to Florida, this region has limited manufacturing and distribution.

Carriers set pricing and charge for services to ensure they are compensated for their costs to provide the service. For example, Owens Corning produces insulation and roofing materials in Jacksonville, Florida. If Lowe's requires a truckload of product delivered to Miami, the trucking firm will price the service to include the 350-mile trip plus the average number of miles necessary to travel north to move another load. As such, the carrier receives compensation for the empty miles it must travel to go from a freight desert to a freight generation location.

Potential Solutions

Through the analysis of truck empty back-haul using FDOT TDA WIM data, the Department's consultant has identified potential solutions for the State of Florida's consideration to coordinate further.

Although potential solutions exist to reduce truck empty backhaul, empty miles will always exist to some degree. It is not practical to expect to achieve absolutely zero empty miles due to the various factors described above. However, reducing empty miles should be achievable. Even if some empty miles cannot be avoided, certain solutions could potentially lower the cost and resources necessary for the empty trips. This reduction would benefit the trucking industry and the savings could be passed along to the consumer. Many factors may contribute to the reduction of empty miles, some of which are discussed below.

Regulatory Solutions

The Florida Freight Mobility and Trade Plan and Motor Carrier System Plan addressed the empty backhaul topic. The following 3 strategies were identified by the state:

1) Seek to increase the development of manufacturing industries in the state. The idea is to employ a strategy to encourage the relocation of manufacturers to Florida to be closer to the distribution system and to focus on the development of Florida-grown manufacturers.
2) Investigate the need for trailer transfer stations to allow drivers to stay within smaller regions with switchovers for longer hauls. Consider more "Pony Express" rather than full loads to split up longer trips and reduce empty backhaul
3) Support projects that improve the efficiency of goods movement at the statewide level.

The FMTP recommended investing in infrastructure that will support industries that will create more outbound freight and thus reduce empty backhaul movements. Statewide prioritization of freight-related projects within Florida are guided by the objectives and strategies identified in the Policy Element of the FMTP. These objectives and strategies were used to develop the prioritization criteria and scoring for freight related projects. Empty Backhaul is one of the prioritization criteria by which projects are assessed to identify their ability to reduce the number of empty backhaul movements. In addition, the Florida Legislature has also pushed for the development of Intermodal Logistics Centers (ILCs) and growth of the manufacturing industries in the state. For example, one of the key legislative directives was the creation of an ILC Infrastructure Support Program and allocation of $5 million annually toward funding at ILC facilities that meet certain criteria. The idea is to develop ILCs in the state, including specific strategies, policies, and investments that capitalize on the empty backhaul trucking and rail market in the state. Finally, another area of focus is the development of public - and private - sector partnerships to support freight generating economic development, including site selection and development, cross - modal connection, land use protection, and marketing.

A recent study, (FSTED Council, 2015) identified the imbalance of truck flows to and from the State as an important strategy for the ports and the State to market to ocean carriers, beneficial cargo owners, distribution center developers and manufacturers. With the imbalance of full inbound truckloads to empty northbound returns, carriers, manufacturers, and distribution centers could be able to secure favorable backhaul rates for northbound distribution of imported containerized cargo and transloaded cargo. This would further enhance the attractiveness of utilizing Florida transportation system and moving north discretionary cargo not destined for the state's consumer base. The CMV industry could benefit by a more robust two-way movement of goods to and from the southeast U.S.

Partnering Solutions

One of the main ways to prevent loss in revenue due to empty backhaul is early detection and planning. Currently, companies and various entities are exploring opportunities to minimize the losses due to empty or light backhaul. An example of this optimization would be - Company A picking up an order for Company B on a return trip to a common destination. By doing this, both companies and organizations benefit because they are able to split the cost of the return trip instead of having a second vehicle make that trip.

One non-profit organization aiming to optimize the consumer goods industry supply chain is the Voluntary Inter-industry Commerce Solutions Association (VICS). Their program known as "Empty Miles" allows dozens of trucking companies to list their empty truck routes on a common website. By doing so, companies are able to collaborate and thus, save a great deal of time and money. To put the potential savings of using empty backhaul services in perspective, the retail company, Macy's, uses "Empty Miles" and is expected to save approximately $25,000 per empty route (Ken Belson, 2010). Of the seventy-five (75) of the 328 routes Macy's posted, 70 of them were filled yielding a savings of approximately $1,750,000. Furthermore, the Empty Miles program saved millions of dollars for the companies in terms of diesel cost. Because of Empty Miles, Schneider National claimed to have saved 5,554 gallons of diesel fuel, which in turn prevented the release of 61.65 tons of carbon dioxide into the atmosphere.

Similar to VICS' "Empty Miles" program, mobile apps like Uber Freight (www.freight.uber.com) are available to match carriers with shippers, which may reduce some of the inefficiencies in the system. Additionally, our literature review found that the "I-10 Connected Freight" (Texas A&M, 2017) identified about 16 other Internet Based Freight Efficiency Applications, as listed below.

Table 6 - Internet Based Freight Efficiency Applications

Brand Name	Services Offered	Website
123Loadboard	Carrier-focused load matching	https://www.123loadboard.com/
Cargomatic	Load matching for short- distance trips in Los Angeles, New York, and San Francisco	https://www.cargomatic.com/
Convoy	Load matching, carrier screening, load tracking, carrier payment	https://convoy.com/
Direct Freight	Load matching	https://www.directfreight.com/home/
Exel Freight Connect	Online broker, matching shippers and carriers	http://exelfreightconnect.com/
Fr8Connect	Online database of carriers and shippers, virtual broker service	https://www.fr8connect.com/home
FreightFriend	Load matching among selected brokers and carriers	https://www.freightfriend.com/
Loadsmart	Load matching for truckload shipments	https://loadsmart.com/#/
Logistitrade	Shipper-focused electronic international trade bidding	https://logistitrade.com/
Posteverywhere	Service that links to multiple load matching boards	http://www.posteverywhere.com/
ShipperNet	Load matching among registered shippers and carriers	http://www.shippernet.com/index.aspx
TransFix	Load matching	http://transfix.io/
Trucker Path	Online information on truck stops, parking, weigh stations, fuel; includes load matching	https://truckerpath.com/
TugForce	Load matching	https://tugforce.com/index.html
uShip	Load board for small and large shipments of different types	https://www.uship.com/
VeriTread	Load matching for heavy-haul movements	http://www.veritread.com/

(Source: Texas A&M, 2017)

Technology Solutions

The transportation industry is experiencing a tsunami of technological advancements. Improved sensing and processing coupled with reduced costs are allowing faster adoption of new technologies.

Collapsible cargo containers hold potential to reduce the number of trucks needed to return multiple cargo containers from their destination back to their origin. While one truck could return multiple folded containers, the other trucks could be available to haul other loads to destination(s) along their route back to their origin. Potential exists for a host of other logistic opportunities such as improved loading and unloading times and container storage benefits. This concept may have the greatest impact when the origin is a rail yard or seaport. Compact Container Systems offers a product currently available that can compress to a 5:1 ratio (http://compactcontainers.com/product/).

Driver Assistive Truck Platooning holds potential to reduce fuel consumption when two tractor-trailer combinations are required to fulfill a shipment. The concept is a result of reduced aerodynamic drag when a follow vehicle can operate in a range from 40'-70' behind a lead vehicle. Since the DATP systems rely on leading safety technologies, such as air disc brakes, adaptive cruise control and automatic emergency braking, the system provides an overall improvement to safety while engaged. Fuel savings are in the range of a 4.5% improvement in fuel efficiency for the lead truck and 7.5% for the follow truck. Not only will the pair of trucks benefit from reduced fuel costs when fully loaded but also when empty on the return trip. Peloton Technology will soon introduce a product that will be commercially available sometime in 2018 (https://peloton-tech.com/).

Highly Automated Vehicles (HAV) have been in development for over 20 years and are on the verge of commercial availability. The technology under development for the trucking industry will enable trucks to operate without a driver onboard. Regulatory constraints may still require a driver to be onboard, but potential exists for the driver to engage in other activities while the truck is in motion. The driver could take on additional responsibilities like identifying additional cargo during the empty return trip or coordinate his/her next pick up before arriving to the current cargo's destination. Hours-of-service restrictions could potentially be relaxed so that the driver can rest while the vehicle is in motion, which would also help alleviate truck parking availability issues. Finally, restricting the initial deployment of completely unmanned trucks to a truck's empty return trip would limit concerns of fully loaded trucks operating autonomously. The reduced driver cost of returning an empty truck could potentially lead to significant cost savings for the fleet operator. In the long term, reduced driver costs for full and empty trips would also alleviate the driver shortage issue currently seen in the trucking industry. In May 2015, Freightliner unveiled their "Inspiration" vehicle, which is capable of Level 3 automation (of SAE's 5 level classification). It still requires a driver to handle the vehicle in certain situations but can allow the driver to focus on other tasks for limited durations (http://www.freightlinerinspiration.com/).

Enhanced traffic monitoring systems, owned and operated by the Florida Department of Transportation, could also reduce costs incurred by fleets during an empty return trip. If a truck is equipped with connected vehicle technologies and is observed to be empty, as identified by WIM sensors, the truck could receive a 'green light' to bypass subsequent weight or agricultural inspection stations along its route back to its origin. Verification of a truck's destination would be required, but the small effort needed to supply this information would offset the time and fuel wasted by not opting in to such a program. Additionally, if a truck was observed to not be empty during a 'green light' program, penalties would likely be easily enforceable.

As the industry evolves, the Department is exploring new ideas and defining the rules of engagement for successful outcomes.

CHAPTER 4: CONCLUSIONS AND RECOMMENDATIONS

Our analysis corroborates the trade imbalance between freight coming in and going out of the state in terms of weight of the commodity. The percentage of empty trucks leaving the state ranges between 30% and 50% depending on the corridor. In addition, approximately 10% trucks on these corridors are partially empty. Approximately 15% to 20% trucks entering Florida are also empty. The percentage of empty trucks in the inbound direction is highest during the month of May, while the percentage of empty trucks in the outbound direction is the lowest during the same month. Less seasonal variation occurs in the inbound direction compared to the outbound direction. Also, the percentage of empty trucks increases during the middle of the day as compared to hours in the night.

Several Florida specific factors and general industry factors influence empty backhaul. Being a consumer state, Florida consumes more than it produces and more freight comes into Florida than Florida exports to other states. High number of retirees and visitors, service industry focus and lack of manufacturing in the state, contribute to the cause. Some types of cargoes can only be transported with specialized modes and equipment. Thus, even if there is cargo available for a backhaul movement the conveyance for the inbound haul may not be suitable. Many transport flows are over short distances covering a specific sequence, such as feeders or local deliveries, which may not be available for backhaul cargo opportunities further away.

Other states and regions also experience freight backhaul issues similar to Florida. The northeast U.S. is a high consumer region due to its highly urbanized population. Similar to Florida, this region has limited manufacturing and distribution.

The Florida Freight Mobility and Trade Plan and Motor Carrier System Plan addressed empty backhaul and identified 3 strategies: 1) Seek to increase the development of manufacturing industries in the state, 2) Investigate the need for trailer transfer stations to allow drivers to stay within smaller regions with switchovers for longer hauls, and 3) Support projects that improve the efficiency of goods movement at the statewide level. The Department is investing in infrastructure that will support industries that will create more outbound freight and thus reduce empty backhaul movements. In addition, the Department is developing strategies and policies to capitalize on the empty backhaul trucking and rail markets in the state. Emerging technological solutions like Empty Miles and Uber Freight also hold much promise. As the industry evolves, the Department is exploring new ideas and defining the rules of engagement for successful outcomes.

Based on the findings of the study, we recommend the following actions for Department's consideration:

- Expand the analysis scope for future efforts to include all freight modes. While truck empty backhaul paints a good picture of the trade imbalance in Florida, a comprehensive multimodal evaluation will provide better insights into the forces influencing empty backhaul and potential solutions.
- Obtain industry data to better understand private sector perspective of empty backhaul. The industry is constantly exploring options to maximize efficiency of their supply chain to reduce cost and maximize profitability. Private parties may be able to offer unique business perspectives that influence empty backhaul.
- Investigate opportunities to improve the quality of the WIM data, perhaps through regular calibration of the WIM sites and coordination with the FDOT Motor Carrier Size and Weight Office.
- Investigate opportunities to improve the robustness of the WIM data. For example, it was identified that Class 9 tractors with no trailer (3-axle bobtails) are currently classified as Class 6 single-unit 3-axle trucks. Creating a new bin (14) within the WIM data could more accurately reflect empty truck movements since, by default, any bobtail Class 9 tractor is not hauling cargo.
- Consider a partnership with Florida Department of Agriculture and Consumer Services and Florida Department of Revenue to identify cargo inside trailers and/or other commodity related data. This additional data for analysis may reveal which industries result in the greatest percent of empty truck movements.
- Investigate Bill of Lading data acquired by FDOT Traffic Operations.
- Leverage synergies between Freight Facilities dataset, Truck Taxonomy research, Empty Backhaul analysis, and Vehicle Inventory and User Survey.
- Consider a Florida Freight Commodity Survey to understand commodity flows at a micro-level.

APPENDIX A – References

1) Figliozzi, M., Harrison, R., & McCray, J. (2000). Using weigh-in-motion data to calibrate trade-derived estimates of Mexican trade truck volumes in Texas. *Transportation Research Record: Journal of the Transportation Research Board*, (1719), 129-135.

2) Guide, T. M. (2001). Publication FHWA-PL-01-021. *FHWA, US Department of Transportation, Washington, DC*.

3) Owusu-Ababio, S., & Schmitt, R. (2015). Analysis of Data on Heavier Truck Weights: Case Study of Logging Trucks. *Transportation Research Record: Journal of the Transportation Research Board*, (2478), 82-92.

4) Beagan, D. F., Fischer, M. J., & Kuppam, A. R. (2007). *Quick response freight manual II* (No. FHWA-HOP-08-010).

5) Stegelin, F. E., & Kilmer, R. L. (1982). An Assessment of Empty Backhauls and Their Impact on Perishable Produce Truck Shipments: Florida Fresh Fruits and Vegetables. *Journal of Food Distribution Research*, *13*(1).

6) Beilock, R., & Kilmer, R. L. (1986). The determinants of full-empty truck movements. *American Journal of Agricultural Economics*, *68*(1), 67-76.

7) FSTED Council (January 2015) Analysis of Global Opportunities and Challenges for Florida Seaports

8) Belson, Ken (2010). Keeping Trucks Full, Coming and Going. *The New York Times.*

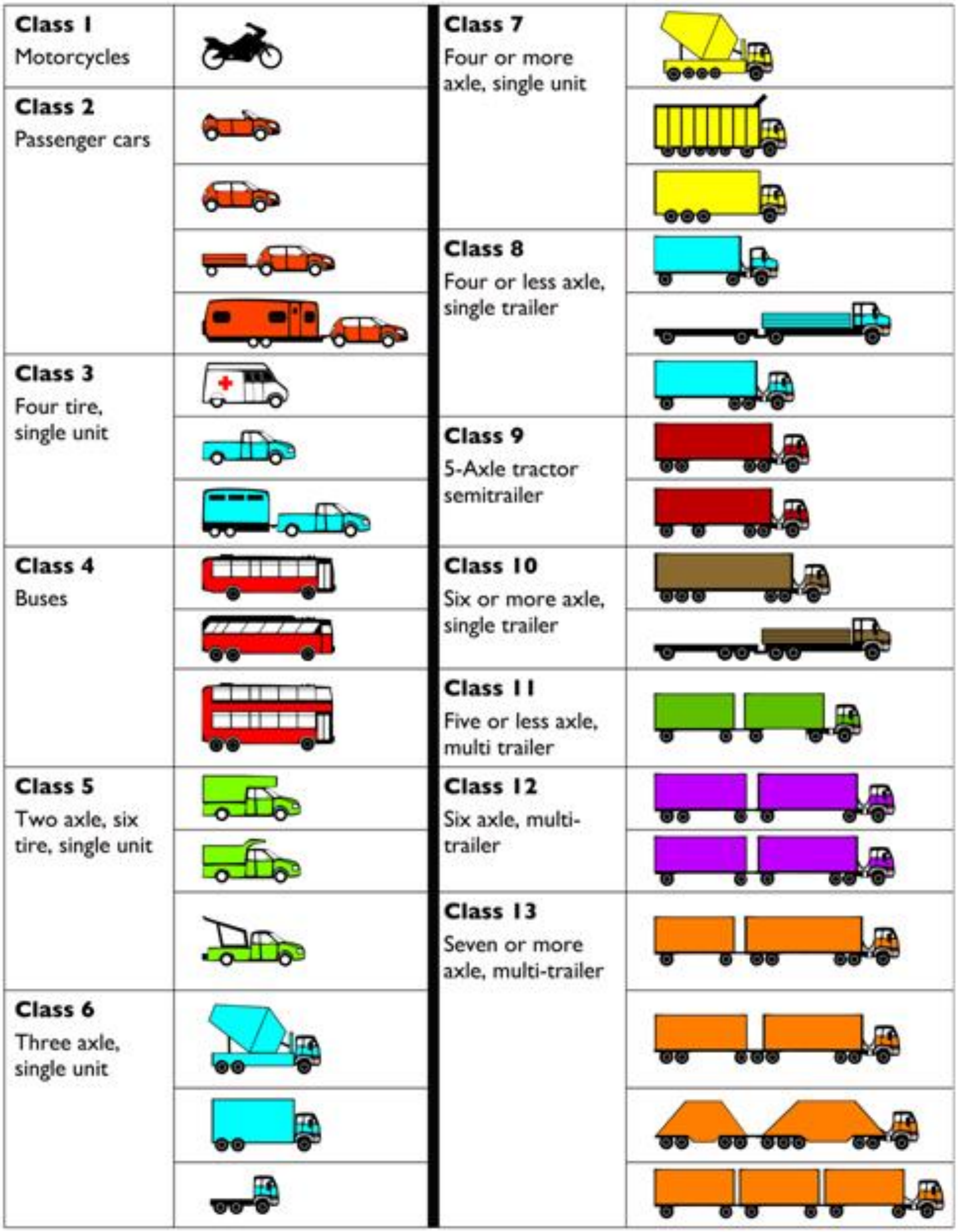
9) Texas A&M (2017). I-10 Connected Freight.

APPENDIX B – Attributes of Weigh in Motion Data

Field	Description	Data Type
FILETYPE	Record Type	VARCHAR2 (3 Byte)
COUNTY	Federal Information Processing Standards (FIPS) Code for County	Number (2)
SITE	Site ID	Number (4)
UNITNO	Unit Number - 1 for single-unit site, 2 for dual-unit site (multiple units required at one location because of number of lanes or logistics for running conduit/cabling)	Number (1)
DIR	Direction of Travel	VARCHAR2 (1 Byte)
LANE	Lane number of travel – Lane 1 begins in the outside lane, when heading North or East and increment from there.	Number (2)
BEGDATE	Date stamp (mm/dd/yyyy)	VARCHAR2 (10 Byte)
TIME_INTERVAL	Time stamp	Number (6)
VEHNO	Vehicle Number – generated by the system beginning at midnight with 1, up to approximately 65,500 and it resets to 1 again until midnight and it resets again	Number (5)
SCHEME F_CODE	Vehicle Class (Scheme "F") Code	Number (2)
VEHTYP	Vehicle Type (Please Refer Table 2 for definitions)	Number (2)
VOL_CODE	Violation Code - Speed, Overweight, etc.	Number (1)
SPD	Speed of Vehicle (in mph)	Number (2)
VEH_LENGTH	Length of Vehicle (in feet) From Bumper to Bumper (format 99.99 decimal implied)	Number (5)
GROSS_WT	Gross Weight of Vehicle (in lbs)	Number (6)
LEFTWGT1	Left Axle 1 Weight (in lbs)	Number (5)
RIGHTWGT1	Right Axle 1 Weight (in lbs)	Number (5)
AXLEWGT1	Axle Weight 1 (in lbs)	Number (5)
LEFTWGT2	Left Axle 2 Weight (in lbs)	Number (5)
RIGHTWGT2	Right Axle 2 Weight (in lbs)	Number (5)
AXLEWGT2	Axle Weight 2 (in lbs)	Number (5)
…	…	…

Field	Description	Data Type
LEFTWGT9	Left Axle 9 Weight (in lbs)	Number (5)
RIGHTWGT9	Right Axle 9 Weight (in lbs)	Number (5)
AXLEWGT9	Axle Weight 9 (in lbs)	Number (5)
NUM_AXLE_SP	Number of Axle Spaces	Number (5)
NUM_AXLES	Number of Axles	Number (5)
WHEELBASE	Wheel base (in feet) – distance from first to last axle (format 99.99 decimal implied)	Number (5)
SPACING1	Axle 1-2 Spacing (in feet) (format 99.99 decimal implied)	Number (5)
SPACING2	Axle 2-3 Spacing (in feet) (format 99.99 decimal implied)	Number (5)
…	…	…
SPACING6	Axle 6-7 Spacing (in feet) (format 99.99 decimal implied)	Number (5)
SPACING7	Axle 7-8 Spacing (in feet) (format 99.99 decimal implied)	Number (5)
SPACING8	Axle 8-9 Spacing (in feet) (format 99.99 decimal implied)	Number (5)
TYPE	E = Error and N = Normal	VARCHAR (1)
ERRMSG	Error Message	VARCHAR (80)

APPENDIX C – FHWA Vehicle Classification Scheme



Class 1	Motorcycles
Class 2	Passenger cars
Class 3	Four tire, single unit
Class 4	Buses
Class 5	Two axle, six tire, single unit
Class 6	Three axle, single unit
Class 7	Four or more axle, single unit
Class 8	Four or less axle, single trailer
Class 9	5-Axle tractor semitrailer
Class 10	Six or more axle, single trailer
Class 11	Five or less axle, multi trailer
Class 12	Six axle, multi-trailer
Class 13	Seven or more axle, multi-trailer

Source: https://www.fhwa.dot.gov/policyinformation/tmguide/tmg_2013/vehicle-types.cfm

APPENDIX D – Truck Percentages by Vehicle Class

Percentage of Truck Records on Sites near the Florida border

Site	County	Location	Vehicle Class	Number of Records	Percentage of Records
9923	Nassau	On I-95 - N/S (South of the state line)	4	77,837	0.93%
			5	836,718	10.02%
			6	182,172	2.18%
			7	3,184	0.04%
			8	373,611	4.48%
			9	6,492,163	77.78%
			10	57,888	0.69%
			11	195,891	2.35%
			12	121,134	1.45%
			13	6,469	0.08%
9949	Escambia	On I-10 - E/W (East of the state line)	4	57,185	1.27%
			5	782,402	17.35%
			6	234,197	5.19%
			7	26,780	0.59%
			8	299,751	6.65%
			9	2,940,399	65.22%
			10	33,223	0.74%
			11	75,181	1.67%
			12	51,259	1.14%
			13	7,957	0.18%
9956	Hamilton	On I-75 - N/S (South of state line)	4	16,833	0.77%
			5	181,149	8.33%
			6	38,821	1.79%
			7	412	0.02%
			8	191,385	8.80%
			9	1,602,453	73.69%
			10	7,142	0.33%
			11	76,384	3.51%
			12	58,373	2.68%
			13	1,505	0.07%

Note: Data shown here is a 3-year average (2015, 2016 and 2017) for 9923 and 9949. Site 9956 only has data starting from June 2017

APPENDIX E – Average Gross Vehicle Weight Per Unit Length

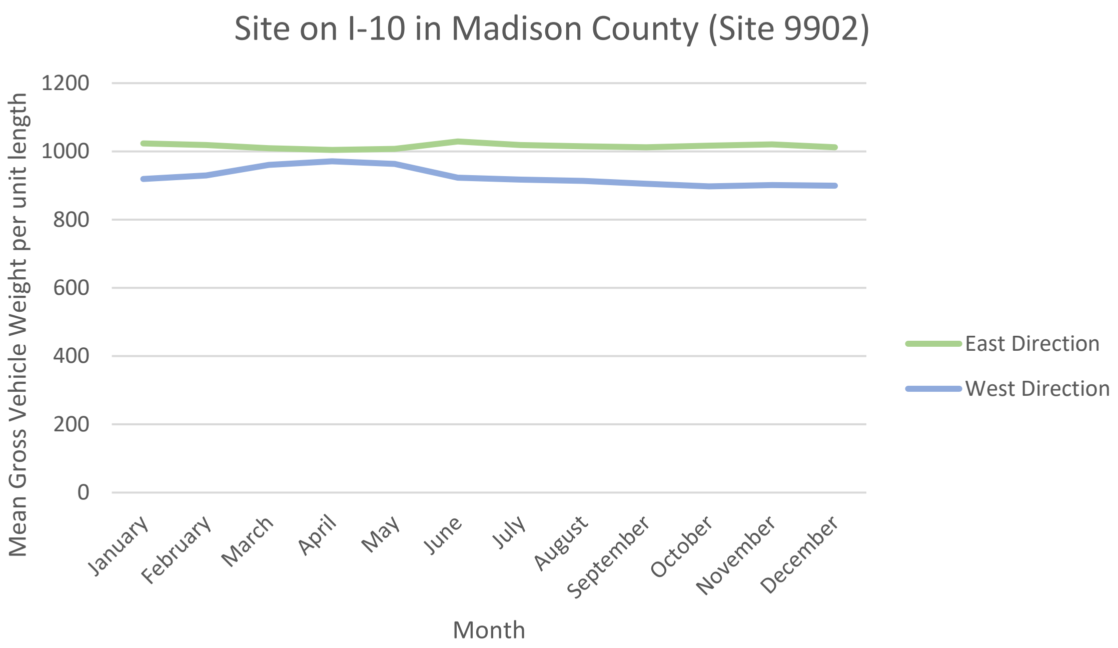
Site Number	County	Location	Class	North Direction		South Direction		North Direction	South Direction
				Average Gross Vehicle Weight per unit length	Number of Trucks	Average Gross Vehicle Weight per unit length	Number of Trucks	Percentage of Trucks	Percentage of Trucks
9905	Duval	On I-95 (South of Jacksonville)	4	1164	28,258	1144	56,058	1.24%	1.13%
			5	829	337,338	837	661,074	14.78%	13.28%
			6	1416	98,833	1559	244,699	4.33%	4.92%
			7	2966	2,810	3002	17,024	0.12%	0.34%
			8	709	125,739	785	286,224	5.51%	5.75%
			9	862	1,601,440	996	3,493,776	70.18%	70.19%
			10	1062	10,977	1387	36,744	0.48%	0.74%
			11	794	46,615	921	117,755	2.04%	2.37%
			12	800	28,671	890	59,624	1.26%	1.20%
			13	1325	1,283	1432	4,644	0.06%	0.09%
9914	Duval	On I-295 (West of Jacksonville)	4	963	48,791	1014	46,943	1.13%	1.13%
			5	807	815,717	847	775,716	18.89%	18.64%
			6	1343	500,094	1407	486,468	11.58%	11.69%
			7	2933	11,804	3104	11,248	0.27%	0.27%
			8	767	326,130	792	320,013	7.55%	7.69%
			9	852	2,449,572	962	2,359,365	56.72%	56.69%
			10	1447	35,362	1307	26,499	0.82%	0.64%
			11	754	93,668	884	94,836	2.17%	2.28%
			12	758	34,393	886	37,478	0.80%	0.90%
			13	1404	2,850	1320	3,314	0.07%	0.08%
9919	Brevard	On I-95	4	1046	29,750	1077	23,988	1.29%	1.02%
			5	939	380,582	908	385,994	16.54%	16.45%
			6	1554	167,620	1641	141,191	7.28%	6.02%
			7	3187	16,931	3297	41,772	0.74%	1.78%
			8	747	203,974	830	170,960	8.86%	7.29%
			9	857	1,411,415	1065	1,506,674	61.33%	64.23%
			10	1264	29,160	1366	17,172	1.27%	0.73%
			11	835	36,701	953	40,158	1.59%	1.71%
			12	879	16,658	961	15,495	0.72%	0.66%
			13	1336	8,506	1415	2,511	0.37%	0.11%
9950	Collier	On I-75 (Naples, Fl)	4	1042	45,216	1055	50,404	1.48%	1.65%
			5	829	975,543	827	1,045,662	31.90%	34.14%
			6	1404	655,385	1832	295,985	21.43%	9.66%
			7	3122	38,124	3365	377,435	1.25%	12.32%
			8	734	294,407	829	289,808	9.63%	9.46%
			9	835	1,003,649	970	951,815	32.82%	31.08%
			10	1317	16,128	1462	25,009	0.53%	0.82%
			11	738	16,153	721	14,794	0.53%	0.48%
			12	808	11,968	716	9,975	0.39%	0.33%
			13	1352	1,706	1353	1,783	0.06%	0.06%
9952	Palm Beach	On I-95 (West Palm Beach, Fl)	4	1037	55,840	1030	47,379	2.04%	1.60%
			5	795	671,654	800	645,419	24.57%	21.78%
			6	1500	144,809	1453	146,390	5.30%	4.94%
			7	3012	23,479	3224	23,527	0.86%	0.79%

Site Number	County	Location	Class	North Direction: Average Gross Vehicle Weight per unit length	North Direction: Number of Trucks	South Direction: Average Gross Vehicle Weight per unit length	South Direction: Number of Trucks	North Direction: Percentage of Trucks	South Direction: Percentage of Trucks
			8	738	173,909	712	180,113	6.36%	6.08%
			9	813	1,577,334	971	1,827,169	57.71%	61.65%
			10	1317	19,276	1034	13,487	0.71%	0.46%
			11	788	40,288	871	48,223	1.47%	1.63%
			12	752	25,187	853	29,376	0.92%	0.99%
			13	1224	1,631	1307	2,552	0.06%	0.09%
9953	Hillsborough	On I-75 (Tampa, Fl)	4	953	21,902	1016	34,931	3.38%	2.35%
			5	786	201,175	849	384,698	31.02%	25.83%
			6	1479	58,429	1524	143,509	9.01%	9.64%
			7	3218	36,089	3259	22,121	5.56%	1.49%
			8	662	52,406	815	130,045	8.08%	8.73%
			9	733	268,668	1066	731,581	41.43%	49.12%
			10	1151	3,781	1571	14,299	0.58%	0.96%
			11	617	3,270	896	15,845	0.50%	1.06%
			12	646	2,399	938	11,067	0.37%	0.74%
			13	1485	411	1502	1,300	0.06%	0.09%
9923	Nassau	On I-95 South of the State Line	4	1179	40,138	1197	37,699	0.93%	0.93%
			5	813	438,247	846	398,471	10.21%	9.83%
			6	1229	99,037	1282	83,135	2.31%	2.05%
			7	2749	2,364	2379	820	0.06%	0.02%
			8	696	181,183	686	192,428	4.22%	4.75%
			9	907	3,343,343	1032	3,148,820	77.86%	77.70%
			10	1122	27,528	1349	30,360	0.64%	0.75%
			11	821	98,332	973	97,559	2.29%	2.41%
			12	820	61,358	916	59,776	1.43%	1.47%
			13	1428	2,763	1492	3,706	0.06%	0.09%
9956	Hamilton	On I-75 South of the State Line	4	1307	8,284	1266	8,549	0.78%	0.77%
			5	823	88,549	826	92,600	8.37%	8.29%
			6	1160	19,452	1235	19,369	1.84%	1.74%
			7	2643	209	2035	203	0.02%	0.02%
			8	557	89,277	554	102,108	8.44%	9.15%
			9	860	779,914	1045	822,539	73.71%	73.68%
			10	1504	4,600	1026	2,542	0.43%	0.23%
			11	816	37,608	965	38,776	3.55%	3.47%
			12	801	29,617	911	28,756	2.80%	2.58%
			13	1472	591	1408	914	0.06%	0.08%
9902	Madison	On I-10	4	1235	27,745	1189	35,279	1.13%	1.55%
			5	816	193,878	800	210,508	7.89%	9.23%
			6	1196	39,058	1197	41,193	1.59%	1.81%
			7	2154	604	2441	856	0.02%	0.04%
			8	679	105,086	694	100,508	4.28%	4.41%
			9	1015	1,987,910	928	1,800,905	80.93%	78.99%
			10	1169	11,561	1003	10,196	0.47%	0.45%
			11	876	53,658	813	52,497	2.18%	2.30%
			12	856	33,656	870	25,841	1.37%	1.13%
			13	1465	3,146	1360	2,215	0.13%	0.10%

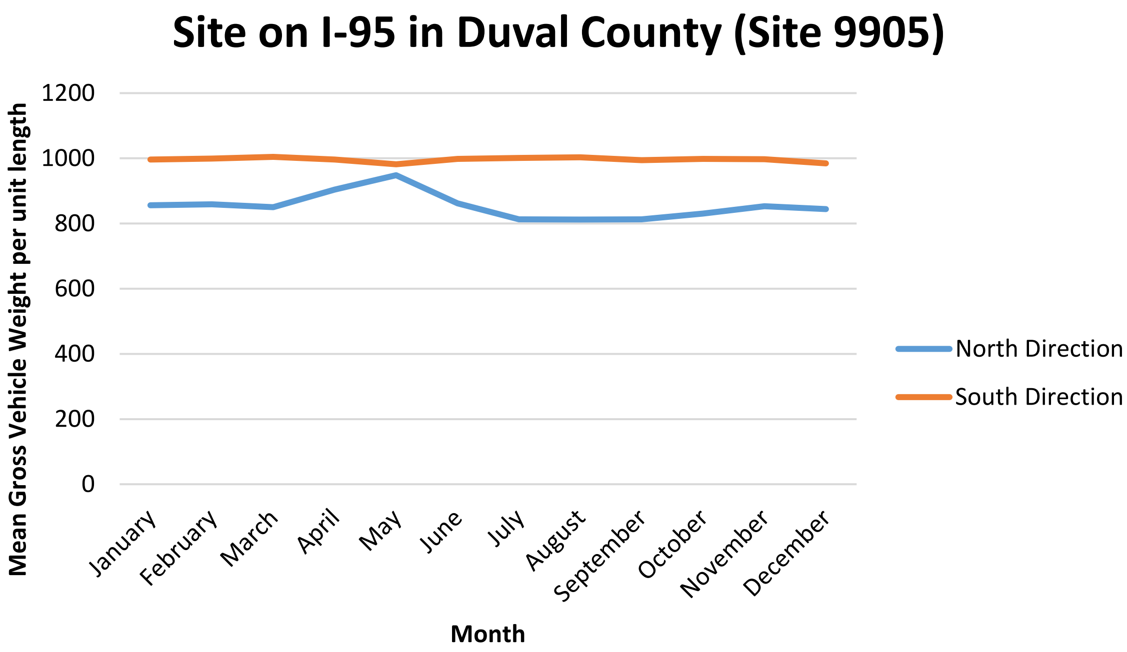
Site Number	County	Location	Class	North Direction		South Direction		North Direction	South Direction
				Average Gross Vehicle Weight per unit length	Number of Trucks	Average Gross Vehicle Weight per unit length	Number of Trucks	Percentage of Trucks	Percentage of Trucks
9906	Volusia	On I-4 (North of Orlando)	4	1042.60	36,948	1104.77	19,559	2.12%	2.27%
			5	786.82	369,124	729.76	222,034	21.22%	25.74%
			6	1421.33	86,346	1250.18	35,250	4.96%	4.09%
			7	3079.75	18,442	2837.59	1,591	1.06%	0.18%
			8	764.68	117,894	672.18	51,072	6.78%	5.92%
			9	822.28	1,045,636	885.48	498,823	60.12%	57.83%
			10	1220.55	8,194	1111.82	3,538	0.47%	0.41%
			11	732.67	36,084	829.61	16,458	2.07%	1.91%
			12	700.59	19,787	797.91	13,747	1.14%	1.59%
			13	1450.58	927	1436.56	529	0.05%	0.06%
9936	Columbia	On I-10	4	1110	15,166	1131	13,561	0.74%	0.72%
			5	799	145,311	856	139,593	7.12%	7.43%
			6	1194	43,081	1247	44,023	2.11%	2.34%
			7	2784	1,216	2885	912	0.06%	0.05%
			8	713	87,460	756	85,094	4.29%	4.53%
			9	993	1,651,659	915	1,509,719	80.94%	80.33%
			10	1392	14,196	1029	9,410	0.70%	0.50%
			11	896	56,815	845	52,487	2.78%	2.79%
			12	874	23,367	818	23,280	1.15%	1.24%
			13	1506	2,243	1426	1,377	0.11%	0.07%
9951	Polk	On I-4 (East of Lakeland)	4	1034	48,769	1114	53,398	1.66%	1.45%
			5	823	610,135	826	786,826	20.71%	21.40%
			6	1260	214,497	1309	214,528	7.28%	5.83%
			7	2562	7,351	3178	51,450	0.25%	1.40%
			8	698	225,766	827	310,117	7.66%	8.43%
			9	841	1,769,805	839	2,142,244	60.09%	58.27%
			10	1202	12,269	1587	35,657	0.42%	0.97%
			11	733	37,534	802	53,666	1.27%	1.46%
			12	809	17,411	758	26,520	0.59%	0.72%
			13	1344	1,953	1428	2,252	0.07%	0.06%
9949	Escambia	On I-10 near Pensacola East of the State Line	4	1166	31131	1198	26054	1.33%	1.20%
			5	798	411076	822	371326	17.63%	17.06%
			6	1406	126412	1606	107785	5.42%	4.95%
			7	2969	7400	3257	19380	0.32%	0.89%
			8	711	145708	743	154043	6.25%	7.08%
			9	1014	1521000	963	1419399	65.22%	65.22%
			10	1047	16391	1123	16832	0.70%	0.77%
			11	845	39289	847	35892	1.68%	1.65%
			12	841	29776	862	21483	1.28%	0.99%
			13	1309	3880	1334	4077	0.17%	0.19%

Data presented here is a 3-year average (2015, 2016 & 2017)

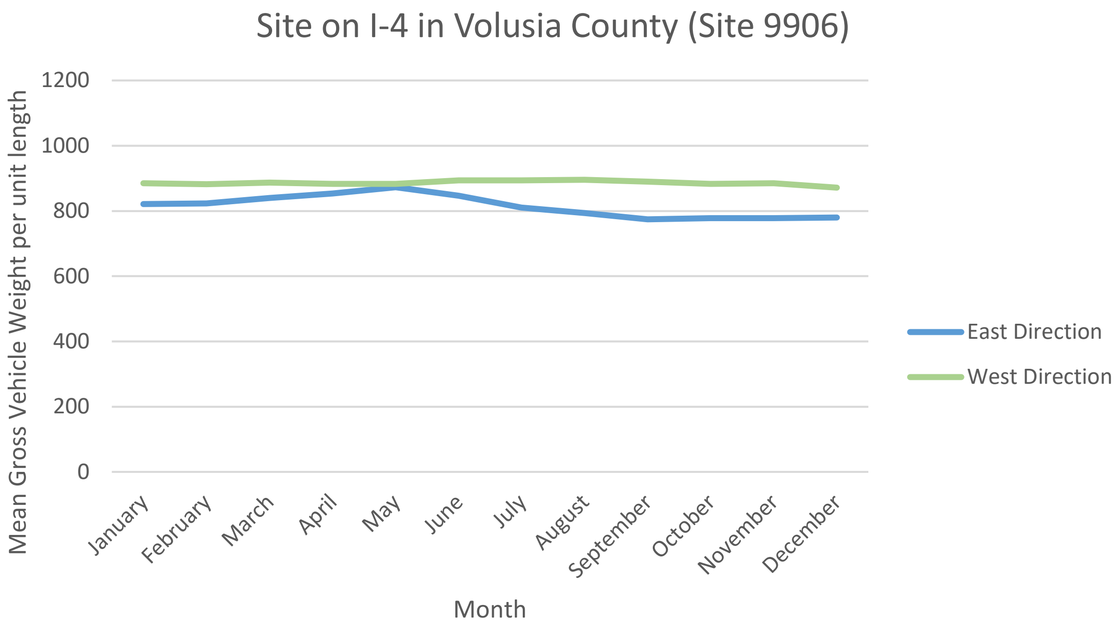
APPENDIX F – Average Gross Vehicle Weight Per Unit Length By Month



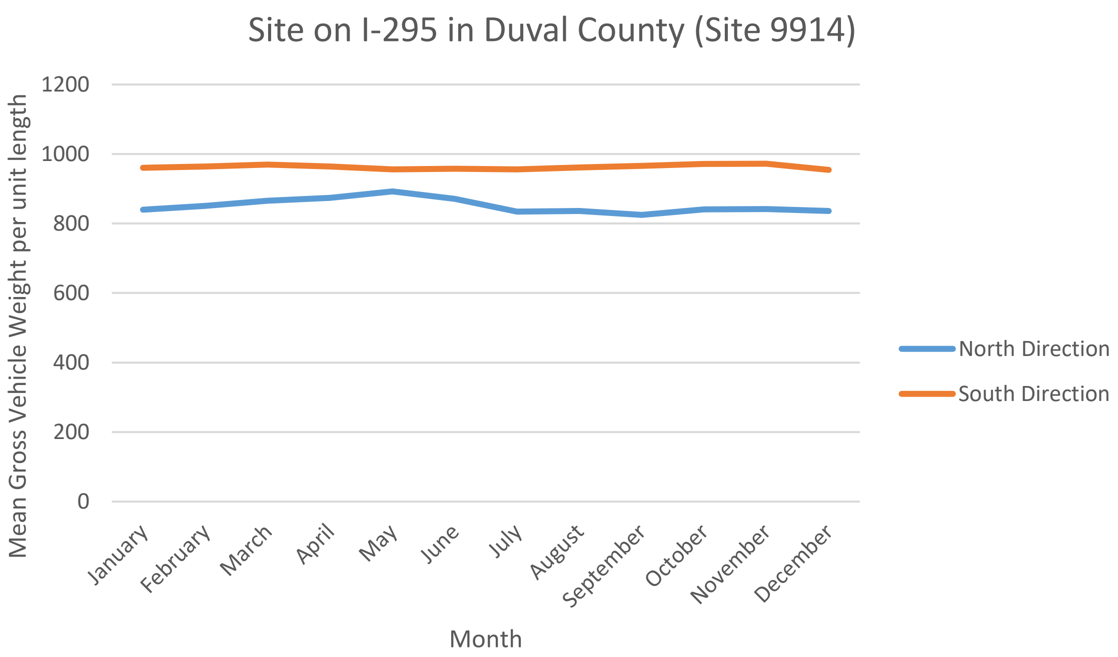
Note: Data presented here is a 3-year average of the Gross Vehicle Weight per unit length



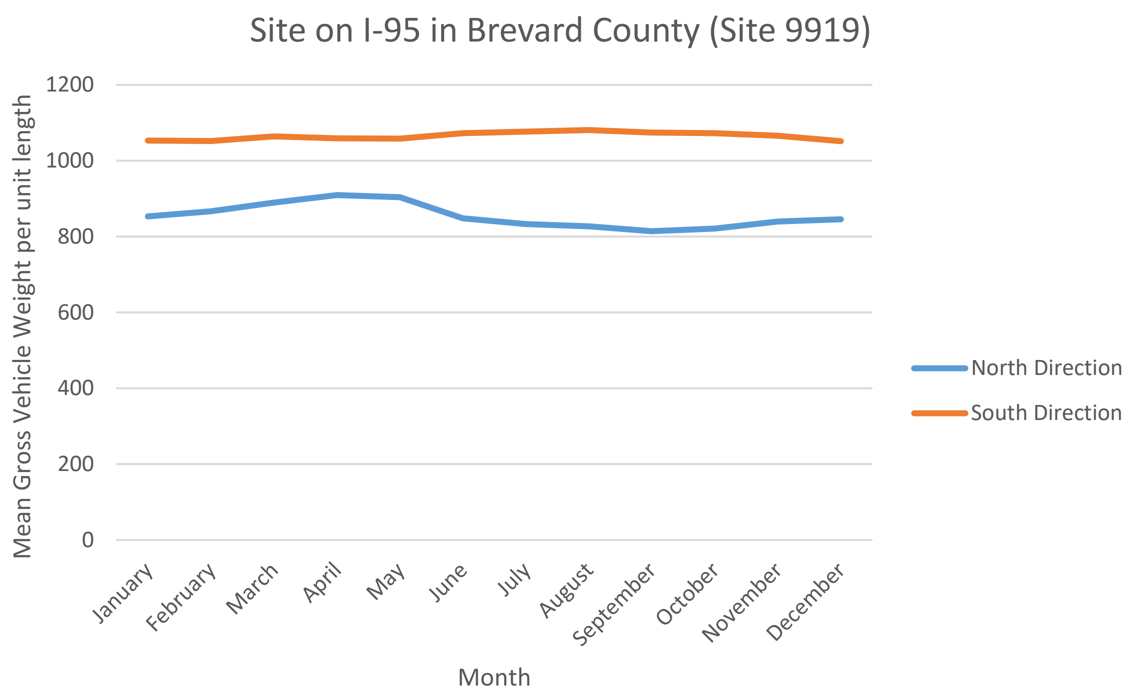
Note: Data presented here is a 3-year average of the Gross Vehicle Weight per unit length



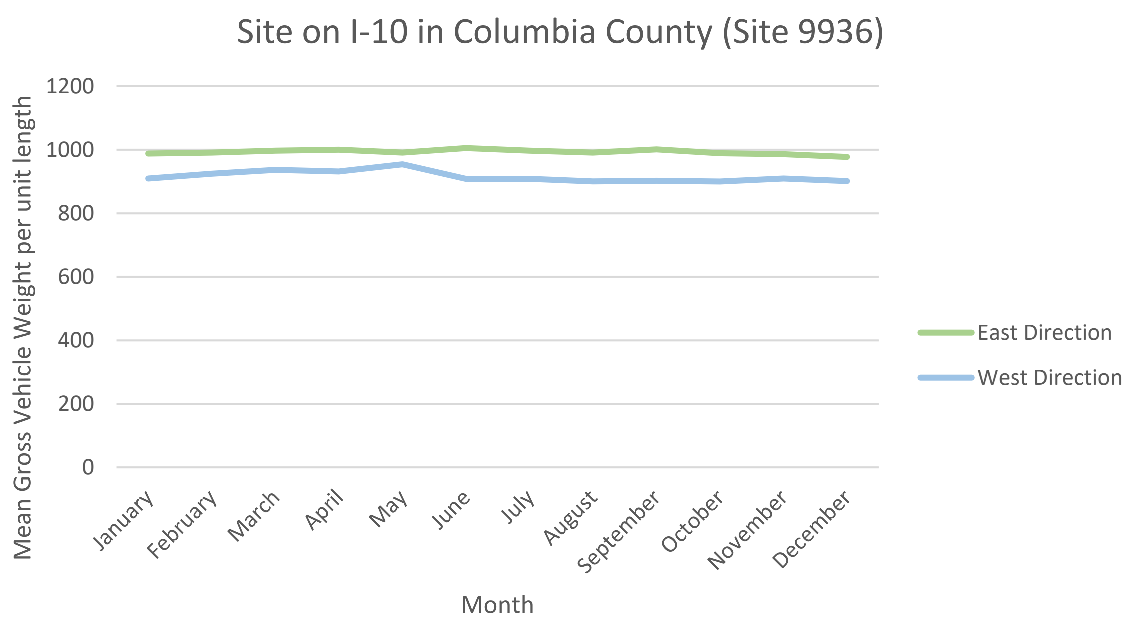
Note: Data presented here is a 3-year average of the Gross Vehicle Weight per unit length



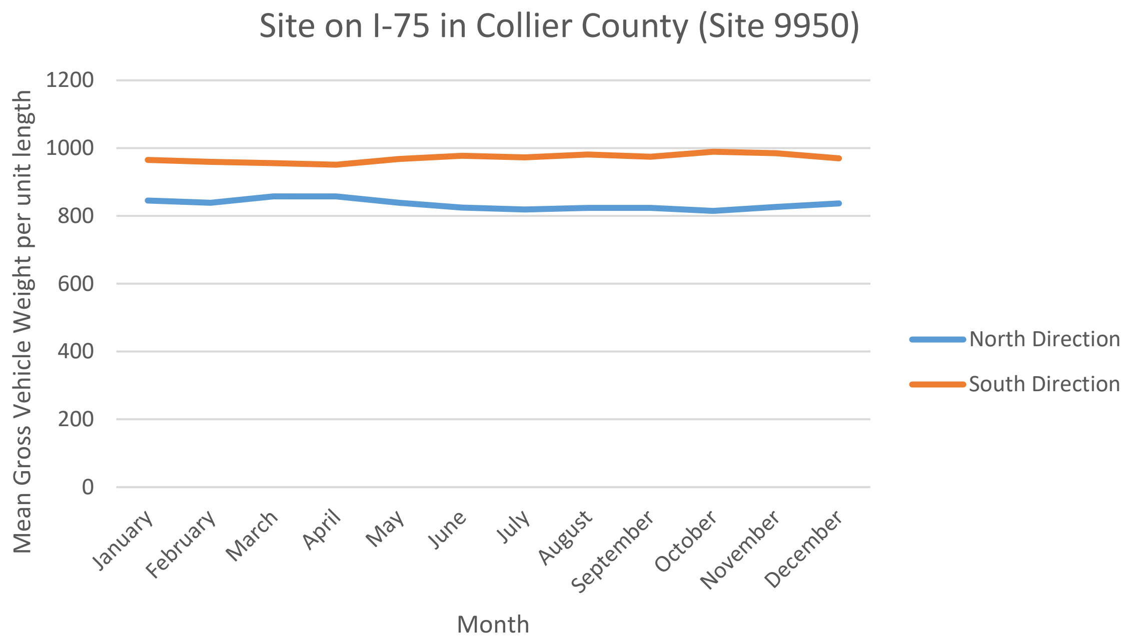
Note: Data presented here is a 3-year average of the Gross Vehicle Weight per unit length



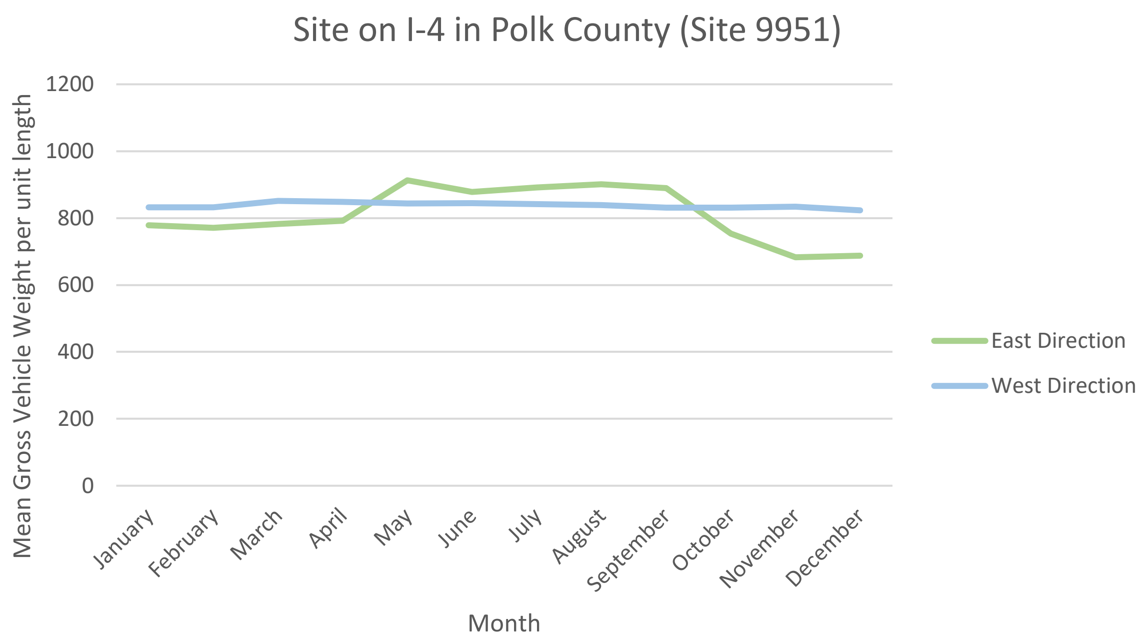
Note: Data presented here is a 3-year average of the Gross Vehicle Weight per unit length



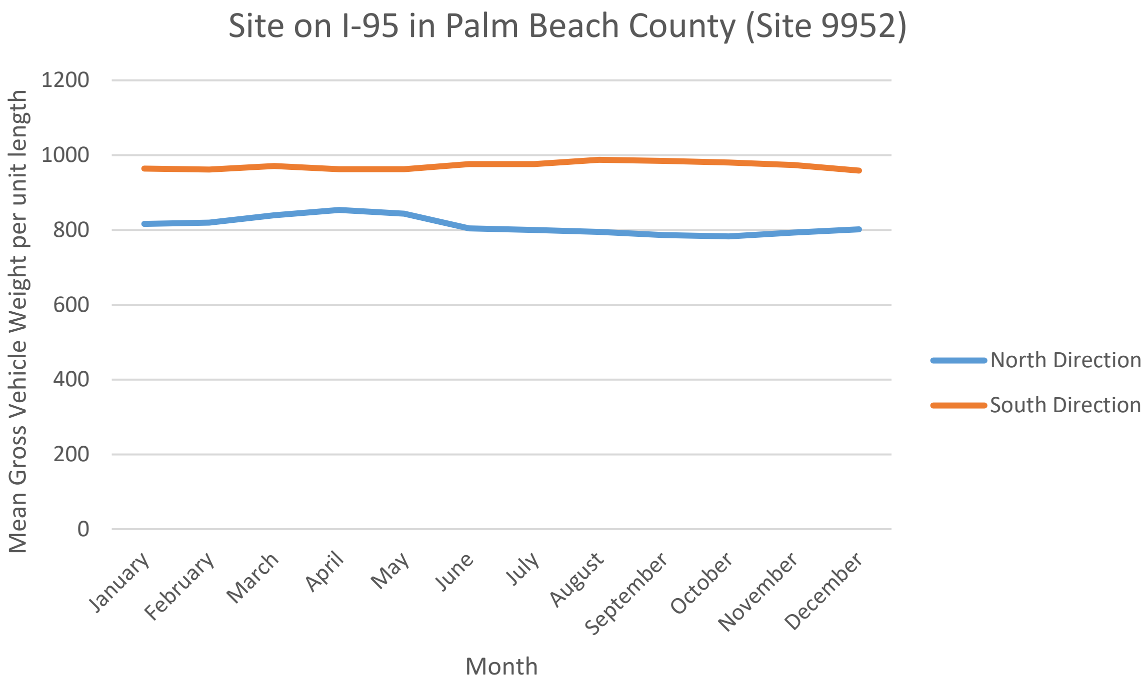
Note: Data presented here is a 3-year average of the Gross Vehicle Weight per unit length



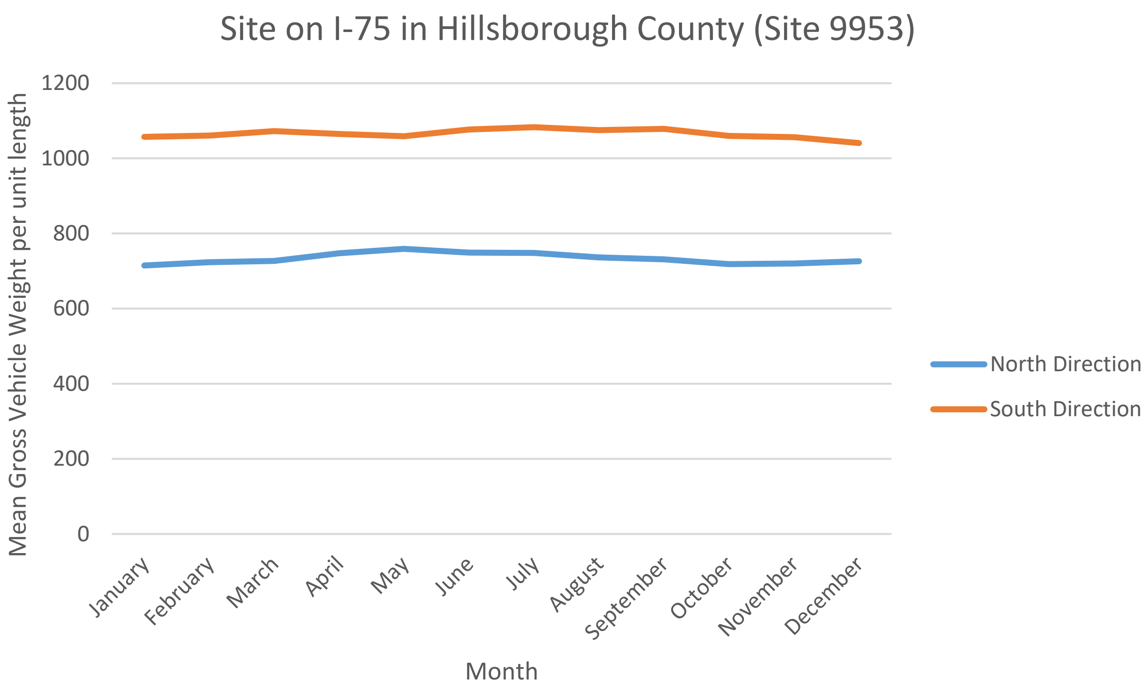
Note: Data presented here is a 3-year average of the Gross Vehicle Weight per unit length



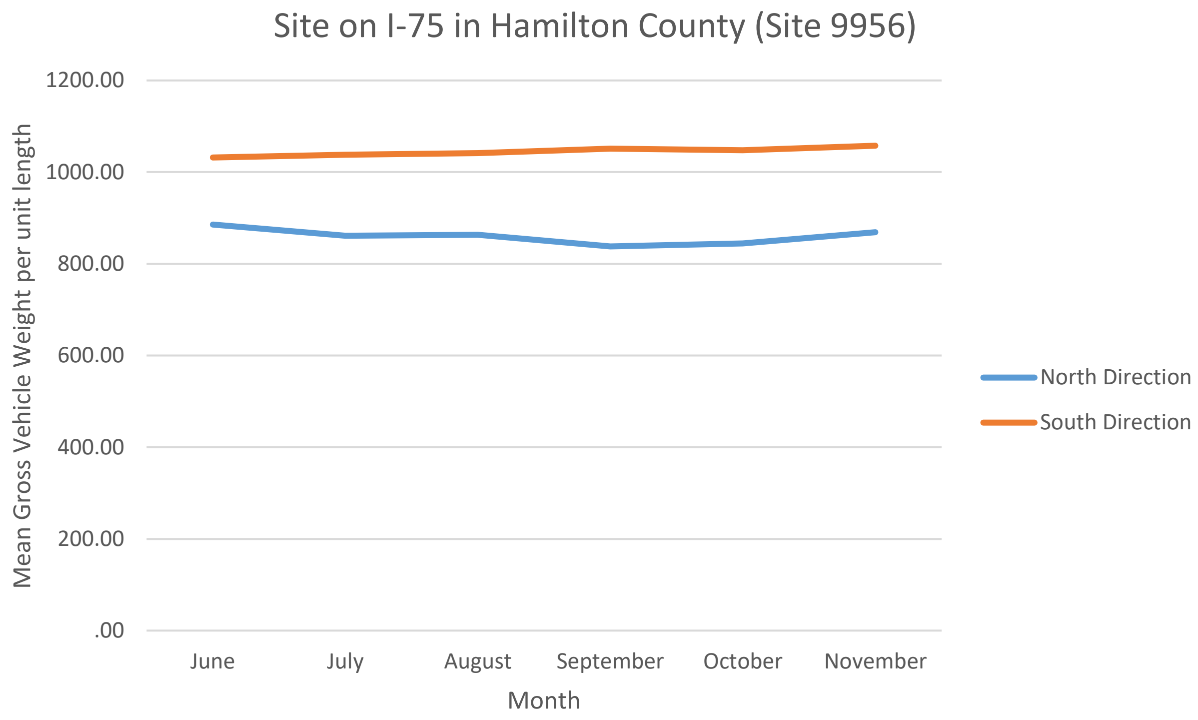
Note: Data presented here is a 3-year average of the Gross Vehicle Weight per unit length



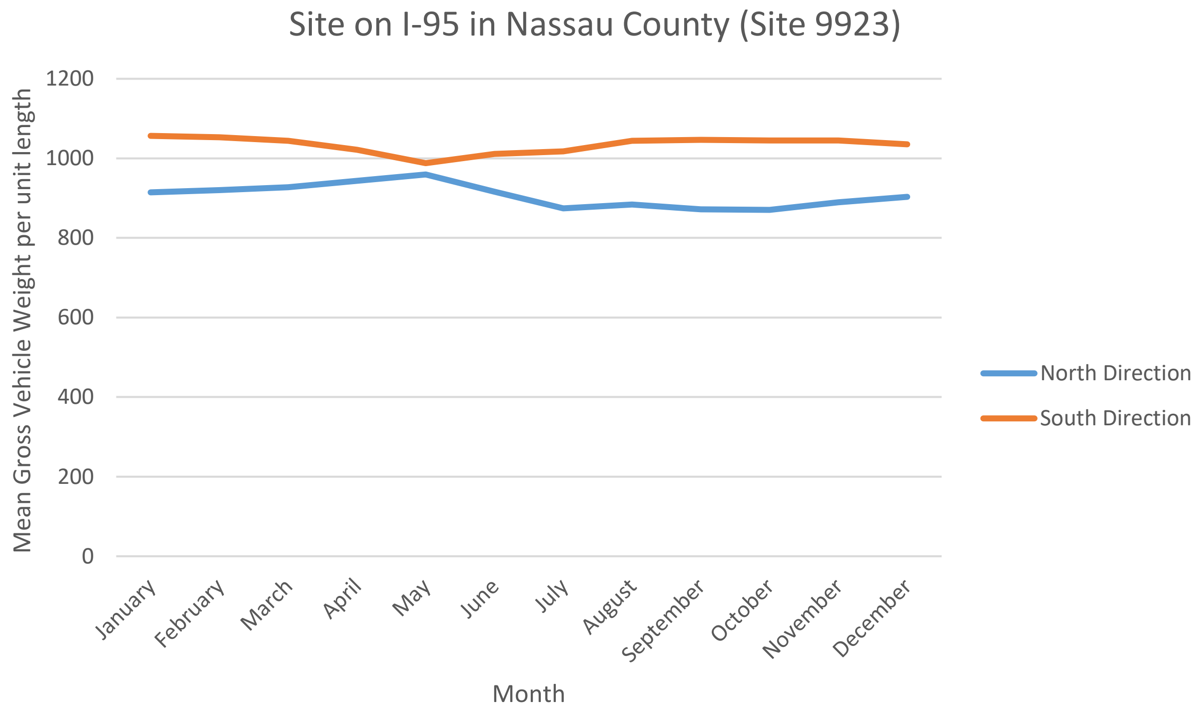
Note: Data presented here is a 3-year average of the Gross Vehicle Weight per unit length



Note: Data presented here is a 3-year average of the Gross Vehicle Weight per unit length



Note: Data presented here is a 6-month average of the Gross Vehicle Weight per unit length (June 2017 – November 2017)



Note: Data presented here is a 3-year average of the Gross Vehicle Weight per unit length

APPENDIX G – Empty and Full Trucks by Direction of Travel

Site	County	Location	In-State/ Out-State	Direction	Number of Trucks			Percentage of Total	
					Total Trucks	Empty Trucks	Full/Heavy Trucks	Percentage of Empty Trucks	Percentage of "Full/Heavy" Trucks
9902	Madison	On I-10	In-State	E	1,987,910	320,222	1,074,880	16.11%	54.07%
			Out-State	W	1,800,905	557,319	810,381	30.95%	45.00%
9905	Duval	On I-95	Out-State	N	1,601,440	696,246	504,239	43.48%	31.49%
		(South of Jacksonville)	In-State	S	3,493,776	649,911	1,723,190	18.60%	49.32%
9906	Volusia	On I-4 (North	In-State	E	1,045,636	519,378	313,199	49.67%	29.95%
		of Orlando)	Out-State	W	498,823	165,313	183,632	33.14%	36.81%
9914	Duval	On I-295	Out-State	N	2,449,572	1,127,018	735,901	46.01%	30.04%
		(West of Jacksonville)	In-State	S	2,359,365	665,649	1,007,641	28.21%	42.71%
9919	Brevard	On I-95	Out-State	N	1,411,415	620,429	395,570	43.96%	28.03%
			In-State	S	1,506,674	202,154	843,747	13.42%	56.00%
9923	Nassau	On I-95 South	Out-State	N	3,343,343	1,277,697	1,280,792	38.22%	38.31%
		of the State Line	In-State	S	3,148,820	421,058	1,690,471	13.37%	53.69%
9936	Columbia	On I-10	In-State	E	1,651,659	316,028	820,526	19.13%	49.68%
			Out-State	W	1,509,719	570,292	570,903	37.77%	37.82%
9949	Escambia	On I-10 near Pensacola East	In-State	E	1,521,000	258,370	817,842	16.99%	53.77%
		of State Line	Out-State	W	1,419,399	407,257	664,625	28.69%	46.82%
9950	Collier	On I-75	Out-State	N	1,003,649	527,874	247,584	52.60%	24.67%
		(Naples, Fl)	In-State	S	951,815	289,273	394,626	30.39%	41.46%
9951	Polk	On I-4 (East of	In-State	E	1,769,805	803,473	464,291	45.40%	26.23%
		Lakeland)	Out-State	W	2,142,244	1,054,127	601,896	49.21%	28.10%
9952	Palm Beach	On I-95 (West	Out-State	N	1,577,334	805,248	404,689	51.05%	25.66%
		Palm Beach, Fl)	In-State	S	1,827,169	369,638	840,785	20.23%	46.02%
9953	Hillsbourough	On I-75	Out-State	N	268,668	180,095	47,822	67.03%	17.80%
		(Tampa, Fl)	In-State	S	731,581	164,557	389,319	22.49%	53.22%
9956	Hamilton	On I-75 South	Out-State	N	778,732	372,640	235,282	47.85%	30.21%
		of the State Line	In-State	S	822,103	90,576	456,171	11.02%	55.49%

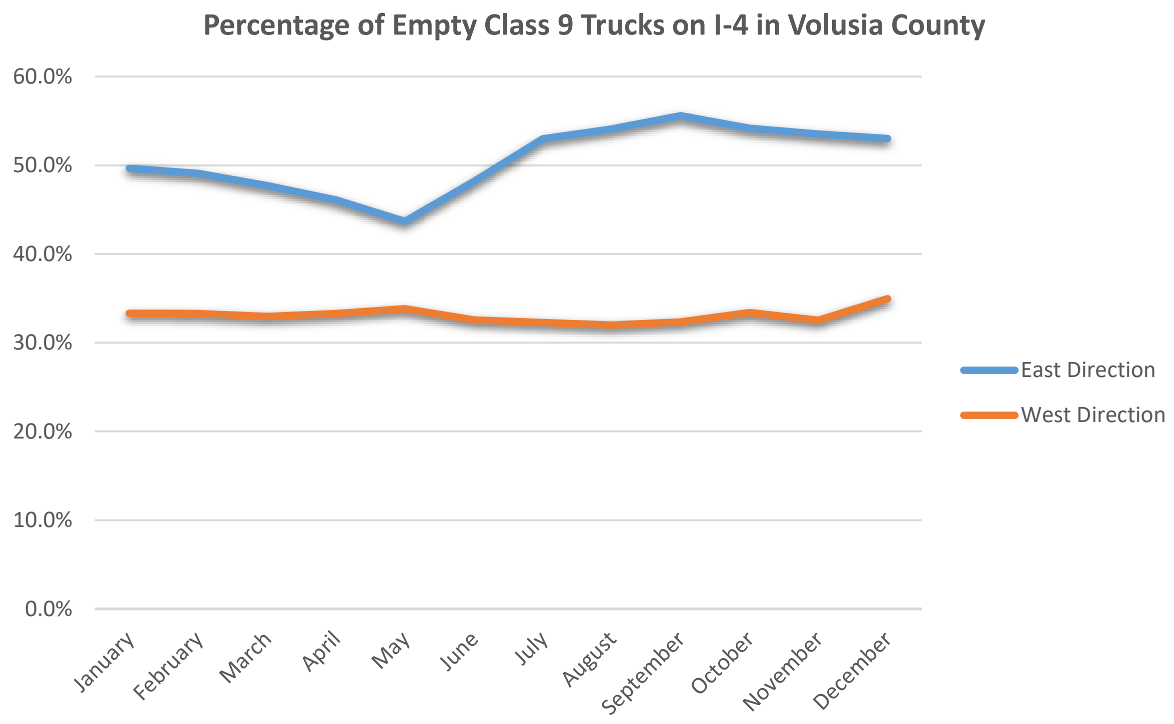
APPENDIX H – Trucks with Gross Vehicle Weight 40K to 60K lbs

Site	County	Location	In-State/ Out-State	Direction	Number of Trucks			Percentage of Total	
					Total Class 9 Trucks (40,000 <= GrossWt < 60,000)	Equally Distributed - No Capacity for additional Cargo	Unequally Distributed - Capacity exists for additional Cargo	Percentage of "Cubed out" Trucks	Percentage of "Partially Empty" Trucks
9902	Madison	On I-10	In-State	E	592,808	409,353	183,455	20.59%	9.23%
			Out-State	W	433,205	277,355	155,850	15.40%	8.65%
9905	Duval	On I-95 (South of Jacksonville)	Out-State	N	400,955	269,857	131,098	16.85%	8.19%
			In-State	S	1,120,675	776,973	343,702	22.24%	9.84%
9906	Volusia	On I-4 (North of Orlando)	In-State	E	213,059	134,913	78,146	12.90%	7.47%
			Out-State	W	149,878	98,827	51,051	19.81%	10.23%
9914	Duval	On I-295 (West of Jacksonville)	Out-State	N	586,653	433,471	153,182	17.70%	6.25%
			In-State	S	686,075	457,045	229,030	19.37%	9.71%
9919	Brevard	On I-95	Out-State	N	395,416	246,763	148,653	17.48%	10.53%
			In-State	S	460,773	304,702	156,071	20.22%	10.36%
9920	Sumter	On I-75 (South of Ocala)	Out-State	N	120,676	78,240	42,436	12.04%	6.53%
			In-State	S	211,959	140,462	71,497	18.25%	9.29%
9923	Nassau	On I-95 South of the State Line	Out-State	N	784,854	552,274	232,580	16.52%	6.96%
			In-State	S	1,037,291	710,148	327,143	22.55%	10.39%

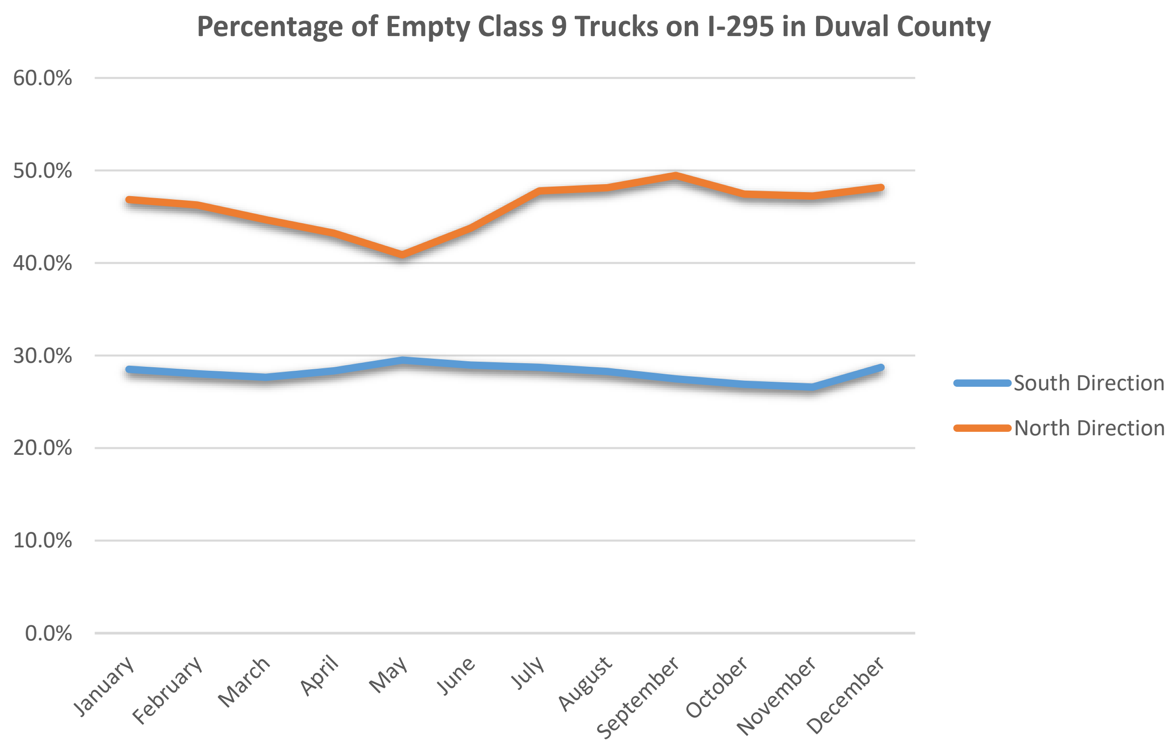
Site	County	Location	In-State/ Out-State	Direction	Number of Trucks			Percentage of Total	
					Total Class 9 Trucks (40,000 <= GrossWt < 60,000)	Uniformly Distributed - No Capacity for additional Cargo	Uneven Distributed - Capacity exists for additional Cargo	Percentage of "Full" Trucks	Percentage of "Partially Empty" Trucks
9936	Columbia	On I-10	In-State	E	515,105	356,847	158,258	21.61%	9.58%
			Out-State	W	368,524	244,453	124,071	16.19%	8.22%
9949	Escambia	On I-10 near Pensacola	In-State	E	444,788	321,336	123,452	21.13%	8.12%

Site	County	Location	In-State/ Out-State	Direction	Number of Trucks: Total Class 9 Trucks (40,000 <= GrossWt < 60,000)	Number of Trucks: Uniformly Distributed - No Capacity for additional Cargo	Number of Trucks: Uneven Distributed - Capacity exists for additional Cargo	Percentage of Total: Percentage of "Full" Trucks	Percentage of Total: Percentage of "Partially Empty" Trucks
		East of the State Line	Out-State	W	347,517	233,797	113,720	16.47%	8.01%
9950	Collier	On I-75	Out-State	N	228,191	125,597	102,594	12.51%	10.22%
		(Naples, Fl)	In-State	S	267,916	152,486	115,430	16.02%	12.13%
9951	Polk	On I-4	In-State	E	502,041	329,435	172,606	18.61%	9.75%
		(East of Lakeland)	Out-State	W	486,221	293,746	192,475	13.71%	8.98%
9952	Palm Beach	On I-95	Out-State	N	367,397	221,984	145,413	14.07%	9.22%
		(West Palm Beach, Fl)	In-State	S	616,746	362,551	254,195	19.84%	13.91%
9953	Hillsbourough	On I-75	Out-State	N	40,751	26,218	14,533	9.76%	5.41%
		(Tampa, Fl)	In-State	S	177,705	109,648	68,057	14.99%	9.30%
9956	Hamilton	On I-75	Out-State	N	170,810	111,570	59,240	14.33%	7.61%
		South of the State Line	In-State	S	275,356	181,980	93,376	22.14%	11.36%

APPENDIX I – Empty Trucks by Month

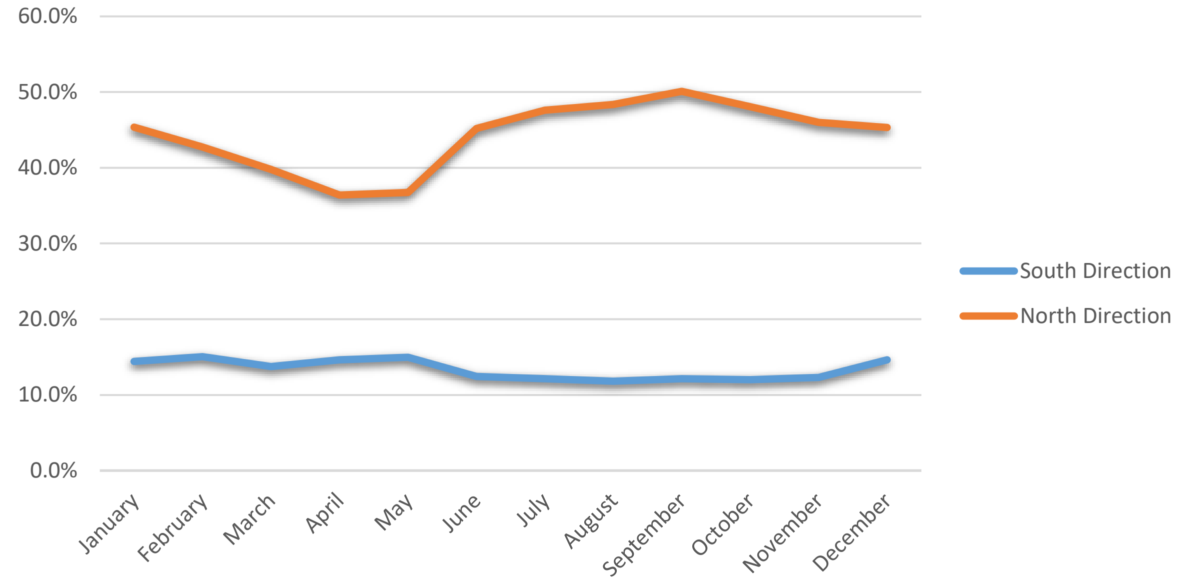


Note: Data presented here is a 3-year average of the percentage of empty trucks by month of the year



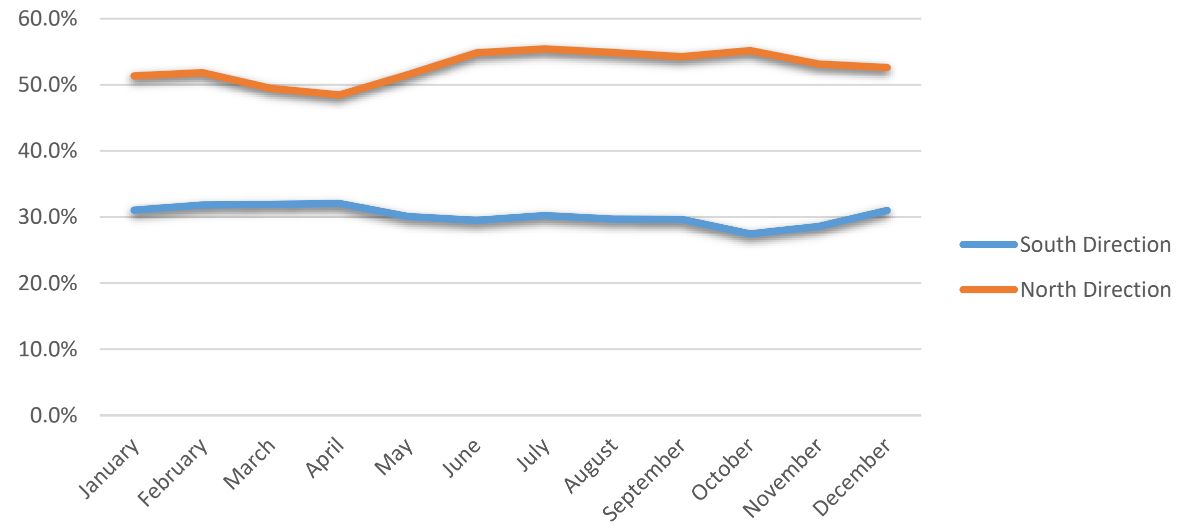
Note: Data presented here is a 3-year average of the percentage of empty trucks by month of the year

Percentage of Empty Class 9 Trucks on I-95 in Brevard County

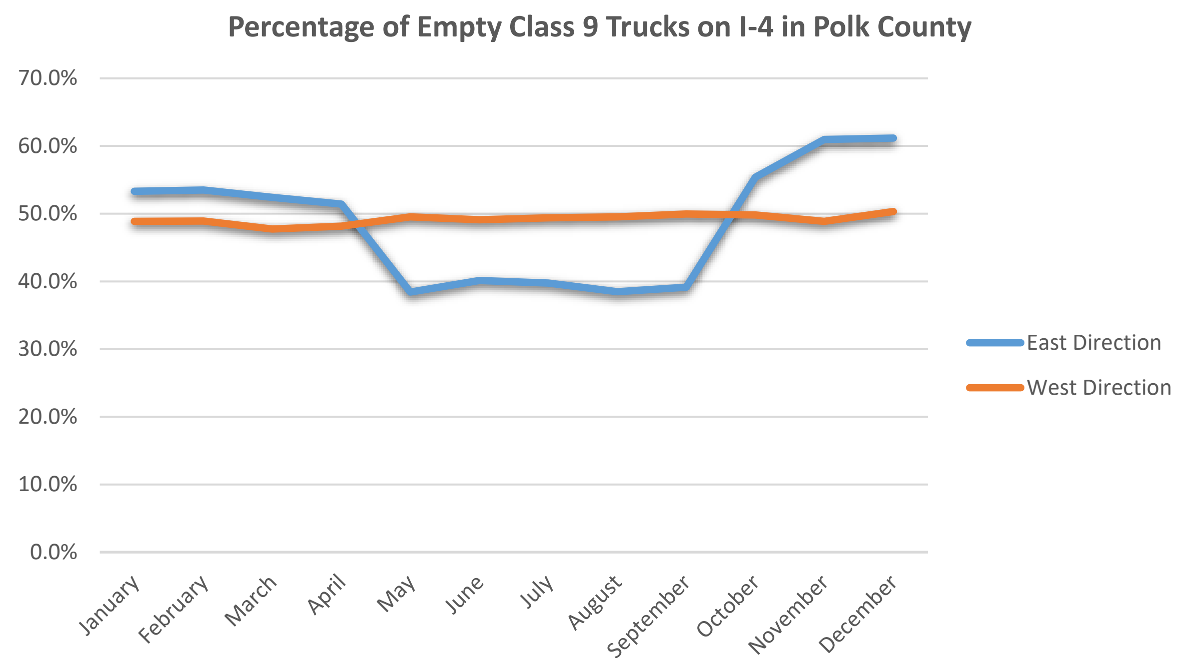


Note: Data presented here is a 3-year average of the percentage of empty trucks by month of the year

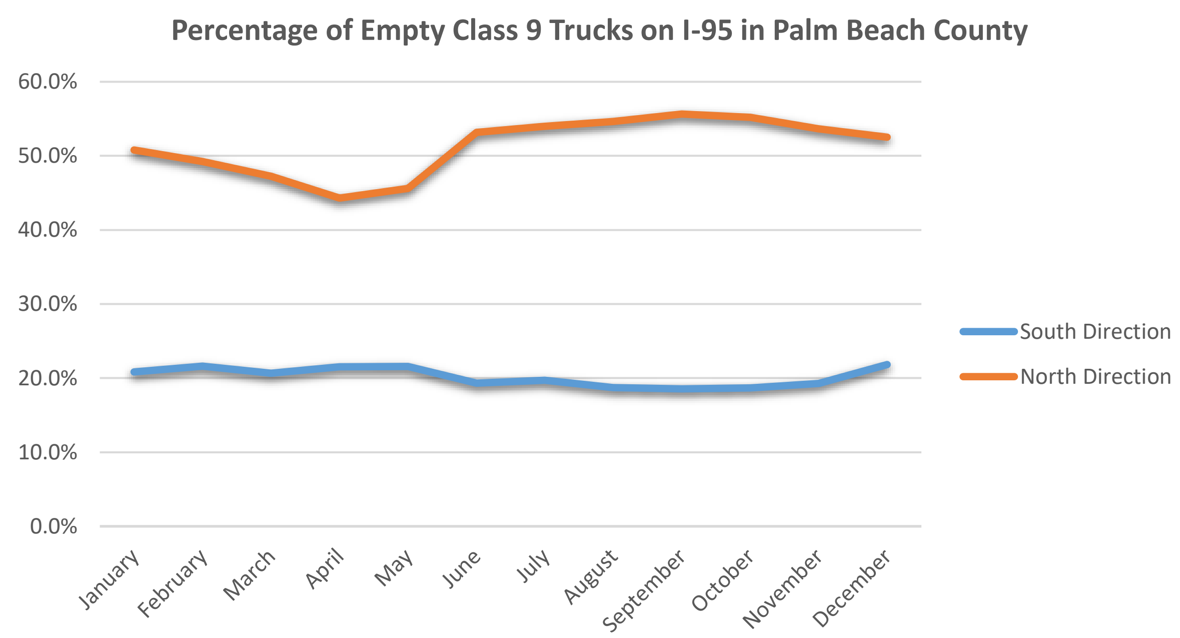
Percentage of Empty Class 9 Trucks on I-75 in Collier County



Note: Data presented here is a 3-year average of the percentage of empty trucks by month of the year

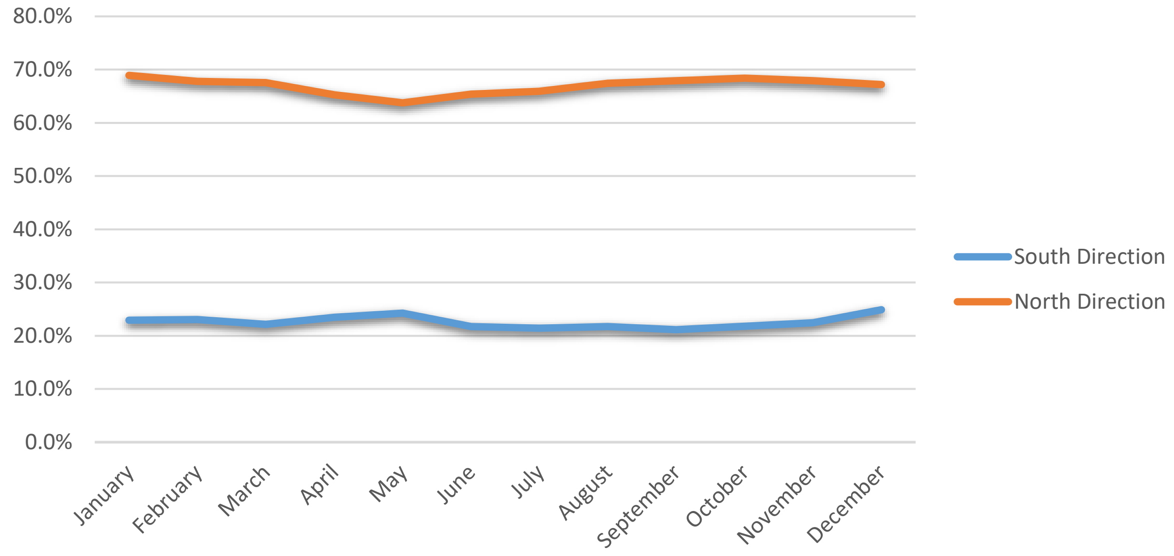


Note: Data presented here is a 3-year average of the percentage of empty trucks by month of the year



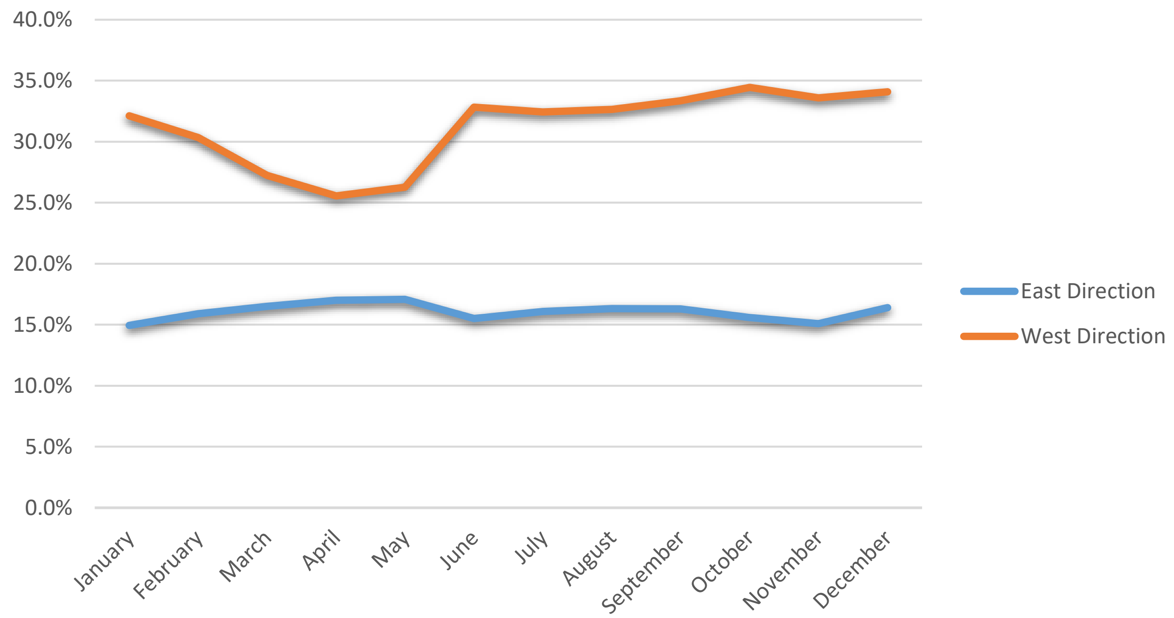
Note: Data presented here is a 3-year average of the percentage of empty trucks by month of the year

Percentage of Empty Class 9 Trucks on I-75 in Hillsborough County

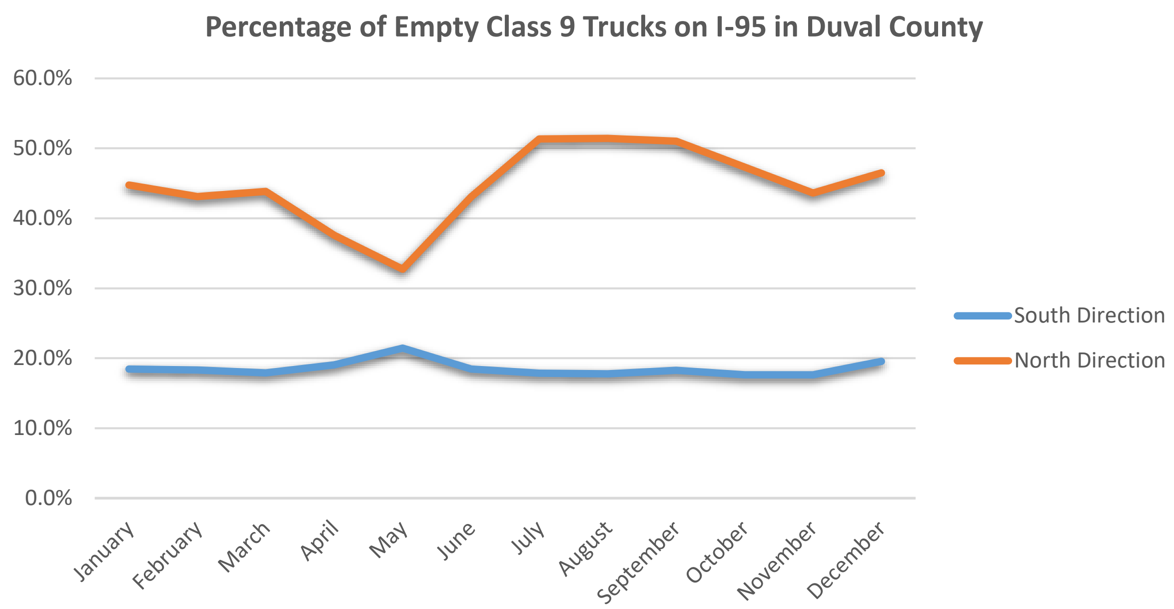


Note: Data presented here is a 3-year average of the percentage of empty trucks by month of the year

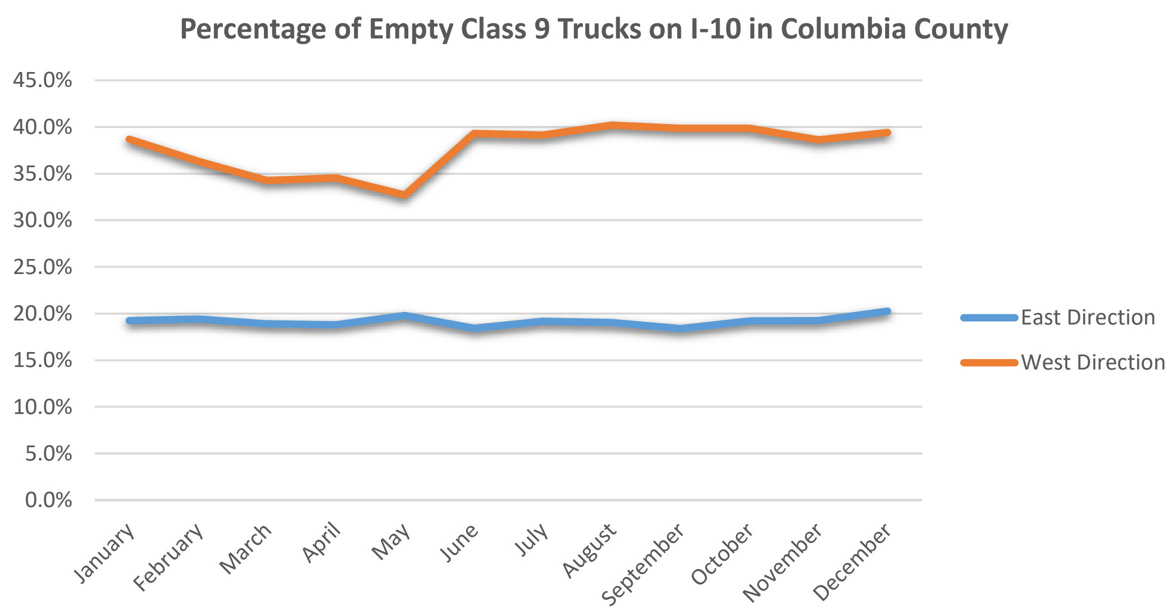
Percentage of Empty Class 9 Trucks on I-10 in Madison County



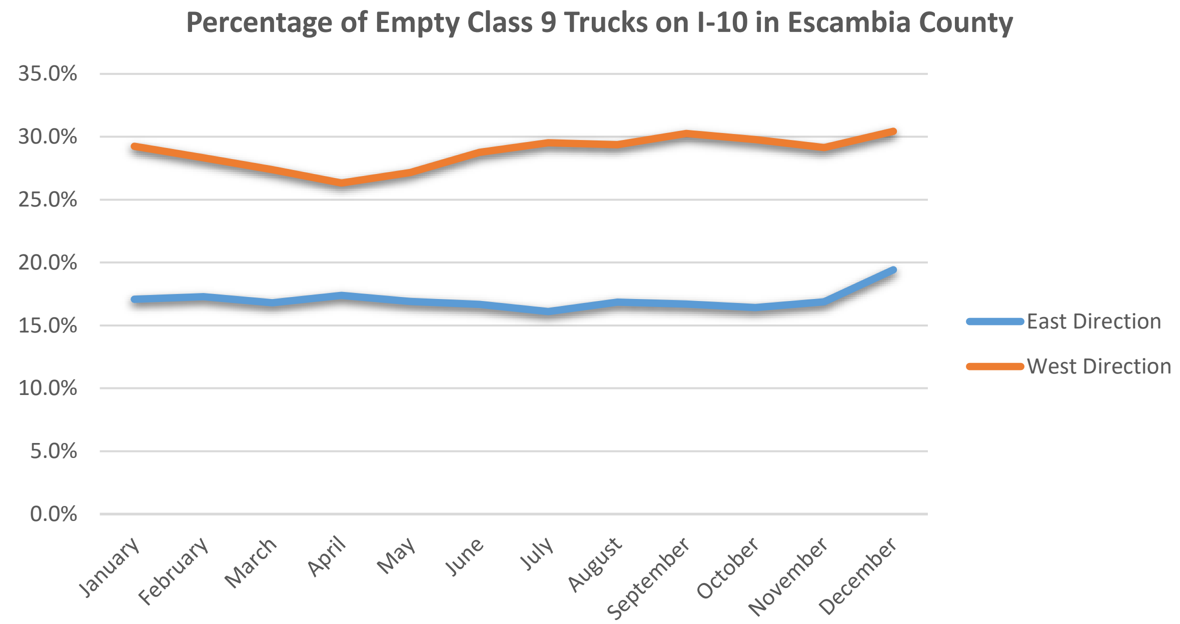
Note: Data presented here is a 3-year average of the percentage of empty trucks by month of the year



Note: Data presented here is a 3-year average of the percentage of empty trucks by month of the year



Note: Data presented here is a 3-year average of the percentage of empty trucks by month of the year



Note: Data presented here is a 3-year average of the percentage of empty trucks by month of the year

APPENDIX J – Empty Trucks by Time of Day

Site	County	Location	Time of Day	Percentage of Empty Trucks		Gross Weight per unit length	
				East Direction	West Direction	East Direction	West Direction
9902	Madison	On I-10	1	14.5%	21.0%	1035	983
			2	12.5%	23.4%	1039	972
			3	13.9%	24.3%	1032	954
			4	15.7%	23.8%	1023	956
			5	19.5%	30.4%	1005	928
			6	17.3%	30.2%	1019	937
			7	18.6%	32.8%	1015	924
			8	17.1%	29.8%	1019	940
			9	16.6%	30.0%	1018	942
			10	17.3%	32.0%	1008	928
			11	17.3%	34.2%	1008	917
			12	18.4%	37.3%	1004	895
			13	19.6%	39.0%	997	885
			14	19.1%	38.3%	995	885
			15	18.7%	35.5%	993	900
			16	17.8%	34.0%	998	912
			17	16.7%	32.0%	1005	923
			18	15.6%	30.4%	1013	931
			19	14.2%	29.3%	1022	932
			20	11.6%	27.7%	1037	939
			21	12.3%	27.7%	1036	942
			22	12.1%	26.7%	1034	946
			23	13.3%	25.5%	1034	958
			24	13.9%	21.9%	1035	977

Site	County	Location	Time of Day	Percentage of Empty Trucks		Gross Weight per unit length	
				South Direction	North Direction	South Direction	North Direction
9905	Duval	On I-95 (South of Jacksonville)	1	15.4%	34.0%	1003	919
			2	13.8%	33.4%	1009	918
			3	16.1%	33.6%	994	917
			4	16.9%	32.7%	1005	931
			5	17.0%	35.1%	1021	923
			6	18.2%	36.5%	1021	918
			7	18.4%	38.7%	1029	906
			8	20.6%	41.0%	1006	886
			9	23.6%	43.5%	979	865
			10	25.0%	45.9%	967	853
			11	24.2%	49.9%	973	830
			12	24.1%	53.1%	975	810
			13	23.5%	53.5%	979	809
			14	22.2%	53.0%	985	810
			15	20.0%	50.8%	993	816
			16	18.0%	48.5%	1002	822
			17	16.3%	45.6%	1008	837
			18	15.6%	41.9%	1004	858
			19	14.0%	38.4%	1009	879
			20	14.1%	36.0%	1006	897
			21	14.1%	34.6%	1001	912
			22	15.2%	34.4%	988	918
			23	14.0%	32.8%	998	926
			24	14.7%	32.7%	1007	929

Site	County	Location	Time of Day	Percentage of Empty Trucks		Gross Weight per unit length	
				East Direction	West Direction	East Direction	West Direction
9906	Volusia	On I-4 (North of Orlando)	1	37.4%	26.6%	888	903
			2	38.5%	24.0%	885	933
			3	41.0%	25.3%	875	921
			4	40.1%	28.1%	876	902
			5	40.4%	26.1%	881	922
			6	42.6%	26.1%	889	935
			7	45.6%	28.4%	867	928
			8	49.1%	30.2%	838	913
			9	56.6%	33.5%	783	890
			10	62.1%	36.6%	747	870
			11	62.5%	38.2%	748	857
			12	61.0%	40.1%	756	850
			13	57.6%	38.6%	777	860
			14	55.5%	39.2%	786	857
			15	53.4%	39.6%	794	855
			16	49.6%	39.5%	816	851
			17	46.0%	37.3%	834	860
			18	44.4%	33.8%	842	877
			19	41.1%	31.9%	862	886
			20	40.3%	28.0%	875	903
			21	38.9%	25.5%	879	914
			22	37.0%	25.9%	891	914
			23	38.3%	26.5%	889	906
			24	37.1%	27.1%	897	895

Site	County	Location	Time of Day	Percentage of Empty Trucks		Gross Weight per unit length	
				South Direction	North Direction	South Direction	North Direction
9914	Duval	On I-295 (West of Jacksonville)	1	23.3%	37.3%	976	893
			2	23.6%	41.4%	975	869
			3	23.3%	41.1%	983	869
			4	22.3%	40.3%	1000	887
			5	23.9%	39.0%	1006	898
			6	25.9%	39.5%	994	903
			7	25.8%	40.1%	992	899
			8	27.6%	42.0%	984	887
			9	31.2%	46.6%	963	855
			10	35.5%	50.4%	929	831
			11	35.6%	51.9%	926	822
			12	35.9%	51.7%	923	822
			13	34.8%	52.0%	931	821
			14	32.3%	51.5%	943	824
			15	31.1%	51.2%	947	825
			16	29.0%	49.6%	954	825
			17	27.0%	47.9%	964	830
			18	23.7%	45.4%	980	842
			19	21.9%	43.3%	983	853
			20	19.9%	40.3%	983	877
			21	19.0%	37.5%	983	893
			22	19.9%	35.7%	986	907
			23	20.6%	36.8%	985	907
			24	21.2%	34.8%	988	915

Site	County	Location	Time of Day	Percentage of Empty Trucks		Gross Weight per unit length	
				South Direction	North Direction	South Direction	North Direction
9919	Brevard	On I-95	1	10.8%	34.7%	1042	889
			2	9.6%	34.1%	1061	895
			3	9.2%	36.8%	1077	887
			4	9.9%	40.0%	1097	876
			5	10.5%	42.6%	1075	866
			6	9.6%	44.7%	1103	859
			7	10.7%	48.1%	1124	844
			8	11.9%	46.8%	1112	847
			9	14.6%	46.1%	1079	859
			10	19.7%	48.3%	1047	836
			11	19.9%	50.0%	1044	833
			12	19.7%	51.7%	1039	816
			13	19.9%	51.0%	1034	820
			14	18.8%	49.6%	1034	829
			15	17.6%	48.0%	1032	839
			16	16.5%	45.3%	1043	855
			17	14.5%	42.8%	1057	871
			18	13.6%	39.3%	1058	887
			19	11.3%	39.5%	1073	876
			20	9.2%	39.4%	1077	875
			21	8.4%	38.3%	1078	879
			22	9.3%	38.2%	1071	880
			23	8.5%	36.9%	1062	886
			24	8.8%	34.8%	1068	886

Site	County	Location	Time of Day	Percentage of Empty Trucks		Gross Weight per unit length	
				South Direction	North Direction	South Direction	North Direction
9923	Nassau	On I-95 (South of the State Line)	1	10.4%	26.5%	1041	973
			2	10.2%	28.3%	1042	970
			3	10.2%	29.9%	1051	959
			4	10.2%	31.9%	1056	953
			5	11.2%	32.8%	1056	969
			6	13.1%	37.1%	1049	944
			7	13.1%	39.0%	1043	926
			8	13.0%	39.8%	1046	919
			9	14.8%	41.4%	1038	901
			10	15.5%	45.4%	1028	866
			11	16.7%	47.6%	1014	852
			12	17.0%	49.1%	1011	843
			13	17.1%	48.1%	1010	849
			14	16.4%	45.4%	1013	862
			15	15.9%	42.6%	1015	873
			16	14.7%	39.5%	1017	887
			17	13.5%	37.3%	1023	899
			18	12.7%	35.1%	1027	913
			19	11.3%	32.8%	1034	923
			20	10.3%	30.4%	1044	940
			21	10.5%	29.2%	1046	955
			22	10.1%	28.5%	1044	964
			23	10.4%	28.1%	1044	972
			24	10.4%	27.9%	1042	973

Site	County	Location	Time of Day	Percentage of Empty Trucks		Gross Weight per unit length	
				East Direction	West Direction	East Direction	West Direction
9936	Columbia	On I-10	1	14.8%	29.2%	999	964
			2	15.4%	29.7%	997	950
			3	13.9%	28.5%	1006	967
			4	14.3%	32.2%	1012	957
			5	14.4%	30.9%	1023	976
			6	18.6%	34.1%	1004	967
			7	18.4%	34.3%	1009	959
			8	18.9%	36.7%	1007	946
			9	19.3%	42.4%	1002	909
			10	21.1%	46.4%	992	878
			11	22.3%	48.1%	985	859
			12	23.4%	47.4%	981	862
			13	24.7%	45.4%	975	870
			14	24.4%	41.9%	971	887
			15	24.4%	40.4%	965	902
			16	23.4%	38.7%	961	906
			17	21.5%	37.8%	970	910
			18	19.2%	35.7%	984	917
			19	17.3%	33.4%	995	925
			20	15.2%	32.5%	1007	931
			21	14.7%	31.2%	1011	933
			22	13.1%	29.8%	1020	942
			23	13.4%	26.9%	1021	964
			24	14.3%	27.6%	1011	966

Site	County	Location	Time of Day	Percentage of Empty Trucks		Gross Weight per unit length	
				East Direction	West Direction	East Direction	West Direction
9949	Escambia	On I-10 (East of the State Line)	1	13.0%	20.0%	1027	1000
			2	14.2%	21.6%	1018	993
			3	15.3%	25.8%	1016	972
			4	12.6%	27.2%	1044	973
			5	17.5%	25.3%	1028	982
			6	16.5%	27.5%	1031	981
			7	19.1%	31.0%	1012	954
			8	19.8%	32.8%	1008	943
			9	19.7%	29.8%	995	952
			10	19.8%	31.6%	997	939
			11	20.2%	32.6%	990	933
			12	20.2%	31.7%	992	941
			13	19.0%	32.2%	1001	943
			14	18.0%	31.9%	1013	953
			15	17.4%	33.2%	1014	944
			16	17.1%	31.9%	1015	952
			17	16.5%	31.9%	1017	950
			18	15.6%	29.7%	1023	962
			19	16.0%	26.6%	1022	978
			20	14.5%	23.6%	1031	994
			21	12.9%	21.5%	1039	1004
			22	13.6%	20.3%	1031	1009
			23	13.1%	20.4%	1027	1001
			24	12.9%	21.7%	1029	987

Site	County	Location	Time of Day	Percentage of Empty Trucks		Gross Weight per unit length	
				South Direction	North Direction	South Direction	North Direction
9950	Collier	On I-75 (Naples, Fl)	1	25.5%	41.2%	948	863
			2	21.9%	38.6%	1006	882
			3	16.2%	38.7%	1051	888
			4	18.7%	43.2%	1049	885
			5	20.7%	50.6%	1041	874
			6	19.7%	46.5%	1034	914
			7	21.2%	44.6%	1044	917
			8	22.3%	48.7%	1018	889
			9	29.1%	56.3%	988	826
			10	34.7%	59.1%	954	808
			11	34.9%	59.8%	955	807
			12	36.7%	58.6%	945	815
			13	38.0%	57.4%	936	824
			14	39.4%	57.9%	929	812
			15	39.0%	57.7%	924	808
			16	39.0%	56.3%	917	805
			17	38.7%	54.7%	908	803
			18	34.8%	51.0%	927	814
			19	28.6%	49.5%	969	811
			20	26.6%	43.8%	978	831
			21	27.3%	43.6%	954	831
			22	24.5%	44.0%	950	832
			23	23.5%	43.1%	949	839
			24	24.4%	39.3%	950	874

Site	County	Location	Time of Day	Percentage of Empty Trucks		Gross Weight per unit length	
				East Direction	West Direction	East Direction	West Direction
9951	Polk	On I-4 (East of Lakeland)	1	38.7%	43.2%	887	852
			2	39.9%	41.7%	881	868
			3	40.9%	42.0%	880	872
			4	41.4%	39.5%	882	884
			5	39.9%	38.4%	904	906
			6	39.2%	37.0%	899	924
			7	41.0%	38.7%	884	907
			8	44.1%	43.3%	863	879
			9	49.0%	49.5%	819	839
			10	50.9%	53.9%	805	811
			11	51.1%	56.3%	801	799
			12	50.9%	56.3%	806	801
			13	50.4%	55.7%	805	807
			14	50.5%	55.5%	801	810
			15	49.5%	56.1%	805	805
			16	47.5%	56.1%	813	803
			17	45.6%	56.0%	827	795
			18	43.4%	53.8%	839	804
			19	42.0%	50.0%	844	830
			20	38.9%	47.1%	870	847
			21	36.0%	44.3%	899	858
			22	35.8%	43.1%	901	865
			23	35.6%	41.0%	906	872
			24	38.1%	43.1%	892	856

\

Site	County	Location	Time of Day	Percentage of Empty Trucks		Gross Weight per unit length	
				South Direction	North Direction	South Direction	North Direction
9952	Palm Beach	On I-95 (West Palm Beach, Fl)	1	16.4%	39.6%	983	875
			2	16.5%	44.9%	980	848
			3	15.9%	38.9%	981	897
			4	14.1%	40.5%	998	912
			5	14.5%	38.0%	994	943
			6	14.5%	49.5%	1000	876
			7	15.6%	54.0%	993	840
			8	17.8%	57.9%	983	811
			9	19.4%	61.7%	980	761
			10	22.6%	63.4%	972	740
			11	25.5%	63.2%	956	743
			12	27.6%	61.7%	942	749
			13	28.7%	59.0%	933	762
			14	29.0%	55.2%	933	779
			15	30.2%	52.3%	928	794
			16	28.5%	48.9%	933	812
			17	24.8%	47.6%	947	819
			18	22.8%	46.6%	956	826
			19	20.5%	43.6%	966	841
			20	18.3%	42.4%	979	843
			21	16.4%	41.8%	987	842
			22	16.6%	38.1%	980	870
			23	15.2%	36.1%	992	879
			24	14.5%	36.0%	996	881

Site	County	Location	Time of Day	Percentage of Empty Trucks		Gross Weight per unit length	
				South Direction	North Direction	South Direction	North Direction
9953	Hillsborough	On I-75	1	16.4%	72.4%	1066	671
			2	14.8%	72.9%	1086	673
			3	12.9%	73.0%	1112	671
			4	15.0%	75.1%	1113	663
			5	17.5%	64.8%	1111	728
			6	17.0%	67.9%	1128	728
			7	18.7%	65.6%	1122	749
			8	22.6%	71.2%	1084	724
			9	23.8%	73.1%	1062	707
			10	25.9%	70.4%	1044	716
			11	27.0%	69.3%	1036	721
			12	29.1%	69.3%	1031	723
			13	30.1%	68.8%	1022	734
			14	31.6%	68.0%	1007	736
			15	29.7%	66.1%	1021	754
			16	28.9%	66.7%	1021	753
			17	27.2%	64.4%	1029	764
			18	24.2%	62.9%	1048	757
			19	21.1%	63.1%	1060	748
			20	17.9%	57.3%	1086	766
			21	16.0%	51.6%	1097	793
			22	14.8%	60.7%	1093	728
			23	14.9%	64.8%	1082	717
			24	16.2%	68.8%	1075	696

Site	County	Location	Time of Day	Percentage of Empty Trucks		Gross Weight per unit length	
				South Direction	North Direction	South Direction	North Direction
9956	Hamilton	On I-75 (South of the State Line)	1	7.5%	39.7%	1049	888
			2	7.1%	42.0%	1055	880
			3	7.0%	43.4%	1067	873
			4	8.3%	43.0%	1067	878
			5	9.1%	42.1%	1071	900
			6	9.8%	43.2%	1075	906
			7	10.2%	45.0%	1073	895
			8	12.4%	45.7%	1060	880
			9	12.7%	47.6%	1052	865
			10	14.0%	52.6%	1035	833
			11	14.7%	56.9%	1028	810
			12	15.4%	58.3%	1022	804
			13	14.7%	57.2%	1021	806
			14	14.0%	56.5%	1025	812
			15	13.4%	53.6%	1031	830
			16	12.5%	49.8%	1036	854
			17	11.5%	47.2%	1040	869
			18	10.7%	45.7%	1045	875
			19	9.9%	43.4%	1049	888
			20	9.5%	42.2%	1047	889
			21	9.1%	41.4%	1044	893
			22	8.8%	40.6%	1044	896
			23	8.3%	40.0%	1038	893
			24	7.7%	40.2%	1044	890

Page intentionally left blank.

Florida Department of Transportation
Transportation Data & Analytics Office
605 Suwannee St., MS 27
Tallahassee, FL 32301
Office (850) 414-4714
http://www.fdot.gov/statistics/